The Response Capability of Designated Special Pathogen Assessment and Treatment Centers: Staffing a Major Health Incident

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Abstract

Healthcare has had several experiences with epidemics in the last century. While most of the diseases associated with these epidemics are infectious, highly contagious without proper precautions, and sometimes untreatable with current treatment, few have generated the challenges associated with Ebola virus disease (EVD). The challenges are especially problematic related to the geographic location of the disease, its virulence, the high case fatality rate, and the rapidity with which the disease can spread. Recent developments with vaccines have helped control the continued threat from EVD, but many other special or unique pathogens still exist. Much of the literature is devoted to the epidemiologic aspects of the diseases: treatment, spread, and eradication. Until recently little was written about how treatment facilities should prepare for the spread of these diseases into areas of the world that so far have been unaffected. The clinical management requires highly specialized training, equipment, and physical facilities to ensure safe and efficient care for this population. Assessment and treatment hospitals have been challenged to develop and implement detailed staffing plans for Ebola and other special pathogens. This project used a descriptive comparative design to evaluate response capability by reviewing the staffing plans of two treatment and six assessment hospitals in the Commonwealth of Virginia to determine the similarities and differences among the designated centers. Each staffing plan was reviewed to determine to what extent recommended characteristics for staffing, as outlined by the 2014 CDC interim guidance, were included in each plan as well as characteristics specific to each center.

Keywords: Ebola, designated assessment and treatment hospitals, special pathogen preparedness

The Response Capability of Designated Special Pathogen Assessment and Treatment Centers: Staffing a Major Health Incident

According to the World Health Organization website (WHO, 2014a), Ebola virus disease (EVD) was first discovered in 1976 in remote villages in Central Africa near tropical rainforests. News surrounding this disease was relatively sparse until March, 2014 when the disease was identified along the borders of Guinea and Sierra Leone with subsequent spread to Liberia and Nigeria. The disease gained widespread attention when two American medical missionaries became infected. Both were treated with an experimental therapy and transferred to the United States for further treatment, and survived the infection.

For the last three decades Healthy People, a national agenda of health related priorities and wellness goals, has established national objectives every ten years to improve the health of all Americans. Recently an objective related to preparedness was added with the goal of improving our ability to prevent, prepare for, respond to, and recover from a major health incident. This objective involves government agencies, non-governmental organizations, private sector, communities, and individuals working together to achieve these goals (Healthy People, 2015).

In August, 2014, the realization that EVD could have a devastating global impact led to the development of preparedness initiatives in many hospitals across the United States. Large medical centers that were located near international airports where travelers from the West African countries might enter the country began to develop plans to care for the EVD population. Most realized very quickly that this could be one of the largest and most expensive endeavors they would ever experience.

There were several challenges related to the required equipment, training, and overall environment of care that needed to be addressed. Only a few centers had the resources necessary to prepare for such a large undertaking, but even with those available resources few healthcare professionals had ever cared for a population with a disease that demonstrated the infectious aggressiveness of EVD. This project focuses on the preparedness of hospitals and care providers through a review of staffing plan characteristics related to the care of the special pathogens populations receiving care in designated assessment and treatment centers in the Commonwealth of Virginia.

Background

Before examining the preparedness scenario in the United States healthcare system, some information related to the difficulties with preparedness in Africa may provide insight as to how the epidemic gained momentum in 2014. Prior to the most recent emergence of the disease, an assessment and evaluation of the disease, healthcare infrastructure, and preparedness of four counties in southeastern Liberia was conducted to determine the extent of the issues (Forrester, et al., 2014). There was one referral hospital in each county and all had outlying clinics. Referral hospitals were designated centers that focused on the special care needs of the population. Before the epidemic there were six physicians to serve the four counties. After the epidemic was announced only three physicians remained. Dr. Christiana Hena (2015), a Liberian physician speaking at a University of Virginia Global Health conference, related that numerous other physicians who were foreign nationals left the country soon after the announcement of the spread of the disease. Nursing staff were not reporting for work or had abandoned the facilities. In one facility providers had not been paid for more than three months, but they were still providing

care. In many cases care was being provided by nursing students, nurses' aides, and volunteers (WHO, 2014b).

Supplies were not available or, when available, there were not sufficient quantities to provide needed care. Items as common as gloves, handwashing facilities, and gowns were not available. Soap, bleach, and alcohol-based hand gel were also in short supply. Some facilities were without electricity, water, and waste disposal facilities.

Communication among facilities was difficult or non-existent. Cell phones and radios were the primary means of communication. Internet service was sporadic and, for the most part, non-existent in many areas of the region.

Transportation of specimens and patients relied on one ambulance in each county. Air transport was not available. Particularly devastating was the number of health care workers in Africa who developed EVD (678), with a commensurate fatality rate of fifty-one percent (WHO, 2014b).

The cultural aspects of an epidemic of this proportion were recognized by Boulton (2015) who noted that cultural beliefs and healthcare beliefs play an important role in the containment of an outbreak. In many areas of Africa the outbreak was associated with witchcraft with stories that a plane full of witches crashed and caused the epidemic.

Another story revolved around the myth of a snake kept in a box by a woman. Her husband, despite warnings, released the snake and it went on a killing spree (Estrada, 2014). These stories and a fear from the original messages communicated by health officials resulted in a marked decline of people seeking healthcare as well as distrust of the healthcare workers.

Theoretical Framework

Using a general systems theory (Bertalanffy, 1968), the characteristics of staffing plans related to special pathogens can be evaluated for their effectiveness and contribution to a desired outcome. Open systems theory (OST), a specific part of general systems theory, is a process that exchanges information with its environment. By examining the relationships between these elements (interaction), a specific outcome (output) can be achieved. The outcome can influence the environment (Katz and Kahn, 1978). In turn this can create a feedback to the input – in this case the staffing plan characteristics (Figure 1).

Review of the Literature

While many of the issues encountered in the African countries were not seen in the United States, preparing for and caring for patients with the disease in the United States is of paramount importance. The characteristics of staffing plans can vary widely based on the overall facility. Staffing plans and policies are not described widely in the literature. For this project a review of the literature related to healthcare providers and their perceptions of the elements of readiness provided some insight into the centers development, implementation, and review of the characteristics of current staffing plans.

Definitions

For the purpose of this project, ***referral center*** is defined as a facility that transfers a suspected patient to another facility for a higher level or specialized care. These facilities may also be described as a ***frontline hospital***. An ***assessment center*** is a facility designated by state and local health authorities as well as hospital administration and designed to care for a special pathogens patient in the initial stages of the disease. In the case of Ebola that period of time ends once a diagnosis is confirmed or ruled out and until discharge or transfer is completed. A ***treatment***

center is a center designated by state and local authorities and hospital administration that can provide comprehensive care of a special pathogens patient for the duration of the illness. ***Containment centers*** are facilities that can provide high-level bio containment. ***Special pathogens*** are defined as those viral or bacterial diseases that are highly hazardous. Many are emerging diseases that require special treatment facilities that can meet the demands of care, including detection, diagnosis, treatment, and prevention. ***Person(s) under investigation (PUI)*** are defined as those individuals who demonstrate consistent signs or symptoms and risk factors. Signs and symptoms include elevated body temperature or subjective fever or symptoms, including severe headache, fatigue, muscle pain, vomiting, diarrhea, abdominal pain, or unexplained hemorrhage.

Cross-training refers to the acquisition of multiple skills in multiple areas that may transcend job roles. ***Personal protective equipment*** *(PPE)* refers to those protective disposable items that healthcare providers wear to maintain a barrier from fluids or airborne pathogens that may come in contact with them when caring for suspect patients. ***Donning*** refers to the application of PPE. ***Doffing*** refers the removal of PPE. ***Capability domains*** or ***elements*** define the eleven areas identified by the CDC that are used to evaluate all designated assessment and treatment centers.

The challenges are many related to caring for this population. Assessment centers face the challenge of caring for these patients for as long as ninety-six hours. At this point the patient is cleared of the diagnosis or is triaged to a treatment center. Transportation to a treatment center requires an ambulance crew that is trained in the same isolation techniques that are required by all other direct care personnel. Treatment centers are facilities that are designated with the ability to care for these patients for the duration of the illness – up to several weeks. There are currently

two designated treatment centers in the Commonwealth of Virginia; Virginia Commonwealth University Medical Center and the University of Virginia Medical Center (CDC, 2015a).

Search methods

A search of the Ovid MEDLINE database was conducted for literature published from 2010 to present. Using the separate keywords "Ebola" (4,385 articles) and "hospitals" (348,491 articles), a combination of the two keywords using "and" resulted in a return of 115 articles. A title search of these articles resulted in a return of 16 articles. The abstract search reduced the number to 9 articles. A search was then conducted using the keyword "preparedness" (8,177 articles). A combination of the previous search using the keyword of "Ebola" with the keyword "preparedness" using "and" narrowed the count to 126 articles. After conducting a title search 9 articles remained. An abstract search of those 9 articles reduced the total to 6 articles. The 9 articles from the first keyword combination and 6 articles from the second keyword combination totaled 15 articles. An extensive review of those articles for quality and content further reduced the number to 6 articles (Figure 2).

A search of the PubMed database using a combination of the keywords "Ebola" and "preparedness" resulted in154 articles. A title search resulted in a total of 15 articles and a search for duplicates (9) resulted in 6 articles. An extensive review of those articles for quality and content resulted in only 1 article (Figure 3) which was combined with the previous Ovid MEDLINE search, bringing the final review to a total of 7 articles.

Selection criteria

All articles selected were case studies, descriptive studies, or expert opinion. Articles targeting elements related to staffing characteristics and readiness were included. Many of the articles were based on perceptions of healthcare professionals who either cared for or trained in

some manner to prepare for the care of special pathogens patients; in this case Ebola. A table summary of the selected articles can be found in Table 1.

Review summary

A recent survey by Speroni, Seibert, and Mallinson (2015a) included questions related to the nurses' perceptions regarding caring for EVD patients. The overall perceived risk was higher among nurses when providing care to confirmed EVD patients. The risk was only slightly lower when providing care to a PUI patient. Of note, only 0.3% of the respondents had cared for a confirmed EVD patient, but nearly half felt prepared to protect themselves from contracting EVD. Twenty-five percent of respondents were concerned with contracting EVD. Almost half thought they should be able to opt out of caring for a confirmed EVD patient. Even though the emergence of EVD did not affect the nurses' willingness to provide direct care, nearly 7% reported that the event has decreased the number of years they plan to continue to be a part of the nursing workforce. The fact that so few respondents cared for a PUI or confirmed patient lends credibility to the fact that their perceptions may be limited and could be affected by some confusion surrounding the care of these patients.

Additionally, the survey examined comments of nurses' perceptions regarding care of persons under investigation and patients with confirmed EVD in the United States (Speroni, Seibert, and Mallinson, 2015b). The American Nurses Association, Nurse.com, and the Washington State Nurses Association assisted with the recruitment for the survey. The survey identified thirteen themes surrounding the subject. Five of the themes were noted to be the most common among the respondents. Lack of preparedness/readiness was mentioned in more than 20% of the responses with the need for training and education. The need for improved communication was mentioned in more than 16% of the surveys. Fear of EVD transmission, lack

of best practice around personal protective equipment (PPE), and lack of professional treatment for nurses rounded out the top five themes. Limitations of the study, mentioned by the author, highlighted that the majority of the respondents were from two states (Maryland and Virginia) which may not be a representative sample and therefore not generalizable to other areas of the country.

Polgreen, Santibanez, Koonin, Rupp, Beekmann, and Del Rio (2015) surveyed a large group of infectious disease physicians and their perceptions related to hospital preparedness for EVD. Almost all reported a substantial degree of preparation for the management of patients. Two-thirds reported that their center had sufficient PPE. However, the majority of respondents indicated a preference that the patient be transferred to a specialized treatment center rather than be treated locally. In addition, some respondents reported that they were relatively unprepared to care for this population. Many infectious disease physicians practice at larger hospitals so the results of this study may not adequately represent smaller hospitals. It is unclear from this study whether any of the respondents had cared for a PUI or confirmed case of Ebola.

The least discussed topic surrounding the care of EVD patients is aligned more heavily with the facilities caring for this population – the cost of care. Costs are difficult to calculate related to the care of the population due to the fact that much of the cost is associated with preparedness.

In the case of caring for the EVD patient population, much of the cost is associated with the specialized PPE that personnel require. All of the PPE worn by healthcare providers is a one-time use disposable product. Hoods, gowns, gloves, shoe covers, face shields and masks are intended to be used once and then put in the disposable waste containers. Even items such as scrubs uniforms and undergarments the healthcare provider is wearing are discarded at the end of

each shift. Additional costs are generated with disposal of all of the waste which requires specialized equipment and a certified hazardous material transport company to move the waste to a designated disposal facility.

