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The 2014–2015 Ebola virus disease (EVD) epidemic and international public health emergency has been referred to as a “black swan” event, or an event that is unlikely, hard to predict, and highly impactful once it occurs. The Chicago Ebola Response Network (CERN) was formed in response to EVD and is capable of receiving and managing new cases of EVD, while also laying the foundation for a public health network that can anticipate, manage, and prevent the next black swan public health event. By sharing expertise, risk, and resources among 4 major academic centers, Chicago created a sustainable network to respond to the latest in a series of public health emergencies. In this respect, CERN is a roadmap for how a region can prepare to respond to public health emergencies, thereby preventing negative impacts through planning and implementation.

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The 2014–2015 Ebola virus disease epidemic (EVD) and international public health emergency has been referred to as a “black swan” event, or an event that is unlikely, hard to predict, and highly impactful once it occurs [1]. As the epidemic has unfolded, causing unprecedented morbidity and mortality to some West African nations, it has emphasized the global impact that highly infectious diseases can have on populations and governments in the modern era. As cases of both imported and locally acquired EVD occurred in the United States, public health officials and healthcare systems have been required to develop strategies for the prevention and control of new infections, communicate to the public about risk, and develop new approaches to ensure the protection of patients, healthcare personnel, and the community.

When viewed through the lens of public health preparedness, EVD is one in a multiyear series of complicated public health events and emergencies that includes bioterrorism, natural disasters, pandemics, and emerging infections. EVD has also highlighted, yet again, the instrumental role that municipal, state, and federal public health leaders play in the control and response to emerging diseases and black swan public health events. Similar to other models of emergency preparedness, a robust and integrated public health infrastructure is required to respond to rare but highly infectious diseases. The benefit of this model is shared responsibility for managing events in a geographic area that might be impractical for any one organization to serve. In the setting of national reductions in funding for public health [2], resource and expertise sharing between public and private partners can complement existing resources, yielding more efficient and comprehensive programs.

Chicago, Illinois, is the third largest city in the United States and, according to the Chicago Department of Aviation, boasts the busiest international airport in the world in terms of annual aircraft operations and the third largest number of arrivals and departures. In
addition, up to 30 passengers from the West African countries previously affected by this EVD event arrive on a daily basis. As the public health response to EVD in the United States has matured, the healthcare and public health community in Chicago rapidly responded with a unique and scalable partnership that shared responsibility among academic medical centers while ensuring the greatest benefit for citizens in the community it serves. Several complementary factors led to the decision to develop a network: Chicago as a national central entry point due to a high-volume airport; a large resident population with a local West African community; and a strong collaboration between academic medical centers and the city public health department. The Chicago Ebola Resource Network (CERN) represents a unique approach to defining a center capable of receiving and managing new cases of EVD, while also laying the foundation for a public health network that can anticipate, manage, and prevent the next black swan public health event. The features of the CERN include shared expertise, risk, and resources. This article describes how the benefits of this approach far outweigh any potential weaknesses, thereby ensuring sustainability for the future and the strength of greater community participation. In addition, this approach specifically aligns well with the national goal of having "a multipronged strategy to ensure vigilance and capacity to respond to all health threats" [2]. A unique feature of this network is collaboration among academic medical centers with shared responsibility and risk coordinated by the local health department to ensure a regional approach that is sustainable and poised for current and future threats, which is a unique advantage over reliance on a single organization, no matter the expertise and capacity of that center.

NETWORK ORGANIZATION AND OPERATIONS

On 16 October 2014, in response to the diagnosis of the first case of EVD in the United States in Dallas, Texas, leaders from several Chicago hospitals met with leadership at the Chicago Department of Public Health (CDPH) to discuss strategies for responding to potential cases of EVD in Chicago. Although unique challenges for responding to EVD were identified by each facility, a common goal of optimizing patient, healthcare worker, and public safety as well as service to the community was identified. It was agreed that a swift response was needed and that a network of hospitals working together would provide the essential infrastructure to respond effectively and efficiently. The next day, Mayor Rahm Emanuel announced the development of CERN. This network, coordinated by CDPH, included representatives from 4 academic medical centers—Lurie Children’s Hospital, Northwestern Memorial Hospital, Rush University Medical Center, and the University of Chicago Medicine—boasting an immediate capability to care for up to 4 adults and 2 children simultaneously.