Daly (2014) presented a descriptive review of costs associated with organizational preparation for the EVD population. Many of the costs were determined by the amount of supplies, extensiveness of staff training, treatment space, and associated services such as laboratory and imaging. According to Daly, the estimated cost for preparation at one center in New York was approximately $150,000. Another center anticipates costs of nearly $15 million for biological containment for current and future disease outbreaks. These costs directly affect whether a center has the funds, personnel, and equipment to care for this population.

Wadman, et al. (2015) focused on preparation of emergency departments' processes developed through expert review and consensus of healthcare workers. Emergency department processes and management of the patients was reviewed extensively at one center. Perhaps one of the most detailed reviews to date, Wadman outlines processes and plans for many of the elements an emergency department may need to follow. Patient screening as well as compliance on the patient's part is considered. Non-compliance with the treatment plan can lead to restraining the patient depending on a competency evaluation. Several of the elements that are covered in this article have changed based on newer guidelines from the CDC (CDC, 2015b). Elements such as laboratory specimen collection, invasive procedures, and dialysis have undergone further evaluation. Some invasive procedures and forms of dialysis may not be available in this population because of the high infection risks for the health care team associated with contaminated blood and body fluids.

An opinion paper published by Augustine and Kuhar (2014), made several recommendations for precautionary measures, but it was written at a time when many facilities in the United States were just beginning to prepare and respond. Similar information from another opinion paper by Cherry, Dunne, Nafziger, Rubin, and Uslan (2014) two months later quickly became irrelevant as the changes to preparation and planning were happening on a weekly and, at times, daily basis. While both of these articles make suggestions for identifying patients and for what isolation techniques should be used, both were written before the current screening guidelines (CDC, 2015b) and recommendations for protective equipment (CDC, 2015c) were developed. At the time of this writing, all of the suggestions made in these two publications have been addressed and resolved.

Staffing readiness plans

In 2014, the CDC together with other partners developed recommendations for a tiered approach to preparedness. Only 55 facilities designated as treatment centers by state and local authorities in conjunction with the CDC exist in the United States (Table 2). Treatment centers were assessed using a survey evaluating the 11 capability domains of care developed by the CDC (Appendix A). Additionally, state health departments, in conjunction with local authorities and center administrations, continue the process of identifying and evaluating assessment facilities using a similar survey also developed by the CDC (Appendix B). These hospitals are prepared to receive and isolate a PUI and care for the patient until a diagnosis is confirmed or transport to a treatment center can be completed (CDC, 2015d). There are only 6 facilities in Virginia that have been designated as assessment centers. Containment centers number even less with only 3 in the United States: Emory Healthcare, Nebraska Medical Center, and the National Institutes of Health.

A tier one hospital, also known as a frontline or referring hospital, can quickly identify and isolate suspect Ebola patients and prepare them for transport to an assessment hospital with guidance from their local health department. Tier two hospitals, or assessment facilities, are equipped to provide care to a suspect Ebola patient for up to ninety-six hours. Assessment centers will transfer a confirmed patient to the next level center as soon as possible. Tier three hospitals, designated as treatment centers, are equipped to treat a patient for the duration of the illness (Figure 4).

Interim guidance from the CDC suggests that the number of staff with direct patient contact should be minimized (CDC, 2015c). Staff members involved in or supporting direct patient care should be trained for their roles and demonstrate proficiency in donning and doffing of PPE, infection control practices, and waste management. Staffing plans should include input from a multidisciplinary team of all involved departments, both clinical and non-clinical staff. Sufficient physician and nursing staff should be available to handle all patient care needs. Each center should have a process for continuous staff input from those who may or may not be directly involved in Ebola patient care and should address employee safety questions and concerns. This process may be formal or informal, but the input from staff and subsequent resolution needs to be documented. The overall safe care of an Ebola patient in a center should have oversight by a site manager (or designee) at all times (CDC, 2015c).

Much of the literature concerning emergency preparedness by healthcare facilities for identifying and treating EVD has been generated since September, 2014. While the disease has been in existence for nearly forty years, it only breached the shores of the United States in mid-year, 2014. Within that time the Centers for Disease Control (CDC) and state health departments have worked feverishly with hospitals across the country to address the issue.

Much of what is written about adequate preparation for meeting the challenge of EVD is based on case studies, surveys, or expert opinion. The next stages of the process around preparedness for this and other special pathogens are still being formulated and many organizations are struggling with the demands that this type of patient population will put on available labor resources and funds.

Considering the fact that the emergence of Ebola in the United States is still relatively new, the work that has been completed since late 2014 has made an impact. The fact that so few diagnosed cases have been treated in this country may be a blessing in disguise. However, the published literature demonstrates a strong need for continued planning and implementation (WHO, 2016).

Nearly all of the available literature mentions or discusses the need for appropriate screening. The identification of a PUI to determine whether that person is at-risk for the disease is vitally important. This component of preparedness may start well before the person is even introduced to the healthcare system. The bulk of screening takes place at the point of entry into the country with most of that happening at international airports. A failure to screen appropriately can lead to serious and deadly consequences.

The proper equipment necessary to care for the population is also a key component. Failure on the part of an organization to provide the healthcare worker with the proper personal protective equipment can lead to unnecessary risk to the caregiver, the center, and the community at large. Quantities of supplies must be adequate to maintain protection for the healthcare workers for the duration of the patient stay. Proper sizing and fit are also a necessary part of the equation to protect the healthcare worker. The bulk of the literature discusses the necessity for PPE in adequate quantities.

The overall costs are also connected to the training, equipment, and resources associated with the readiness needed based on the level of the designated level of the center; assessment or treatment center. Costs are difficult to calculate based on the predictability of caring for a patient. While preparation is necessary, how much is needed is unpredictable based on the possibility that only a small number of patients will be identified or even require the care.

Project Question

This project provided answers to the question of the response capability of assessment and treatment centers in the Commonwealth of Virginia to the care of a special pathogens patient as evidenced by their staffing plans. These plans are designed to provide the healthcare professionals with a comprehensive and detailed guide to providing safe and efficient care for this extremely high-risk population. Consideration for the healthcare provider is as important as the care they deliver. Staffing plans should share common characteristics, with only minimal variation related to the environmental space, style or type of personal protective equipment, and types of available support services. Plans should minimally include the recommended elements related to staffing plans suggested by the CDC interim guidance (CDC, 2014).

Performing a thorough review of the available staffing plans from the designated assessment and treatment centers in Virginia and comparing the characteristics of each served to provide a description of the commonalities and differences across the Commonwealth. Comparing this information to the recommendations set forth by local, state, and national authorities assisted with the development of a framework that can provide these facilities with information to improve staffing plans and provide healthcare professionals with the support that is required to care for this population.

Methods

The challenges faced by organizations to develop staffing plans for the EVD population are unique. While many facilities are familiar with the standard nurse to patient ratios, the level of care needed for this population is much more acute and requires special training to meet and maintain a safe environment for patient and healthcare provider. Staffing plans differed based on the level of care the center provides as well as the physical location and layout of the area used to provide this specialized care. Despite the differences, there is a need for some common staffing plan characteristics.

Purpose of the project

The purpose was to determine the response capability of Ebola assessment and treatment hospitals in the Commonwealth of Virginia by completing a thorough review of current staffing plans. An evaluation of the staffing plans of six assessment and two treatment hospitals in Virginia was conducted to determine the similarities and differences among the designated centers. Each available staffing plan was reviewed to determine to what extent recommended characteristics for staffing, as outlined by the CDC interim guidance (CDC, 2014) were included in each plan, as well as any additional characteristics unique to the center. Gaps in the plans were identified and will be shared with the centers in an effort to improve the plan. Consideration of perceptions and input from healthcare providers can assist to transform these plans into evidence-based and comprehensive plans.

Project design

This study used a descriptive, comparative design to perform a descriptive evaluation of the characteristics of each staffing plan. The characteristics of each staffing plan were reviewed

and evaluated to determine the similar and unique elements for each center and then compared to the recommended characteristics suggested by the CDC interim guidance (CDC, 2014).

Protection of human subjects

A formal letter requesting the information from The University of Virginia Medical Center, Virginia Commonwealth University Health System, Sentara Princess Anne Hospital, Winchester Medical Center, Mary Washington Hospital, Centra Lynchburg Hospital, Augusta Health, and Virginia Hospital Center was sent to the designated contact person for each center. Designated contact information was provided by the Virginia Hospital and Healthcare Association. Every effort was made to maintain the anonymity of each center during the evaluation of staffing plan characteristics. This descriptive study did not involve human subjects and was submitted to the UVA Institutional Review Board – Health Sciences Research for review. The study received waived status prior to commencement (UVA tracking #19200).

Context

This descriptive study evaluated current response capability in the Commonwealth. Several elements were considered important during the review of the available information. Response capability is dependent on having a team of healthcare workers large enough to deliver ongoing care. Response systems require specific mechanisms to ensure readiness, promote process improvement and front-line feedback into the care delivery process.

Description of the sample

Staffing plans are designed to describe details of the readiness plans and should include input from a multidisciplinary team of all potentially affected departments. They demonstrate the number of staff required and a schedule of all needed support, both clinical and non-clinical, for the prescribed time, as outlined per the centers designation as a treatment or assessment center.

Plans should also include a process for continuous staff input from those who may or may not be directly involved in patient care and should address safety questions and concerns. Details for internal and inter-facility transport of the patient may also be included in the plan (CDC, 2015b).

Setting

The setting was the Commonwealth of Virginia which includes two treatment and six assessment hospitals located across the state. There are five international airports in Virginia that receive travelers from West African nations. There are three interstate roadways that travel through the state; two traverse north and south, one traverses east and west (Figure 5).

Procedures

For the first phase of the study, a formal letter was submitted to a designated contact at each center to request a copy of their current staffing plans related to care of the EVD population. Centers were instructed to send the plans to a designated mailbox at the University of Virginia School Of Nursing. A follow-up visit to each designated center was made over the following months to discuss any available plans and to obtain any additional information. These visits coincided with the follow-up visits conducted by representatives from the Virginia Department of Health, Virginia Hospital and Healthcare Association, and other local and regional departments that are required as part of each designated center's annual evaluation. Review of the characteristics of each available plan was conducted to determine similarities and unique elements of the plans. Plans were also reviewed for minimum content of the characteristics suggested by the CDC interim guidelines.

Staffing plans for emergency departments and inpatient areas were requested. Some assessment centers have made the decision to keep a patient in the emergency department for the duration of their stay and only have plans for that area.

The study identified any unique and undetermined characteristics in the available staffing plans. Follow-up with the designated contact, or designee, to discuss these characteristics was done with a goal of considering the possible application at other centers. These characteristics assisted with defining best practices for both assessment and treatment centers.

Measurement

The staffing plans, if available, and all personal communication from all assessment and treatment centers was reviewed using a data collection instrument based on the capability domain for staffing published in the CDC interim guidance in December, 2014 (Tables 3 and 4). Unique characteristics were added to the supplemental data collection instrument (Table 5) and were marked for all centers that may include the characteristic. Characteristics were marked as present, not present, or undetermined based on the staffing plan and any additional information learned during the visits to each center.

Analysis

For this project characteristics were not analyzed for content or comprehensiveness. The expectation that variation existed between assessment and treatment centers was supported. This could be explained by the fact that treatment centers were the first to plan for and manage this patient population. Assessment centers were not designated until the following year and therefore have had less time to develop comprehensive plans. Another factor to consider is that large treatment centers typically operate from long-standing emergency preparedness programs that have been tested and implemented many times.

Ethical Considerations

Treatment modalities and care delivery for the special pathogens populations, especially the EVD population, has resulted in numerous ethical discussions. Staffing plans and decisions

related to who will care for the population have created some ethical issues for the caregivers. There is continued discussion related to the topic of opting out of caring for the special pathogens population, a topic that was mentioned by Speroni, et al. (2015a).

In many designated centers the care team is comprised of volunteers who complete the training and care for the patients at all times. The emergency room teams may include all personnel since there is no way to predict when or how a patient may enter the system through the emergency department. All of the centers included in this project honor exceptions to being a team member. Some reasons might include physical inability related to wearing the PPE, restricted duty related to injury, pregnancy, or other reasons that are accepted by the organization.

For the most part all of the designated centers in Virginia rely on a volunteer team to deliver all of the care for the EVD and special pathogens populations. This volunteerism reaches all disciplines and support services including laboratory, environmental services, transportation, and waste disposal services.

Results

All designated centers in the Commonwealth of Virginia participated in the project at some level. The letter requesting information provided limited results, but all of the centers were welcoming and able to provide the available information during the face-to-face conversations with the leadership team for each center during the annual evaluation visit.

Each assessment center was able to provide limited written detail regarding their staffing plans. Of note, assessment centers were not evaluated for initial designation until mid-2015 and, for the most part, have not cared for an EVD patient or a PUI. This could explain the limited

details, but it is important to note that all of the assessment centers stated that their staffing plans continue to be a work in progress.

Most assessment centers plan to care for the EVD population and possibly all special pathogen populations in the emergency department to avoid risks associated with the movement of patients through the hospital to other care areas. This has led to a predominance of emergency department personnel on the care team. Many are supplemented by intensive care unit nurses as needed.

Though many of the assessment centers could not produce a detailed written staffing plan, all were able to verbally provide some detail related to the number of team members, the various roles of the team members, care rotation, notification of team members and how input from the team members forms and changes the plan (Table 6). Most centers were not able to articulate the inclusion of some support staff roles (i.e., social work, nutrition, human resources, or chaplaincy), which resulted in an undetermined result for each of the centers. It should be noted that assessment centers are expected to care for patients for less than 96 hours. Most, if not all, patients would be transferred to a treatment center within the first 72 hours or as soon as a diagnosis is confirmed. Consensus regarding the need for some support staff roles and what support staff may be required at assessment centers has not been fully established. This may reduce the need for extensive involvement from several of the non-direct care or support services.

Only one center was not able to provide a staffing plan or a verbal confirmation of a plan that addressed care beyond the first 24 hours. According to documentation this was identified in their initial designation visit in 2015.

The treatment centers provided plans which included all of the recommended elements related to staffing plans (Table 7) suggested by the CDC interim guidance (CDC, 2014). Treatment centers began to formulate their plans in mid-2014, when EVD transmission was escalating outside the borders of the United States. These plans were an extension of existing emergency management plans that had been in place for several years. Adaptations were made to meet the needs of this highly infectious population of patients and have been further adapted to meet the predicted needs of other special pathogen populations.

Teams are comprised of a core group of healthcare workers across all disciplines including direct and non-direct caregivers. Plans include treatment modalities in both emergency department and intensive care unit settings. Both centers plans have been developed to include several weeks of clinical care in a secure setting that can meet the needs of the patient in any phase or level of care. Staff input related to the process of care is encouraged and has been used to improve care delivery and ensure the safety of caregivers.

Common to all of the centers is the concern related to maintaining a core team to care for this population. All organizations experience turnover whether related to resignation, promotion, or role change. Most centers spoke to the challenges associated with care providers that choose to opt-out of caring for special pathogens population, but all centers honor those choices.

Based on information obtained for this project, direct care teams range from 10-100+ members. One treatment center provided information (Table 8) that demonstrates the minimum number of direct care providers and support personnel for EVD patients in the early phase of the disease based on recommendations and the experience of the center and includes several assumptions related to care delivery (University of Virginia, 2016). It is anticipated that later phases of the disease, also referred to as the wet phase, would require additional direct care

providers to meet the clinical needs of the patient and to ensure an adequate rotation of direct care providers as the patient acuity increases. It is important to note that all team members require extensive training in infection control practices and the use of PPE which may require several days. Most centers have a plan for training and re-training, but all verbalized the use of just-in-time training for reinforcement.

Some unique characteristics were identified from both treatment and assessment centers (Tables 9 and 10). Many of these characteristics were either unrelated to direct care or had no relationship to the staffing plan. One of the assessment centers noted that their plan was to have the caregiver spend no more than 20 minutes delivering direct care to a patient. This could result in more donning and doffing procedures resulting in increased cost and the likelihood for error during the donning and doffing procedures. It should be noted that the patient in an assessment center may be less acute and does not require continuous care.

Another assessment center has a plan for a PUI patient for up to seven days. Assessment centers typically provide care for up to four days, but this center has the capacity to reach out to other hospitals in their system for additional trained personnel. While it would be rare that a PUI would not be diagnosed as positive or negative within a few days, it is possible that there could be some barriers to diagnosis.

One assessment center made the decision to hire and train a dedicated person for special pathogen preparedness. The person in this position manages all aspects of the program and has oversight for planning, training, and staffing operations. Other centers rely on their emergency management personnel, as well as managers and directors of care areas to work together as a team to manage specific functions of the plans.

A staffing plan at one assessment center scheduled nurses for a four-hour shift and rotated new staff in every four hours. Most centers however continue to plan for a twelve-hour shift with staff rotation every two hours.

At least three of the assessment centers include one round of life-saving drugs and defibrillation for patients. All centers refrain from performing manual cardiac compressions as a life-sustaining measure.

Nearly all of the centers rely on transitional space to care for this population. The area is used on a day-to-day basis for normal operations, but the space can be converted quickly to meet the needs of the special pathogen population. One treatment center uses a dedicated space for the special pathogens population. Their Unique Pathogen Unit, or UPU, is set up in a constant state of readiness. The space is used for training, drills, and some simulations when not being used to care for patients.

Discussion

Summary

All of the designated centers in the Commonwealth of Virginia have dedicated multiple resources and personnel to prepare for the EVD population. Today all of the centers are examining systems more broadly and have adapted their programs to prepare for other special pathogens that have been identified as potential problems for healthcare systems.

Maintaining engagement and overcoming challenges related to turnover are recognized by all of the centers. Some preliminary discussion has begun to explore the possibilities of sharing resources among the centers, but geographical distance between centers and other challenges to maintain staffing in all areas of the hospital are difficult to overcome.

An unanticipated result of the study was recognized during the visits to each center. While most centers developed and operationalized their plans based on the needs of that center, the discussions led to an open dialogue related to what other centers were experiencing. These discussions provided an opportunity for networking among the centers and offered a common conduit for information and introduction to key people in other centers. One notable example was an invitation for team members of one assessment center to participate in the training program at one of the treatment centers. This resulted in both centers learning from each other and opened the door for continued collaboration.

Most of the centers discussed other challenges related to caring for the special pathogen population. Patient transport external to the centers or between centers has been a challenge for many of the centers. Most of the centers have worked with local Emergency Medical Services (EMS) to provide this service, but a few continue to face the challenge of providing consistent services. Only one treatment center has developed an internal program to provide transportation for patients. This program provides transport from any local or regional area as well as transport from an assessment center to their treatment center.

Another challenge discussed at each visit was related to decedent care. Few, if any, of the centers have had meaningful discussions with their local funeral homes regarding disposition of the deceased patient. Nearly all of the centers have contacted local funeral home directors, but most are not interested in managing the deceased patient due to the associated community stigma related to special pathogen patients, namely EVD patients. One treatment center has had success collaborating with two local funeral homes to manage the deceased patient. The center provides the transport of the patient to the funeral home location and the crew moves the patient to a designated area of the facility negating the need for funeral home staff to handle the body. There

may be some advantages to adopting a state-wide coordination of the disposition of deceased patients, but this would require a dedicated transport network to reduce the risk associated with the population.

Interpretation

This descriptive study is the first to examine the characteristics of staffing plans in assessment and treatment facilities in the Commonwealth of Virginia related to care of the EVD and special pathogens populations. This study identified gaps and variations in the plans and provided an initial understanding of the variances among assessment and treatment centers.

The project identified the benefits of networking and combining resources when possible to offset some of the challenges related to training, equipment, and engagement. There may be some opportunities yet to be identified related to efforts to reduce the costs of maintaining readiness, especially in the domain of direct care provider numbers.

Limitations

A limitation of the study was the ability of each center to provide a detailed and complete staffing plan. Most designated assessment centers have not cared for a PUI or confirmed case of Ebola and as a result, may have less comprehensive plans. The study is also limited to one state which may make the results less generalizable to other areas of the country.

Conclusions

Information from the study will be used to inform policy makers and contribute to future planning for Ebola and other special pathogens. The strength of the study is the ability to identify gaps in the plans and make recommendations related to the current best practice. While the study does identify gaps and defines recommendations, it does not ensure that the gaps are addressed or will be perceived as important by the designated facilities.

The chance of an EVD patient entering the healthcare system in the United States has diminished since early 2015. There have been several PUIs, but no diagnosed EVD patients. The preparedness that all designated centers has undertaken cannot be dismissed.

Maintaining team numbers and training were highlighted at every center visit. Added to that is the realization that there have been no events in nearly two years resulting in some indifference to the need for preparedness. Nearly all of the centers are challenged to maintain a state of readiness, but all realize the necessity of continued training despite the lack of actual events.

Caring for the EVD population requires special training, specific equipment, and a distinct environment. In an effort to ensure the safety of patients, healthcare professionals, and communities, organizations are compelled to provide the healthcare provider with the necessary equipment and training to maintain a safe environment. Staffing plans are an important part of the equation and must take all elements into consideration. Training, equipment, and environment are important, but it is equally important that staffing plans are designed to account for an adequate number of caregivers in each role. Plans should also provide recommendations for length of time in direct care and define the need for supportive personnel. The omission of even one element can lead to a catastrophic event. This study also supports the development of best practice in the future related to other special pathogens.

The primary purpose of the project was to identify gaps in the various staffing plans and make recommendations to address those gaps. The number of assessment hospitals is larger and demonstrated more variation in staffing plan characteristics. These facilities may be the first contact for an EVD patient making it more important that any gaps be identified quickly.

The findings will be disseminated to each participating center in a report that maintains each center's anonymity. The results of this project will be submitted for presentation at the Special Pathogens Summit scheduled for the fall of 2017 in Richmond, Virginia. In addition, the project results will be submitted to a peer reviewed journal appropriate for the target audience. The initial journal identified as appropriate for manuscript submission is the Infection Control and Hospital Epidemiology Journal. Author guidelines for this journal are attached in Appendix C.

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Table 1

Literature Search Summary – Hospital preparedness

Author	Purpose of study	Study design: Type of design	Method	Sample and Size	Type of Analysis	Major findings and implications
Wadman, M. C. (2105)	Evaluation and planning	Case study	Processes developed through expert review and consensus of health care workers	Not applicable – evaluated one facility	Not applicable	Identification and initial testing of patient under investigation. Appropriate personal protective equipment and isolation requirements. Processes to facilitate diagnostic testing to fully evaluate patients under investigation. Modifications of therapeutic interventions to ensure the safety of the provider. Safe management of waste.
Daly, R. (2014)	Preparation costs	Descriptive	Estimation of costs associated with preparation for EVD patients	Not applicable	Not applicable	Costs are determined by amounts of personal protective equipment, training staff, dedicated treatment space, laboratory and imaging, administrative steps.

Augustine, J. (2014)	Hospital preparation	Opinion		One facility	Executive summary	Ask more questions, take precautions, step-up surveillance
Cherry, R. (2014)	Hospital preparation	Opinion		Not applicable	Executive summary	Prepare PPE kits, streamline EVD screening, train first responders
Polgreen, P. (2015)	Infectious Disease Physician assessment of readiness	Descriptive	Convenience sampling	1566 emerging infections network physician members surveyed. Response rate of 55.5% (869 respondents)	Fisher's exact and Chi-square	Nearly all demonstrated a substantial degree of preparation. Two-thirds reported sufficient availability of PPE. The majority preferred patients be transferred to specialized treatment centers. Some respondents indicated that they were unprepared.
Speroni, K. (2015a)	Nurses perceptions regarding care of PUI and confirmed EVD	Descriptive	Convenience sampling	1091 initiated surveys – 118 only provided demographics, 7 did not provide care in the United States. Results of 966 RN, LPNs and nurse technicians surveys analyzed	Content validity established by a ten member panel of content experts	Part a – nurses' perceptions related to risk associated with caring for confirmed EVD vs. PUI. Also looked at preparation, impact on career plans. Limitations – disproportionate number of nurses from Maryland and Virginia.

Speroni, K. (2015b)	Examine qualitative comments from an on-line survey	Descriptive	Convenience sampling	966 respondents provided 3,106 comments	Qualitative content analysis used to guide coding of qualitative comments	Part b - Thirteen themes assessed with top five listed as, 1)lack of preparedness/readiness, 2)lack of training and education, and improved communication needed, 3)fear of EVD transmission, 4)lack of PPE and infection prevention, 5)nurses not treated professionally.