The operational objective of the network is to ensure that adult and pediatric patients with confirmed or suspected EVD could be identified and promptly referred to a CERN hospital for additional evaluation and medical care in a timely fashion to permit the immediate initiation of care. Thus, CDPH worked with officials at O’Hare Airport and portals of entry into the healthcare system in Chicago (ie, all hospitals, emergency departments, urgent care centers, and clinics) to ensure consistent symptom screening for all patients with recent travel from affected areas of West Africa. If a new person under investigation (PUI) was identified at O’Hare or in the community, CDPH’s Chief Medical Officer was notified by officials at O’Hare Airport, the referring medical facility, or emergency medical services (EMS) providers. If it was determined that a PUI required additional evaluation or care, the patient was transferred to a CERN facility by EMS providers trained to do so using appropriate infection control measures. A rotation of CERN hospitals to evaluate PUIs was predetermined. After CDPH’s Chief Medical Officer (CMO) confirmed the on-call hospital’s readiness in consultation with the hospital’s CMO, the PUIs were transferred to the appropriate CERN hospital. The working standard was to transfer the patient to the CERN facility within 1 hour. After a CERN hospital accepted a PUI, that facility was placed at the end of the rotation, allowing the facility time to replenish its resources (eg, personal protective equipment [PPE]) and to evaluate and share its experiences with the other CERN hospitals.

The network demonstrated the benefits of the high level of coordination and cooperation: Although the initial 2 PUI cases required >6 hours for preparation and isolation, the last 3 cases required <1 hour each. In addition, the evaluation of PUI cases has been prompt; for example, in one PUI, arrival and isolation occurred at 4:30 PM, and with immediate blood draws and diagnostic workup, a malaria smear and diagnosis were complete by 10:30 PM.

ADVANTAGES TO THE NETWORK APPROACH

Shared Expertise

A major strength of this approach is the sharing of skills and knowledge between academic medical centers in the network and public health system, through engagement of state and local public health officials. Following the first cases of EVD transmission in the United States, confusion and dissent regarding best practices were present at the national level. Nonetheless, individual healthcare organizations needed to make quick decisions on how to care for these patients while optimally protecting healthcare workers, at times without a compelling evidence base to guide these decisions. With 6 former or current Centers for Disease Control and Prevention epidemic intelligence service officers, access to biosafety experts from the Argonne National Laboratory, nationally acclaimed critical care physicians,
infection control and infectious disease experts experienced in controlling transmission of highly infectious agents such as plague and vaccinia, regional leaders in bioterror preparedness, experts in clinical bioethics, and biohazard and public health laboratory safety experts at the table, CERN was able to make informed decisions quickly and easily. Shared experiences and strengths led to rapid development and adoption of CERN standards including use of level 3 biohazard PPE in containment units; development of standard operating procedures guided by experienced biohazard laboratory staff; high-level and ongoing training with assessment of competency; presence of observers at every step in the care process; and commitment to providing advanced care such as dialysis, ventilatory support, obstetric and neonatal care, urgent surgical procedures, and even resuscitation using only voluntary staffing. These early decisions were designed to ensure that CERN hospitals would meet or exceed the standards of existing containment isolation centers such as Emory and Nebraska. Collectively, this expertise has been applied to allow CERN facilities to safely care for PUIs without breaches in infection control. Additionally, CERN is prepared to care for 4 active adult patients simultaneously.

**Shared Risk**

For healthcare systems willing and able to extend resources and expertise to manage patients with potential EVD, the organizational risks are potentially significant and must be considered. For the Dallas hospital that cared for the first patient with EVD with subsequent US transmission, the financial cost was estimated at $384,000 [3], with the additional and substantial intangible costs of reputational impact [4] and costs associated with the care of employees who secondarily contracted EVD. These concerns for reputational harm and potential loss of market share, loss of community confidence, and, perhaps most important, compromise of the confidence of facility staff and clinicians are real. In contrast, our network has emphasized the benefits of cooperation, while reducing the financial and public relations challenges in becoming unfortunately stigmatized as the single “Ebola hospital.” An additional major advantage of the shared risk approach is that by having a large consortium of stakeholders, healthcare workers are less inclined to feel that their institution is placing an unnecessary and disproportionate risk to their personal workplace. As PUI cases emerge from airport screening procedures, it is a network that is a regional resource. This framing of a team role, as part of a coordinated public health response, assures fears that might exist among administrators, boards of governance, and even corporate overseers. Public fears can also be allayed: With numbers comes strength, and the public health response is seen as robust and coordinated, not siloed and ad hoc. Finally, a very real benefit is provided to healthcare workers: With a larger workforce and a broader base of centers caring for potential cases, time for rest and recovery between PUI cases (and thereby less risk of infection control breaches) is created by network participation. Time between cases also provides each facility with time to objectively assess its experience with providing care to a suspected patient and share its insight with other network members. This permits effective modifications to network hospital operating procedures in real time, further improving care to future PUIs and optimizing healthcare worker safety.