Table 2

Current Ebola Treatment Centers as of 2/18/15

- Maricopa Integrated Health Systems; Phoenix, Arizona
- University of Arizona Health Network; Tucson, Arizona
- Kaiser Los Angeles Medical Center; Los Angeles, California
- Kaiser Oakland Medical Center; Oakland, California
- Kaiser South Sacramento Medical Center; Sacramento, California
- University of California Davis Medical Center; Sacramento, California
- University of California Irvine Medical Center; Orange, California
- University of California Los Angeles Medical Center; Los Angeles, California
- University of California San Diego Medical Center; San Diego, California
- University of California San Francisco Medical Center; San Francisco, California
- Children's Hospital Colorado; Aurora, Colorado
- Denver Health Medical Center; Denver, Colorado
- Emory University Hospital; Atlanta, Georgia
- Grady Memorial Hospital; Atlanta, Georgia
- Ann & Robert H. Lurie Children’s Hospital of Chicago; Chicago, Illinois
- Northwestern Memorial Hospital; Chicago, Illinois
- Rush University Medical Center; Chicago, Illinois
- University of Chicago Medical Center; Chicago, Illinois
- Johns Hopkins Hospital; Baltimore, Maryland
- University of Maryland Medical Center; Baltimore, Maryland
- National Institutes of Health Clinical Center; Bethesda, Maryland
- Baystate Medical Center; Springfield, Massachusetts
- Boston Children's Hospital; Boston, Massachusetts
- Massachusetts General Hospital; Boston, Massachusetts
- UMass Memorial Medical Center; Worcester, Massachusetts
- Allina Health’s Unity Hospital; Fridley, Minnesota
- Children’s Hospitals and Clinics of Minnesota - Saint Paul campus; St. Paul, Minnesota
- Mayo Clinic Hospital - Rochester, Saint Marys Campus; Rochester, Minnesota
- University of Minnesota Medical Center, West Bank campus, Minneapolis, Minnesota
- Nebraska Medicine - Nebraska Medical Center; Omaha, Nebraska

- North Shore System LIJ/Glen Cove Hospital; Glen Cove, New York
- Montefiore Health System; New York City, New York
- New York-Presbyterian/Allen Hospital; New York City, New York
- NYC Health and Hospitals Corporation/HHC Bellevue Hospital Center; New York City, New York
- Robert Wood Johnson University Hospital; New Brunswick, New Jersey
- The Mount Sinai Hospital; New York City, New York
- MetroHealth Medical Center; Cleveland, Ohio
- Children's Hospital of Philadelphia; Philadelphia, Pennsylvania
- Hospital of the University of Pennsylvania; Philadelphia, Pennsylvania
- Lehigh Valley Health Network - Muhlenberg Campus; Muhlenberg, Pennsylvania
- Penn State Milton S. Hershey Medical Center; Hershey, Pennsylvania
- University of Texas Medical Branch at Galveston; Galveston, Texas
- Texas Children's Hospital; Houston, Texas
- University of Virginia Medical Center; Charlottesville, Virginia
- Virginia Commonwealth University Medical Center; Richmond, Virginia
- Children’s Hospital of Wisconsin, Milwaukee; Milwaukee, Wisconsin
- Froedtert & the Medical College of Wisconsin – Froedtert Hospital, Milwaukee; Milwaukee, Wisconsin
- UW Health – University of Wisconsin Hospital, Madison, and the American Family Children’s Hospital, Madison; Madison, Wisconsin
- MedStar Washington Hospital Center; Washington, D.C.
- Children's National Medical Center; Washington, D.C.
- George Washington University Hospital; Washington, D.C.
- Harborview Medical Center; Seattle, Washington
- Seattle Children’s Hospital; Seattle, Washington
- Providence Sacred Heart Medical Center; Spokane, Washington
- West Virginia University Hospital; Morgantown, West Virginia

Note. Obtained from https://www.cdc.gov/vhf/ebola/healthcare-us/preparing/current-treatment-centers.html

Table 3

Data Collection Instrument - Response Capability of Assessment Center

Characteristic			Center #			
Written plan available - Y / N (circle one)			Present	Not present	Undetermined	Comments
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing				
		Physician/LIP				
		Respiratory Therapy				
		Patient Transportation				
	Support services	Emergency Management				
		Environmental Services				
		Laboratory Services				
		Nutrition				
		Supply Chain				
		Pharmacy				
		Social Work				
		Human Resources				
		Security				
		Technology services				
		Facilities services				
Plan has been developed and scheduled to support 96 consecutive hours of clinical care. Sufficient physician and nursing staff should be available to handle the patient's care needs (assessment center)	0-24 hours	Nursing				
		Physician/LIP				
	25-48 hours	Nursing				
		Physician/LIP				
	49-72 hours	Nursing				
		Physician/LIP				
	73-96 hours	Nursing				
		Physician/LIP				
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns		Direct Care providers				
		Indirect Care providers				
		Employee Union				
		Safety concerns addressed				

Table 4

Data Collection Instrument - Response Capability of Treatment Center

Characteristic			Center #			
Written plan available - Y / N (circle one)			Present	Not present	Undetermined	Comments
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing				
		Physician/LIP				
		Respiratory Therapy				
		Patient Transportation				
	Support services	Emergency Management				
		Environmental Services				
		Laboratory Services				
		Nutrition				
		Supply Chain				
		Pharmacy				
		Social Work				
		Human Resources				
		Security				
		Technology services				
		Facilities services				
Plan has been developed to manage several weeks of clinical care. Staffing includes dedicated critical care nurses, physicians, environmental services, infection control practitioners, laboratory staff, and respiratory services personnel designed to minimize the number of staff with direct patient contact (treatment center)		Critical care nurses				
		Physician/LIP				
		Environmental Services				
		Infection control practitioner				
		Laboratory staff				
		Respiratory Therapy				
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee		Direct Care providers				
		Indirect Care providers				
		Employee Union				
		Safety concerns addressed				

safety questions and concerns	

Table 5

Data Collection Instrument - Response Capability, Unique characteristics

					Center #
		Circle one (Direct or Indirect)			Comments
			Assessment	Treatment	
	Characteristic #1	Direct Care	Indirect Care		
	Characteristic #2	Direct Care	Indirect Care		
	Characteristic #3	Direct Care	Indirect Care		

Table 6

Results for Assessment Centers

Key **P = present, NP = not present, U = undetermined**			Center #1	Center #2	Center #3	Center #4	Center #5	Center #6
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing	P	P	P	P	P	P
		Physician/LIP	P	P	P	P	P	P
		Respiratory Therapy	P	P	P	P	P	NP
		Patient Transportation	P	P	P	P	P	P
	Support services	Emergency Management	P	P	P	P	P	P
		Environmental Services	P	P	P	P	P	P
		Laboratory Services	P	P	P	P	P	P
		Nutrition	U	U	U	U	U	U
		Supply Chain	P	P	P	P	P	P
		Pharmacy	U	P	U	P	P	U
		Social Work	U	U	U	U	U	U
		Human Resources	U	U	U	U	U	U
		Security	P	P	P	P	P	P
		Technology services	P	P	P	P	P	P
		Facilities services	P	P	U	P	P	P
Plan has been developed and scheduled to support 96 consecutive hours of clinical care. Sufficient physician and nursing staff should be available to handle the patient's care needs (assessment center)	0-24 hours	Nursing	P	P	P	P	P	P
		Physician/LIP	P	P	P	P	P	P
	25-48 hours	Nursing	P	U	P	P	P	P
		Physician/LIP	P	U	P	P	P	P
	49-72 hours	Nursing	P	U	P	P	P	P
		Physician/LIP	P	U	P	P	P	P
	73-96 hours	Nursing	P	U	P	P	P	NP
		Physician/LIP	P	U	P	P	P	NP
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns		Direct Care providers	P	P	P	P	P	P
		Indirect Care providers	P	U	P	U	P	P
		Employee Union	n/a	n/a	n/a	n/a	n/a	n/a
		Safety concerns addressed	P	U	P	P	P	P

Table 7

Results for Treatment Centers

Key **P = present, NP = not present, U = undetermined**			Center #7	Center #8
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing	P	P
		Physician/LIP	P	P
		Respiratory Therapy	P	P
		Patient Transportation	P	P
	Support services	Emergency Mngmt.	P	P
		Environmental Srvcs.	P	P
		Laboratory Services	P	P
		Nutrition	P	P
		Supply Chain	P	P
		Pharmacy	P	P
		Social Work	P	P
		Human Resources	P	P
		Security	P	P
		Technology services	P	P
		Facilities services	P	P
Plan has been developed to manage several weeks of clinical care. Staffing includes dedicated critical care nurses, physicians, environmental services, infection control practitioners, laboratory staff, and respiratory services personnel designed to minimize the number of staff with direct patient contact (treatment center)		Emergency department and critical care nurses	P	P
		Physician/LIP	P	P
		Environmental Services	P	P
		Infection Control Practitioner	P	P
		Laboratory Staff	P	P
		Respiratory Therapy	P	P
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns		Direct Care providers	P	P
		Indirect Care providers	P	P
		Employee Union	n/a	n/a
		Safety concerns addressed	P	P

Table 8

Minimum staffing requirements for EVD patients

Direct care # of patients	EVD 1	EVD 2
RN - day shift	2	4
RN - evening shift	2	4
RN - night shift	2	4
Total RN FTEs per week*	8.4	16.8

Support role # of patients	EVD 1	EVD 2
Safety officer - day	1	1
Safety officer - evening	1	1
Safety officer - night	1	1
Total FTEs per week*	4.2	4.2

One EVD patient would require a total of 12.6 FTEs

Two EVD patients would require a total of 21 FTEs

Assumptions
36 worked hours per week*
Use of N95 mask
Patient(s) in early (dry) phase
Full garb with donning and doffing tolerance
Time in PPE not to exceed 3 total hours
(includes donning and doffing)

Adapted from University of Virginia Incident Action Plan, 2016

Table 9

Results for Assessment Centers, Unique characteristics

Characteristic #1 (one center)	Facility has a dedicated part-time position for special pathogen management
Characteristic #2 (one center)	Nurses work 4-hour shift and rotate every four hours
Characteristic #3 (one center)	Nurses only in contact with patient for a maximum of twenty minutes
Characteristic #4 (one center)	Plan for PUI up to seven days
Characteristic #5 (one center)	Quarterly education for direct caregivers
Characteristic #6 (one center)	Inclusion of first round of life saving drugs or defibrillation, but no compressions

Table 10

Results for Treatment Centers, Unique characteristics

Characteristic #1 (one center)	Facility has a dedicated unit for special pathogens populations
Characteristic #2 (one center)	Facility has own ambulance transport system. All personnel trained with other direct care providers.
Characteristic #3 (one center)	Facility has a detailed plan for decedent affairs and has collaborated and held drills with two local funeral homes.

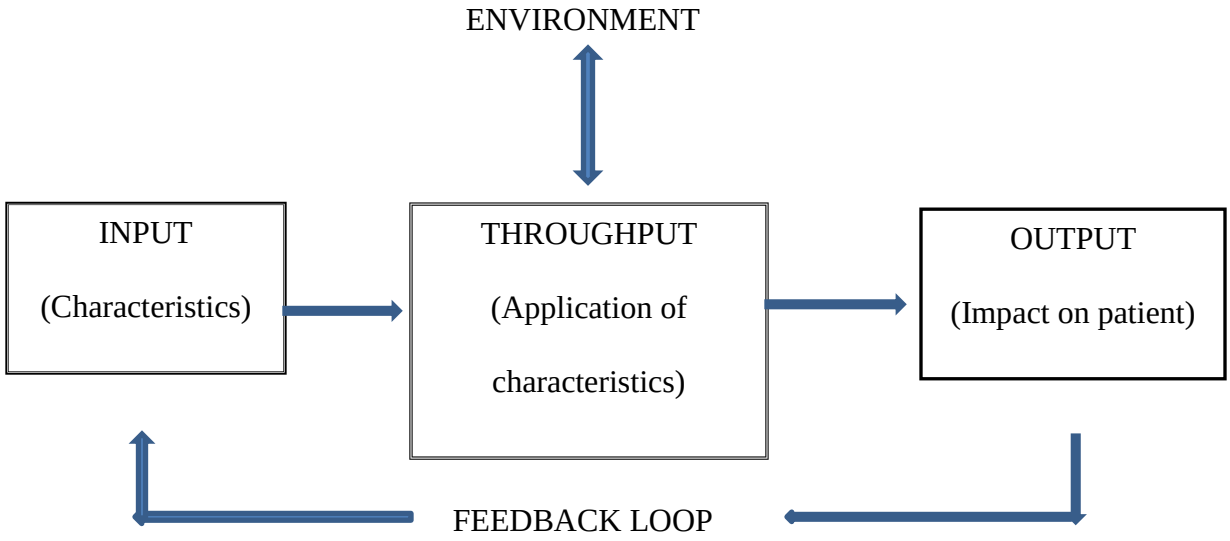

Figure 1. Adapted from Open System Model with a feedback loop and the impact on the environment of care.

Note: Created based on the work of Bertalanffy (1968) and Katz and Kahn (1978).

Bertalanffy, L. (1968). General systems theory: Foundations, development, applications. New York: George Braziller, Inc.

Katz, D. & Kahn, R. L. (1978). Communication: feedback processes and evaluation. In The social psychology of organizations (pp 427-474). 2e New York: John Wiley & Sons.

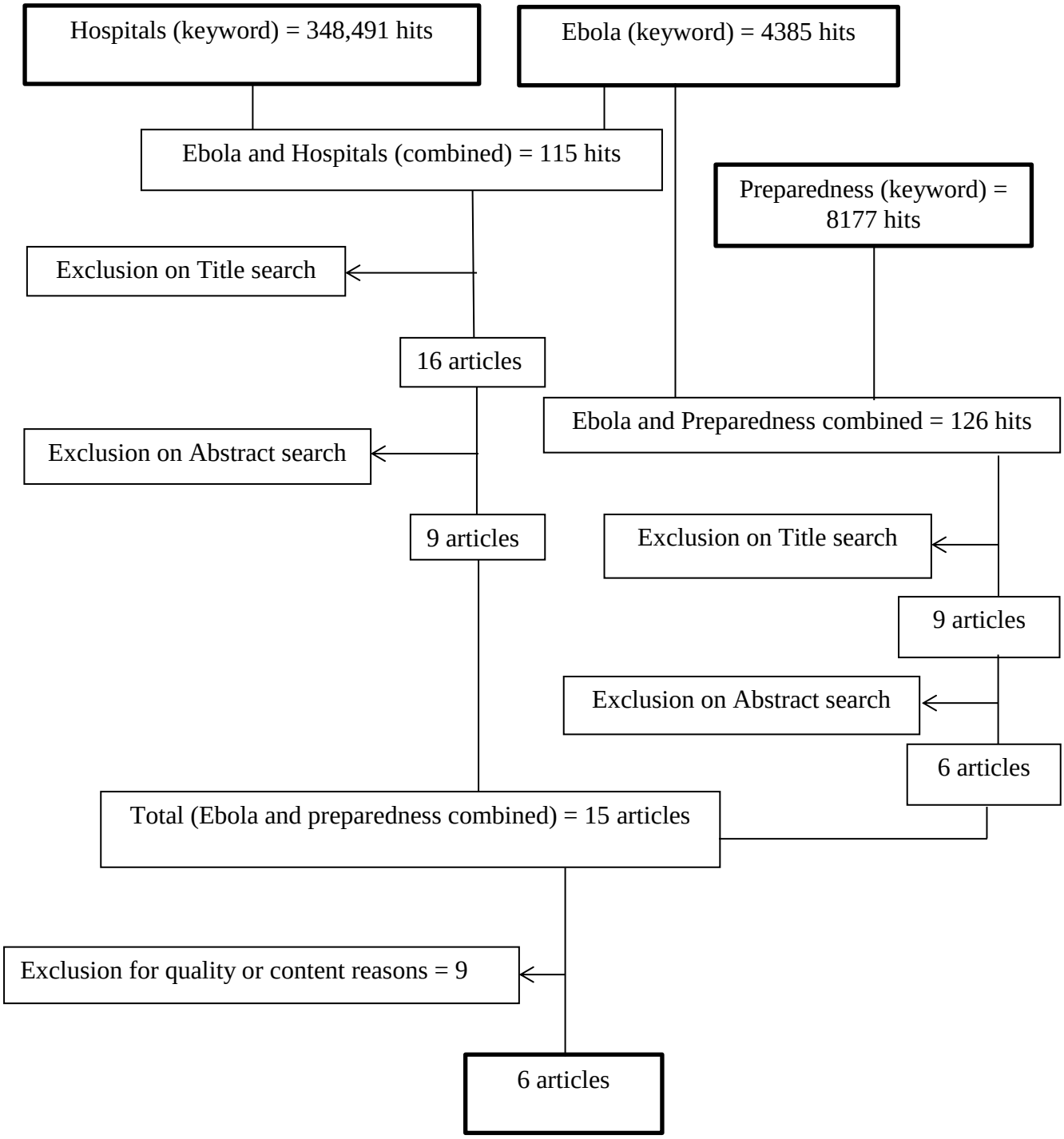

Figure 2. Literature Search from Ovid Medline 10/31/15

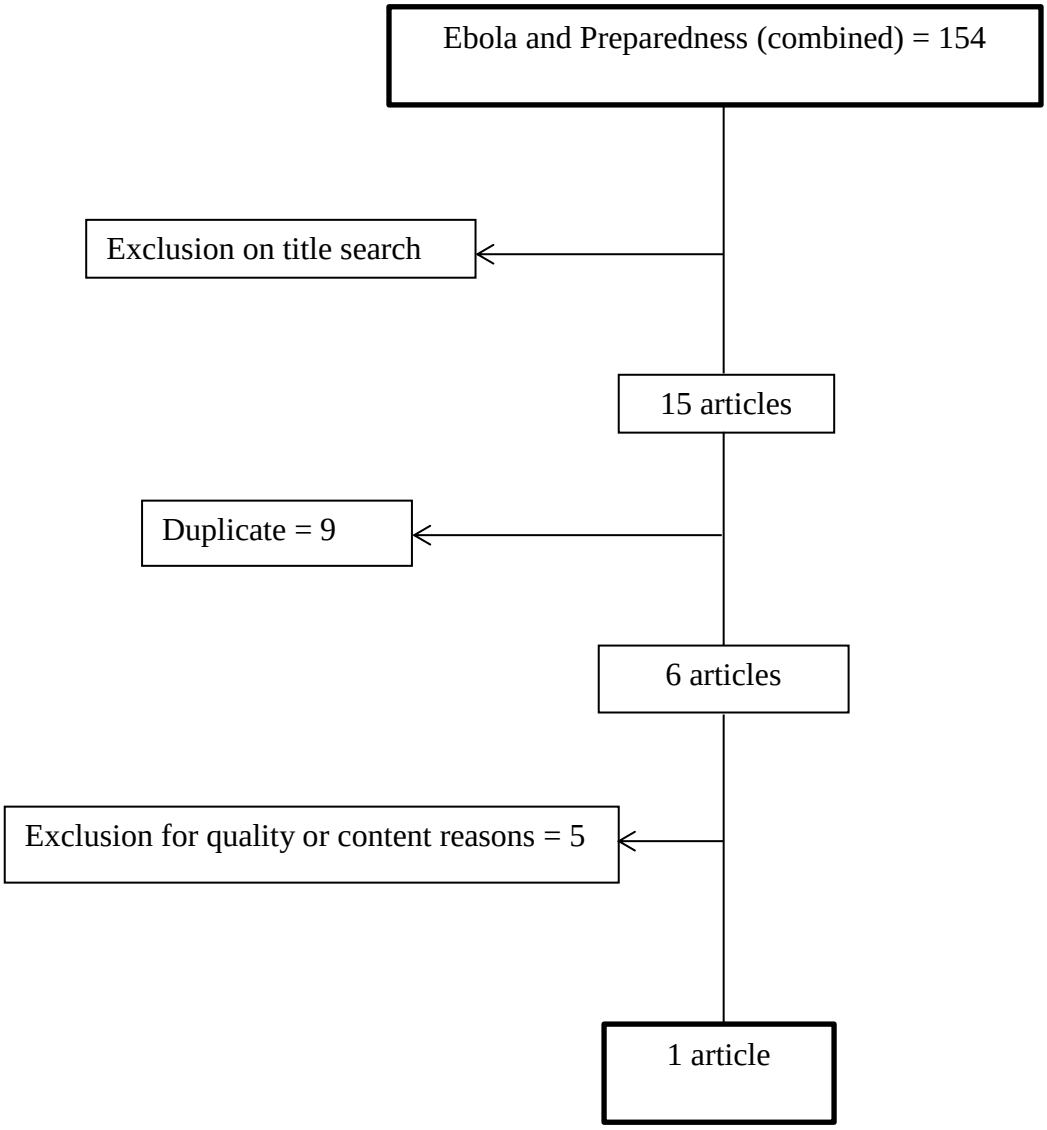

Figure 3. Literature Search from PubMed – 10/31/15

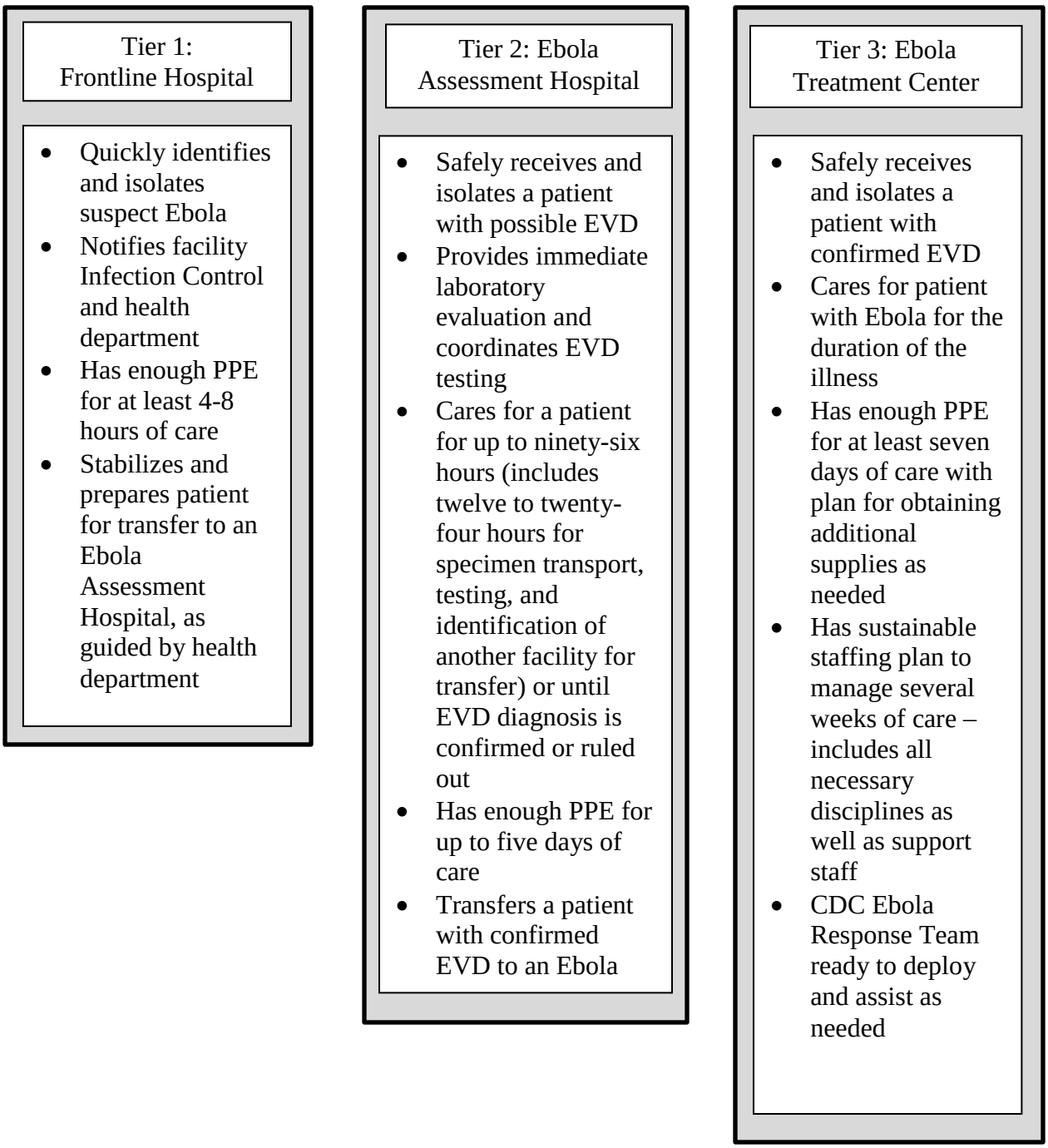

Figure 4. Adapted from a Three-Tiered Approach for Hospital Preparedness to Manage EVD

Centers for Disease Control and Prevention. (2014). 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. http://www.cdc.gov/vhf/ebola/healthcare-us/preparing/hospitals.html