**Shared Resources**

From a regional and national perspective, CERN provides perhaps its largest benefit through shared resources. By developing the network, Chicago has created increased capacity within a single region. This allows patients and families to remain close to home in many cases, and obviates the need for secondary transport and may potentially reduce issues of challenging housing needs for a family. An additional benefit is the resulting flexibility in patient distribution. By having a combination of primarily adult sites, a dedicated pediatric center, and an adult and pediatric hospital on a shared campus, the network has allowed seemingly limitless possibilities to meet the needs of patients and families. This was achieved without having to manage the complexity of shared credentialing or liability, as care was provided within the existing infrastructure of established medical centers. As a network, we are now ready to accommodate ill family members of PUIs or handle the possibility of ≥2 cases simultaneously without dramatically interrupting clinical operations at a single facility. We also have reserve capacity for a variety of scenarios, including a shortage of healthcare workers, PPE, and laboratory equipment, or other disaster-related situations that might affect a facility. Individual areas of expertise also enhanced the network. For example, the complexity of managing issues related to the care of children, such as facilities and personnel aspects of biocontainment, would have been extremely difficult to surmount in a single institution, as there are significant age-related and developmental issues that need to be factored into staffing, workflows, and facility design for a biocontainment program for children. By including 2 dedicated facilities for care of children, the requisite expertise and resources were present at the network development and implementation phases to permit seamless care for children who were under investigation for EVD. Clinical protocols and just-in-time training content, while retaining the nuances of local practice, share consensus best practices across facilities. Sites have standardized regarding PPE type and quantity to have in preparation for events. Discussions for shared credentialing are in progress among the network sites.

**POTENTIAL WEAKNESSES OF THE NETWORK APPROACH**

Although the value of the network approach seems evident, we do appreciate the potential weaknesses of our approach.
Coordinating an effort as large as ours required time and commitment from all participating centers. As we have described, executive leadership and health department oversight were critical aspects in our evolution. A second issue is that establishing a comprehensive network requires a broad footprint of resources, with a high level of dedication of partners to the issue being addressed. Other limitations are that the network has an inpatient focus for hospitalized patients and their isolation and care and that sites must be collaborative to ensure that external funding and patient allocation are managed equitably. Finally, non-network providers must be engaged during the process to meet the basic demands of screening, assessment, and stabilization. Once created, however, the network preserves the essential role of the local health department as a coordinator of public engagement and response as a part of a public health response system. The network can also serve as a regional resource for best practice and education for the public health system in the instance of primarily outpatient diseases (eg, 2009 H1N1) or diseases that require the involvement of more hospitals due to disease burden.

MANAGING THE NEXT BLACK SWAN

EVD has been thought to be a rare and unexpected event, pushing the public and clinical health communities to be prepared to provide care in uncertain conditions; however, it is almost certainly true that another rare and unexpected event awaits. Whether that event is a new pandemic such as influenza, or a highly infectious respiratory virus such as measles, creating networks that can enable a rapid response will be critical to protecting the public health. In this respect, CERN is a roadmap for how a region can prepare to respond to public health emergencies, thereby preventing negative impacts through planning and implementation. By developing the relationships and connections necessary for a coordinated response, the network allows for familiarity among key hospital personnel, including clinical staff, EMS transport, communications, and public health. By developing the shared infrastructure for a response, the network takes the focus away from EVD and places emphasis on a bigger picture: preparation as a community at large for containment of and to care for patients with highly infectious diseases. Finally, by enacting a network to manage potential EVD cases, we have created an active, functional system that exists and is in use; by sustaining and maintaining it, the network ensures that our public health response for the next event will be real and robust, not merely simulated and planned.

Note

Potential conflicts of interest. All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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