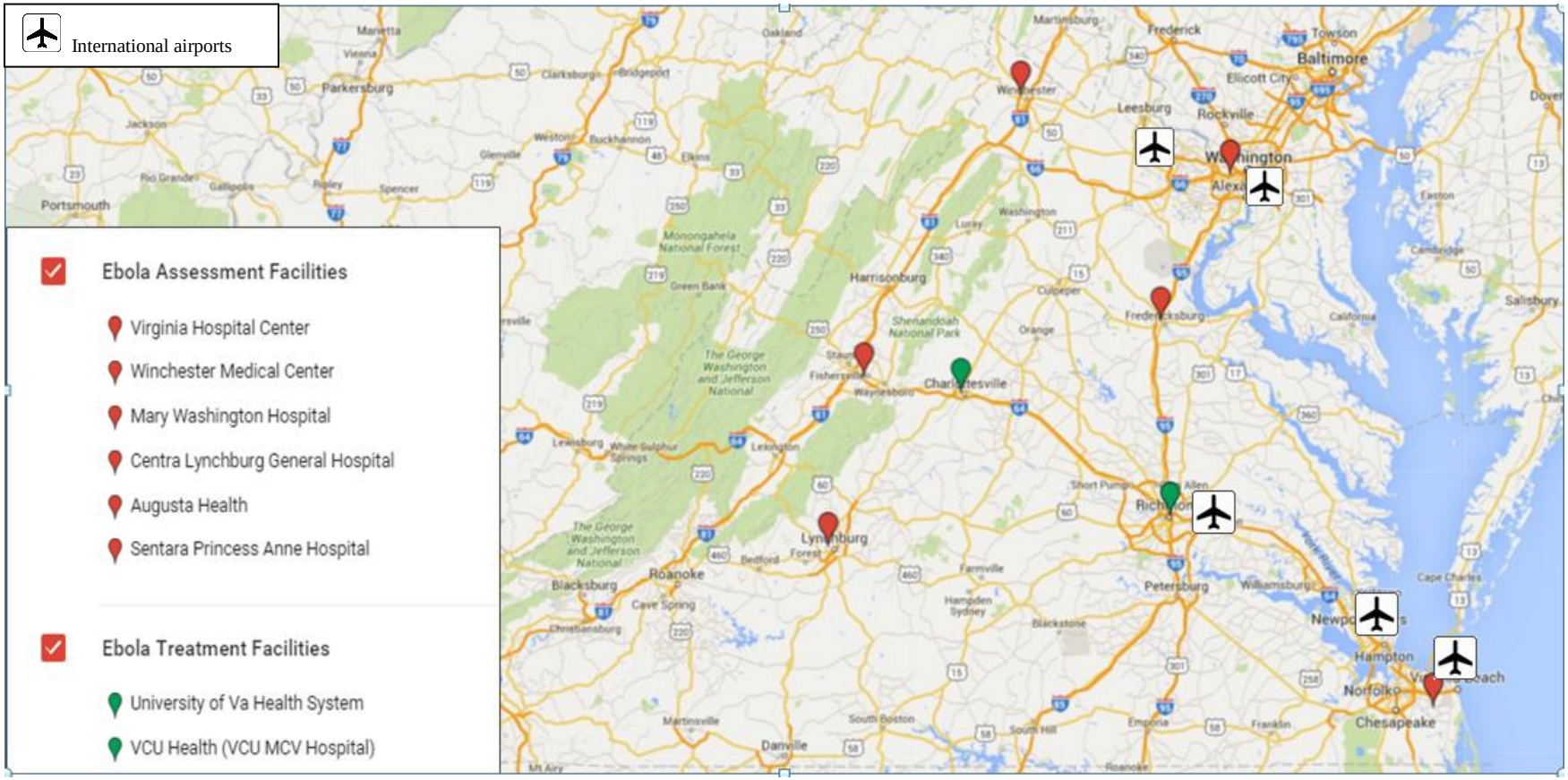

Figure 5. Map of international airports, assessment facilities, treatment facilities, and interstate highways

Appendix A - Elements of Treatment Center Capability

Ebola Treatment Center Capability	Capability Description	Minimum Capability in Place? Y/N[1]
Facility Infrastructure-Patient Room(s)	Hospital has a private room with in-room dedicated bathroom or covered bedside commode, is equipped with dedicated patient-care equipment and has available separate areas immediately adjacent to patient room: one for putting on (donning) of personal protective equipment (PPE) and one for removing (doffing) of PPE. These areas must be large enough to allow a trained observer to safely and effectively supervise donning and doffing of PPE.	
Patient Transportation	The state and local public health agency, emergency medical services provider(s), and the hospital have collaborated on the development of interfacility transportation plans that include identification of transport provider(s) with adequate training and PPE to safely transport a patient. Appropriate plans are in place for safe intrafacility patient transfer from ambulance entrance to treatment unit.	
Laboratory	Laboratory procedures/protocols, dedicated space, if possible, possible point-of-care testing, equipment, staffing, reagents, training, and specimen transport are in place. See CDC's Interim Guidance for Specimen Collection, Transport, Testing, and Submission for People Under Investigation (PUIs) for Ebola Virus Disease (EVD)(http://www.cdc.gov/vhf/ebola/healthcare-us/laboratories/specimens.html).	
Staffing	Readiness plans include input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff. Staffing plans have been developed to manage several weeks of clinical care. Staffing includes dedicated critical care nurses,	

	physicians, environmental services, infection control practitioners, laboratory staff, and respiratory services personnel designed to minimize the number of staff with direct patient contact. The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns.	
Training	A limited number of staff should have direct contact with patients. All staff that will be involved in patient care or supporting patient care have been appropriately trained for their role. Staff members who are involved in patient care have demonstrated proficiency in donning and doffing of PPE, proper waste management, infection control, and safe transport of lab specimens. Ongoing training program is in place and breaches in infection control are addressed through retraining. Teams have conducted a functional exercise of core processes. For more information, see CDC's Information for Healthcare Workers and Settings(http://www.cdc.gov/vhf/ebola/healthcare-us/index.html).	
PPE	Given current PPE shortages, hospitals may not be able to procure in advance the amount of PPE needed for the time to care for a patient with EVD. Therefore, at a minimum, to be ready to accept and care for patients with EVD, hospitals will need sufficient PPE for Ebola for at least 7 days. If hospitalization is anticipated to exceed 7 days, state and local health authorities, in collaboration with CDC, may provide or facilitate the procurement of additional PPE supplies. Staff who are involved in patient care or supporting patient care have	

	successfully drilled and demonstrated proficiency on donning/doffing(http://www.cdc.gov/vhf/ebola/healthcare-us/ppe/guidance.html). The overall safe care of patients with EVD in a facility must be overseen by an onsite manager at all times. Each step of every PPE donning/doffing procedure must be supervised by a trained observer to ensure proper completion of established PPE protocols. Additional information regarding PPE supplies and how to increase access to PPE(http://www.cdc.gov/vhf/ebola/healthcare-us/ppe/supplies.html) is available online.	
Waste Management	Hospital should have secured the services of a waste management vendor capable of managing and transporting Category A infectious substances and have appropriate containers and procedures for the safe temporary storage of Category A infectious substances. Staff are trained in the correct use of PPE and are trained in the proper handling and storage of Category A infectious substances at the facility. If a vendor capable of transporting Category A infectious substances has not been arranged, hospitals may consider sequestering medical waste until the patient's Ebola test result becomes known. At that time, if the patient is confirmed to have EVD, arrangements must be made with a vendor capable of managing for the waste as a Category A infectious substance; if the patient is ruled out for EVD, waste can be handled according to routine procedures in compliance with local waste management ordinances(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/waste-management.html).	

	For more information, see: Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/hospitals.html).	
Worker Safety	Worker safety programs and policies are in place. The hospital is in compliance with all federal or state occupational safety and health standards applicable to reducing employee exposure to the Ebola virus. Hospital has a program for ensuring direct active monitoring(http://www.cdc.gov/vhf/ebola/exposure/monitoring-and-movement-of-persons-with-exposure.html) of all healthcare workers involved in direct patient care to ensure monitoring for 21 days since last exposure. This monitoring should be done in coordination with local and state public health agencies.	
Environmental Services	Hospital has a program in place to clean and disinfect patient care areas and equipment, including use of an Environmental Protection Agency-registered hospital disinfectant with a label claim of potency at least equivalent to that for a nonenveloped virus, such as norovirus, rotavirus, adenovirus, and poliovirus. Hospital has staff trained in correct cleaning and disinfection of the environment, safe practices, and correct use of PPE; and cleaning staff are directly supervised during all cleaning and disinfection(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/hospitals.html). For more information, see Information for Healthcare Workers and Settings(http://www.cdc.gov/vhf/ebola/healthcare-us/index.html).	
Clinical Competency	Staff members who will be involved in managing the patient are familiar with the clinical protocols for management of patients with EVD and have access to consultation from experienced clinical EVD specialists. For more information, see Ebola Treatment(http://www.cdc.gov/vhf/ebola/treatment/index.html).	

Operations Coordination	The hospital has a practiced emergency management structure and a plan and methods for routinely communicating with relevant local and state public health agencies, emergency management authorities, its healthcare coalition (if appropriate), and the hospital's employees, patients, and community to ensure coordination of the response and communication regarding any persons under investigation for EVD and patients being treated for EVD in the facility.	
State/Hospital selection as an Ebola treatment center	The hospital and the state public health department, as the hospital's regulatory authority, have agreed that the facility is ready to serve as an Ebola treatment center.	

[1] Minimum capability can be considered adequate if all elements in the capability description are sufficiently met.

(http://www.cdc.gov/amd/project-summaries/novel-filoviruses.html)

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Centers for Disease Control and Prevention
National Center for Emerging and Zoonotic Infectious Diseases (NCEZID)
Division of Healthcare Quality Promotion (DHQP)

Appendix B = Elements of Assessment Center Capability

Ebola Assessment Hospital Capability	Capability Description	Minimum Capability in Place? (Y/N)[1]
Facility Infrastructure: Patient room(s)	Hospital has a private room with in-room dedicated bathroom or covered bedside commode, equipped with dedicated patient-care equipment, including separate areas immediately adjacent to patient room: one for putting on (donning) of personal protective equipment (PPE) and one for removing (doffing). These areas must be sufficient to allow a trained observer to safely and effectively supervise donning and doffing of PPE.	
Patient Transportation	Joint determination by state and local public health agency, emergency medical services, and hospital of interfacility transport plans (transfer of patients with confirmed EVD to the designated Ebola treatment hospital) including identification of transportation provider(s) (including ground and air transport) with appropriate training and PPE to safely transport a patient. Intrafacility plans for patient transport (for example, from ambulance entrance to the designated ward or unit for patients under investigation) are developed and in place. Additional information on patient transport(http://www.cdc.gov/vhf/ebola/healthcare-us/emergency-services/ems-systems.html) is available.	
Laboratory	Diagnostic laboratory procedures and protocols are in place for testing of specimens for Ebola by the nearest Laboratory Response Network (LRN) laboratory capable of testing for Ebola, addressing dedicated space (if possible), possible point-of-care testing, equipment selection and disinfection, staffing, reagents, training, and specimen transport for routine clinical diagnostic testing at the facility, as well as protocols for lab	

	personnel PPE use and training. For more information, see CDC's Interim Guidance for Specimen Collection, Transport, Testing, and Submission for People Under Investigation(http://www.cdc.gov/vhf/ebola/healthcare-us/laboratories/specimens.html).	
Staffing	Readiness plans include input from a multidisciplinary team of all potentially affected hospital departments (including clinical and nonclinical staff). Staffing plans have been developed and scheduled to support 96 consecutive hours of clinical care. Sufficient physician and nursing staff should be available to handle the patient's care needs. The facility has a process for continuous staff input from those who may or may not be directly involved in Ebola patient care, including from employee unions, and has addressed employee safety questions and concerns.	
Training	All staff involved in or supporting patient care are appropriately trained for their roles, and according to their roles, have demonstrated proficiency in donning and doffing of PPE, proper waste management, infection control practices, and specimen transport. Ongoing training is provided and breaches in infection control are addressed through retraining. Bearing in mind the need to limit the number of staff in direct contact with the patients, hospitals should consider comprehensive cross-training. For more information, see CDC's Information for Healthcare Workers and Settings(http://www.cdc.gov/vhf/ebola/healthcare-us/index.html).	
PPE	For patients who are clinically stable and without vomiting, copious diarrhea, or obvious bleeding, or a clinical condition that warrants invasive or aerosol-generating procedures (intubation,	

	suctioning, active resuscitation), personal protective equipment (PPE) and infection control practices according to the CDC's guidance for clinically stable PUIs(http://www.cdc.gov/vhf/ebola/healthcare-us/emergency-services/emergency-departments.html) may be used. For patients with vomiting, copious diarrhea, or obvious bleeding, or patients requiring invasive or aerosol-generating procedures, PPE designated for the care of hospitalized EVD patients should be used(http://www.cdc.gov/vhf/ebola/healthcare-us/ppe/guidance.html). Clinical staff has successfully drilled and demonstrated proficiency in donning/doffing PPE. The overall safe care of Ebola patients in a facility must be overseen by an onsite manager at all times, and each step of every PPE donning/doffing procedure must be supervised by a trained observer to ensure proper completion of established PPE protocols. Hospital has selected appropriate PPE for Ebola and has at least a 4–5-day supply of PPE in stock and a vendor capable of providing re-supply. In the event that a facility does not have sufficient PPE, the facility should work with local healthcare coalitions, emergency management services, and local and state public health departments, in collaboration with CDC, to identify additional PPE resources. See CDC's additional information regarding PPE supplies and how to increase access to PPE(http://www.cdc.gov/vhf/ebola/healthcare-us/ppe/supplies.html).	
Waste Management	Ebola assessment hospitals should have in place the services of a waste-management vendor capable of managing and transporting Category A infectious substances, have appropriate containers and procedures for the safe temporary storage of	

	Category A infectious waste, and ensure staff are trained in the correct use of PPE and in the proper handling and storage of Category A infectious substances at the facility. If a vendor capable of transporting Category A infectious substances has not been arranged, hospitals may consider sequestering medical waste until the patient's Ebola test result becomes known. At that time, if the patient is confirmed to have Ebola, arrangements should be made with a vendor capable of managing the waste as a Category A infectious substance; if the patient is ruled out for Ebola, waste can be handled according to procedures in compliance with local waste management ordinances(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/waste-management.html). Additional information is available at Interim Guidance for Environmental Infection Control in Hospitals for Ebola Virus(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/hospitals.html).	
Worker safety	Worker safety programs and policies are in place. The hospital is in compliance with all federal or state occupational safety and health regulations applicable to reducing employee exposure to the Ebola virus. Hospital has a program for assuring direct active monitoring(http://www.cdc.gov/vhf/ebola/exposure/monitoring-and-movement-of-persons-with-exposure.html) of all healthcare workers involved in direct patient care to assure monitoring for 21 days since the last known exposure. This monitoring should be done in coordination with local and state public health agencies.	
Environmental Services	Hospital has a program in place to clean and disinfect patient care areas and equipment, including use of an Environmental Protection Agency-registered hospital disinfectant with a label claim of potency at least equivalent to that for a non-enveloped	

	virus (norovirus, rotavirus, adenovirus, and poliovirus), PPE, and safe practices. Designated staff are trained in correct cleaning and disinfection of the environment, safe practices, and correct use of PPE; and cleaning staff are directly supervised during all cleaning and disinfection(http://www.cdc.gov/vhf/ebola/healthcare-us/cleaning/hospitals.html). For more information, see Information for Healthcare Workers and Settings(http://www.cdc.gov/vhf/ebola/healthcare-us/index.html).	
Clinical Management	Staff who will be involved in managing the patient know the clinical protocols for management of PUIs. For more information, see evaluation(http://www.cdc.gov/vhf/ebola/healthcare-us/emergency-services/emergency-departments.html) and discharge(http://www.cdc.gov/vhf/ebola/healthcare-us/evaluating-patients/discharging.html) of patients under investigation.	
Operations Coordination	The hospital has an emergency management structure, plans and processes for routinely communicating with local and state public health agencies, emergency management authorities, its healthcare coalition (if appropriate), and hospital employees, patients, and community leadership, to ensure coordination of the response and communication regarding any PUIs for Ebola.	

[1] Minimum capability can be considered adequate if all elements in the capability description are sufficiently met.

(http://www.cdc.gov/amd/project-summaries/novel-filoviruses.html)

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Appendix C

Last updated August 27, 2014

Infection Control & Hospital Epidemiology

Published for The Society for Healthcare Epidemiology of America
in partnership with Cambridge University Press

Instructions for Authors

GENERAL INFORMATION

Manuscripts submitted to *Infection Control & Hospital Epidemiology (ICHE)* should consist of original investigations that will contribute to the fields of healthcare epidemiology and infection prevention with the ultimate goal of improving healthcare safety. *ICHE* welcomes submissions that address the transmission of pathogens or that involve the use of epidemiological principles and methods to evaluate or improve the delivery of care within healthcare institutions. Examples of appropriate material include studies of infection surveillance, the impact of preventive measures on infection rates; analyses of resource use and costs related to infections or other adverse events in patients; occupational health; or pertinent regulatory issues. Authors are responsible for ensuring that manuscripts adhere to the formats noted in the Instructions for Authors. Articles should be submitted electronically at the journal's submission website, at http://iche.edmgr.com.

ARTICLE TYPES

Original Articles should include a title page, a structured abstract of no more than 250 words (see below), a text of no more than 3,000 words, no more than 7 tables and figures, and no more than 40 references.

Concise Communications should include a title page, a narrative abstract of no more than 50 words, a text of no more than 1,200 words, no more than 2 tables or figures, and no more than 10 references.

Research Briefs should include a title page, a text of no more than 900 words, no more than 1 table or figure, and no more than 10 references. This category of article is intended for the presentation of short, focused, and evidence-based experimental observations: substantial preliminary and novel results of importance to the journal readership but not substantial enough in content to warrant a longer presentation. Research Briefs undergo the same peer review as longer article types.

Letters to the Editor should not exceed 900 words and should include no more than 1 table or figure and no more than 10 references.

Invited Reviews, including guidelines and position papers: committees, task forces, and authors under the auspices of the Society for Healthcare Epidemiology of America, and all others considering the preparation of a review, should contact the Editorial Office during the very earliest phases of development. The Editor-in-Chief will verify that there are no similar or overlapping documents under development. Anticipated length, format, number of citations, and

mechanisms for peer review and publication by *ICHE* and the involvement of any other organizations will be negotiated with the journal and publisher well in advance of submission.

Commentaries are by invitation only. Please contact the journal office if you are interested in writing a Commentary.

MANUSCRIPT PREPARATION

Authors are encouraged to follow the Uniform Requirements for Manuscripts Submitted to Biomedical Journals; this is the format used in PubMed/MEDLINE. They should strive for a concise article that is unencumbered by excessive detail. Authors who are not fluent in English should have their manuscript checked by a native speaker of English and/or an editing service that provides such assistance. Manuscripts that do not follow the required format or are poorly prepared may be rejected for that reason.

For guidance regarding the reporting of randomized (CONSORT), observational (STROBE), meta-analyses (PRISMA), and other clinical trials, please consult www.equator-network.org.

Double space the entire manuscript, including title page, abstract, body, references, tables, and figure legends. Use left justification only, so that the right margin is ragged. Number pages consecutively, beginning with the title page. Use a standard font (such as Times New Roman or Helvetica) and set the font size to 12 points (for tables as well as text). Each component of the article should begin on a separate page, as follows: title page, abstract, body text, acknowledgments, references, appendices, figure legends, and tables. All these components must be in a single file, except any figures, each of which should be a separate file (see Figures and Figure Legends, below).

Title Page

The title page should include the following information: (1) the title of the manuscript; (2) the names of the author(s), including each author's highest academic degree or professional certification; (3) the departmental and institutional affiliation of each author, including city, state, and country; (4) the name, address, telephone number, fax number, and e-mail address of the author responsible for correspondence, and (if different) the name and address to be used for reprint requests; (5) if relevant, a statement about any previous presentation of the data or findings in a preliminary report or abstract; (6) an abbreviated title of not more than 45 characters (including spaces), to be used as a running head in print and for search results online; and (7) a word count for the body of the text (ie, excluding the abstract and the references). Acknowledgment of financial support and potential conflicts of interest must be included and should be placed in the Acknowledgments section (see below).

Abbreviations should conform to those given in the *AMA Manual of Style*. Symbols for units of measurement (mm, mL) should not be followed by periods. Chemical or generic names of drugs, materials, and equipment are strongly preferred; a proprietary name may be given only after it is preceded by the generic or chemical name the first time it appears and must be followed by the name of the manufacturer or supplier. Terms and abbreviations must be defined at first use, separately for the abstract, the body, and each table and figure. Use only common abbreviations

and use as few as possible; and do not abbreviate terms used fewer than 5 times. Abbreviate genus names after first mention.

Abstract

Original Articles should include a structured abstract of no more than 250 words. The following headings are suggested: Objective, Design, Setting, Patients (or Participants), Methods (or Interventions), Results, and Conclusions. If this list of headings is inappropriate, variations are permitted: for example, a study that involved no intervention would use the heading "Methods" rather than "Intervention"; or an analysis of an existing data set might use the heading "Methods" in place of both "Intervention" and "Setting." For brevity, parts of the abstract can be written in phrases rather than complete sentences, .e.g.,"Design: Retrospective cohort study". The contents of each section should conform to the guidelines below.

Objective. Begin with a clear statement of the precise objective or question addressed in the report. If more than one objective is addressed, indicate the main objective and state only key secondary objectives. If an a priori hypothesis was tested, it should be stated.

Design. Describe the basic design of the study. Include the duration of follow-up, if any. Use as many of the following terms as apply.

• For intervention studies: randomized controlled trial; nonrandomized controlled trial; doubleblind; placebo controlled; crossover trial; before-after trial.
• For studies of screening and diagnostic tests: indicate the criterion standard against which a new or alternative test is being compared; blinded or masked comparison.
• For studies of prognosis: inception cohort (subjects assembled at a similar and early time in the course of the disorder and followed thereafter); cohort (subjects followed forward in time, but not necessarily from a common starting point); validation cohort or validation sample, if the study involves the planing of clinical predictions.
• For studies of causation: randomized controlled trial; cohort; case-control; survey (preferred to "cross-sectional study").
• For descriptions of the clinical features of medical disorders: survey; case series.
• For studies that include a formal economic evaluation: cost-effectiveness analysis; cost-utility analysis; cost-benefit analysis. For new analyses of existing data sets, the data set should be named and the basic study design disclosed.

Setting. To assist readers in determining the applicability of the report to their own clinical circumstances, include a brief description of the study setting(s) such as: primary or tertiary referral center, private or public institution, or an ambulatory or acute care setting.

Patients or participants. Provide information on important eligibility criteria, and key sociodemographic features of patients and how they were selected, including the number of otherwise eligible subjects who were approached but refused to participate. If matching was used for comparison groups, specify the characteristics that were matched. In follow-up studies, the proportion of participants who completed the study must be indicated. In intervention studies, the number of patients withdrawn because of adverse effects should be given.

For selection procedures, these terms should be used, if appropriate: random sample ("random" refers to a formal, randomized selection in which all eligible subjects have a fixed and usually

equal chance of selection); population-based sample; referred sample; consecutive sample; volunteer sample; convenience sample.

Intervention(s). Describe the essential features of any interventions, including the method and duration of administration. The intervention should be named by its most common clinical name (eg, the generic term "oseltamivir"), the brand name of a drug, if a specific product was studied, and the name of the manufacturer or supplier for any product(s) mentioned in the manuscript, including software.

Results. Give the main results of the study in narrative form. Define measurements that require explanation for the expected audience of the manuscript. If possible, the results should be accompanied by objective data and the exact level of statistical significance. For comparative studies, confidence intervals should relate to the differences between groups. When risk changes or effect sizes are given, indicate absolute values, so that the reader can determine the absolute, as well as relative, impact of the finding. Approaches such as "number needed to treat" to achieve a unit of benefit are encouraged when appropriate. Studies of screening and diagnostic tests should use the terms sensitivity, specificity, and likelihood ratio. If predictive values or accuracy are given, prevalence or pretest likelihood should be given as well.

Conclusions. Only those conclusions of the study that are directly supported by the evidence reported should be given, along with the clinical application; indicate whether additional study is required before the information should be used in normal clinical settings. Equal emphasis must be given to positive and negative findings of equal scientific merit.

Clinical trials identifier. If your manuscript is the report of a randomized clinical trial that has been registered in a public trials registry, please provide the trial registry name, the registration identification number, and the URL for the registry at the end of the abstract. This information will be published in the journal if the manuscript is accepted.

Body Text

The main sections and subdivisions of the body text should be indicated by side heads flush with the left margin and two lines above the text.

Keep Introduction, Methods, Results, and Discussion distinct and separate. The Methods section should provide detail sufficient to allow others to re-create your experiment. Methods may not be described or restated in figure legends or table notes, but must be all together in the Methods section. The Results section contains the previously unpublished data derived by this application of your methods. The Discussion section contains your interpretation of the reported data and comments on its meaning. There should be no separate section labeled "Conclusion." Avoid duplicating in the text data that have been provided in tables or figures. Also avoid duplication within the text; the Discussion section should not restate all the findings that have been presented in Results and/or in tables and figures.

The Editor requests that authors reporting the results of clinical trials describe clearly the following: (1) eligibility criteria; (2) whether subjects were admitted before allocation to one of the study groups; (3) the method of randomization; (4) whether the study was "masked," what

specific information was masked, and whether subjects, clinicians, and evaluators were masked; (5) the method used to identify treatment complications; (6) an explanation and analysis of subjects lost to follow-up; (7) statistical methods used; and (8) information that led to the determination of the size of the study groups and the expected differences between groups. For all studies involving human subjects, the Methods section should include a statement that the study was reviewed and approved by the authors' institutional review board.

Footnotes are acceptable in tables but cannot be used in the body of the manuscript; any footnotes in your manuscript will be integrated into the text, perhaps in parentheses.

Acknowledgments

Financial support. The Acknowledgments section should list all sources of financial support for the work, including any financial arrangement with a company whose product is related to the study. If there was no financial support, that too should be stated. The statement should be consistent with disclosures that would be stated in the ICMJE Form for Disclosure of Potential Conflicts of Interest.

Examples:
• *Financial support*. The GERES Project is supported by the French Ministry of Health. Additional support for this study was provided by Becton-Dickinson and SIMS France.
• *Financial support*. H.S.C. received grant support from the Department of Veterans Affairs Rehabilitation Research and Development Service Merit Review (C2234-MD and C3-2442MD), D.B.L. received support from the US Public Health Service (grant HC41024), and A.E.T. received salary support from an Emerging Infectious Diseases Cooperative Agreement. C.U. receives 2% salary support from Aventis Pasteur for work on another study.
• *Financial support*. None reported.

Conflict of interest. The Acknowledgments section must contain a statement of potential conflicts of interest. If the manuscript is accepted for publication, the disclosures will be published. The Acknowledgments section of the manuscript must list the name of each contributing author and any potential conflicts of interest for each author for the previous three years; if no potential conflict exists, that too should be stated. The statement should be consistent with disclosures that would be stated in the ICMJE Disclosure Form. There is a potential conflict of interest when anyone involved in the publication process has a financial or other beneficial interest in the products or concepts mentioned in a submitted manuscript, or in competing products, that might bias his or her judgment. Examples of potential conflicts of interest with respect to a company whose product is mentioned in the manuscript include owning stock (except as part of a diversified portfolio), receiving grants, serving as a consultant, or being on the speakers' bureau. (This information is exclusive of the financial support discussed above.)

Examples:
• *Potential conflicts of interest*. S.A. and K.H. report that they are shareholders in Loke Diagnostics (Aarhus, Denmark).

• *Potential conflicts of interest*. K.L.H. reports having consulted for and having received grant support from Astellas and reports having received an honorarium from Cubist before starting employment with the New York Department of Public Health in 2009.
• *Potential conflicts of interest*. E.F.M. reports that she has been a consultant to Merck, Novartis, and GlaxoSmithKline and is member of the speakers' bureaus for Ortho McNeil and Novartis. J.A.S. reports that he received research funding from Bayer and Ortho McNeil and that he has been a consultant for Bayer and Pfizer. J.D.C. reports that he is an employee of AB Biodisk.
• *Potential conflicts of interest*. All authors report no conflicts of interest relevant to this article.

***Authorship and manuscript preparation*.** If the manufacturer of a product discussed in a submitted manuscript had a role, either directly or through a third party, in the gathering or preparation of data or in the writing of the manuscript, that information must be disclosed in the Acknowledgments section. If anyone other than the named authors had a role in the gathering or preparation of data or in the writing of the manuscript, that too should be disclosed.

Examples:
• *Manuscript preparation*. Steris Corporation provided assistance with study design and data acquisition.
• *Manuscript preparation*. Statistical and other analyses were done by 3M Medical Division.
• *Manuscript preparation*. MedCommunications (Philadelphia) provided assistance in preparing and editing the manuscript.

Disclosure documentation. All authors of Original Articles, Concise Communications, and Research Briefs are required to complete and upload the ICMJE Form for Disclosure of Potential Conflicts of Interest when and if they are asked to submit a revision of their manuscript. All authors of Letters and invited manuscripts (Letters in Reply, Commentaries, Reviews, and Guidelines) are required to complete and upload the ICMJE Disclosure Form when they initially submit their manuscript. Note that this documentation is in addition to the disclosure statements in the Acknowledgments section of the manuscript file.

Thank you notes. Persons should not be thanked in the Acknowledgments section without their knowledge and consent. Authors will be asked during the submission process to confirm they obtained permission from all persons thanked by name in the Acknowledgments section.

REFERENCES
References should be cited consecutively in the text, with superscript numbers placed outside periods and commas and inside colons and semicolons. References cited only in tables or figure legends should be numbered as though all were cited at the point at which the table or figure was first mentioned.

A paper that is "in press" may be included in the reference list if it has been accepted for publication. Citations such as "in preparation," "submitted for publication," "unpublished data," and "personal communication" should be given in parentheses in the text only, including the names of all individuals to whom the information should be attributed, as well as each person's highest academic degree and the month and year of the information's origin. For personal communications, specify whether the communication was written or oral.

At the end of each manuscript, list the references in numerical order, double spaced, according to the order they are cited in the text. If there are 7 or more authors, list the first 3 authors' names, followed by "et al"; otherwise, list all authors. Abbreviations of journal names should conform to *Index Medicus* or MEDLINE. Unlisted journals should not be abbreviated. Authors are responsible for bibliographic accuracy. Journal titles should be cited as they existed at the time of publication. Format references according to the style given in the AMA Manual of Style, 10th Edition.

Journal article *(examples)*
1. Pittet D, Simon A, Hugonnet S, Pessoa-Silva CL, Sauvan V, Perneger TV. Hand hygiene among physicians: performance, beliefs, and perceptions. *Ann Intern Med* 2004;141:1-8.

2. Camins BC, Richmond AM, Dyer KL, et al. A crossover intervention trial evaluating the efficacy of a chlorhexidine-impregnated sponge in reducing catheter-related bloodstream infections among patients undergoing hemodialysis. *Infect Control Hosp Epidemiol* 2010;31:1118-1123.

Journal article in press *(example)*
3. Figueroa P, Johanssen KL, Price FG, et al. Outbreak of *Acinetobacter* infection in a neonatal intensive care unit. *Pediatr Infect Dis J* (in press).

Paper presented at a professional meeting *(example)*
4. Chen LF, Freeman JT, Sexton DJ, Choi YI, Anderson DJ. NHSN definition of laboratorydetected BSI is overly sensitive for *Enterococcus*. In: Program and abstracts of the 19th Annual Scientific Meeting of the Society for Healthcare Epidemiology of America (SHEA); March 18– 22, 2009; San Diego, CA. Abstract 359.

Book *(example)*
5. Heoprich PD. *Infectious Diseases*. 2nd ed. New York, NY: Harper & Row; 1977.

Chapter in a book *(example)*
6. Schaffner W. Psittacosis: ornithosis, parrot fever. In: Beeson PB, McDermott W, Wyngaarden JB, eds. *Cecil Textbook of Medicine*. 15th ed. Philadelphia, PA: W. B. Saunders; 1979:336-338.

Web page *(example)*
7. Clinical laboratory fee schedule. Centers for Medicare and Medicaid Services website.http://www.cms.gov/ClinicalLabFeeSched/02_clinlab.asp#TopOfPage. Published 2010. Accessed April 2, 2010.

TABLES
Prepare tables with the MS Word table editor; text formatted to look like a table by use of tabs and hard returns is not acceptable and will be rejected. Include tables in the same file as the rest of the manuscript, not in separate files. Tables should be double spaced. Number tables in the order in which they are cited in the text, and provide a descriptive title for each table.

Every column in a table requires a head that describes the contents of the cells below. The units of measure for all data must be clearly stated in the heads, in the stub (leftmost) column, or in data cells, as appropriate. Do not use vertical lines, and do not use ditto marks for repeated information.

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The Response Capability of Designated Special Pathogen Assessment and Treatment Centers: Staffing a Major Health Incident

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Abbreviated Title – Response Capability of Designated Centers

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Abstract

Objective: This study determined the response capability of designated special pathogen centers by reviewing hospital response staffing plans to determine presence of recommended Centers for Disease Control and Prevention (CDC) characteristics and unique center characteristics.

Design and Setting: A descriptive comparative study evaluating the response staffing plans of two treatment and six assessment hospitals in the Commonwealth of Virginia.

*Participant*s: All eight CDC designated special pathogen centers in the Commonwealth were included in the study.

Methods: A written request for a copy of current staffing plans was followed by a routine annual visit by hospital association and public health department personnel to obtain written response staffing plans. Identified gaps were shared with the centers in an effort to improve individual plans.

Results: Many of the assessment centers could not produce a detailed written staffing plan, but all provided some degree of information. The treatment centers provided plans which included all of the recommended elements suggested by the CDC interim guidance. Common to all of the centers is the concern of maintaining a core care team for the special pathogen population.

Conclusions: Assessment centers do not have sufficient detailed written response staffing plans based on CDC guidance. Despite the need, most hospitals are challenged to maintain the required state of readiness as demonstrated in the CDC guidance. The study identified gaps in staffing plans and proposed recommendations to achieve a higher state of readiness through a mutual stakeholder networking approach to support sustained improvements as a collective group within the Commonwealth.

Introduction

This study provided answers to the question of the response capability of assessment and treatment centers in the Commonwealth of Virginia to the care of an Ebola patient as evidenced by their staffing plans. These plans are designed to provide the healthcare professionals with a comprehensive and detailed guide to providing safe and efficient care for these extremely high-risk populations. Consideration for the healthcare provider is as important as the care they deliver. Staffing plans should share common characteristics, with only minimal variation related to the environmental space, style or type of personal protective equipment (PPE), and types of available support services. Plans should minimally include the recommended elements related to staffing plans suggested by the Centers for Disease Control and Prevention (CDC) interim guidance.[1]

Performing a thorough review of the available staffing plans from the designated assessment and treatment centers in Virginia and comparing the characteristics of each served to provide a description of the commonalities and differences across the Commonwealth. Comparing this information to the recommendations set forth by local, state, and national authorities assisted with the development of a framework that can provide these facilities with additional information to improve staffing plans and provide healthcare professionals with the assurance and support that is required to care for this population.

The objective of the study was to determine the response capability of Virginia-based CDC designated special pathogen centers established in response to the Ebola Virus Disease (EVD) events of 2014 in the U. S. There are five international airports in Virginia that receive travelers from West African nations. There are three interstate roadways that travel through the

state; two traverse north and south, one traverses east and west (Figure 1). The staffing response plans of the six assessment hospitals and two treatment hospitals were evaluated to determine to what extent the CDC interim guidance[1] recommendations for staffing were included in each plan as well as any additional characteristics unique to the center. Identified gaps in the plans were shared with the centers in an effort to improve the plan. Consideration of the perceptions of direct healthcare providers can transform these plans into evidence-based and comprehensive plans.

Method

A descriptive comparative design was used to perform a descriptive evaluation. The specific elements of each staffing plan were classified as similar or unique elements for each center and compared to the recommended elements suggested by the CDC interim guidance.[1]

For the first phase of the study a formal letter was sent to a designated contact at each center to request a copy of their current staffing plans related to care of the EVD population. A follow-up visit to each designated center was made over the following months to discuss any available plans and to obtain any additional information. These visits coincided with the follow-up visits conducted by representatives from the Virginia Department of Health, Virginia Hospital and Healthcare Association, and other local and regional agencies that are required as part of each designated center's annual evaluation.

Information was requested from two academic medical centers that were designated treatment centers: The University of Virginia Medical Center and Virginia Commonwealth University Health System. Six designated assessment centers also participated in the study: Sentara Princess Anne Hospital, an acute care hospital; Winchester Medical Center, a not-for-profit regional referral center; Mary Washington Hospital, a not-for-profit regional hospital;

Centra Lynchburg Hospital, part of a regional non-profit healthcare system; Augusta Health, a general medical and surgical hospital; and Virginia Hospital Center, a tertiary care facility. Designated contact information was provided by the Virginia Hospital and Healthcare Association.

All designated centers in the Commonwealth of Virginia participated in the study at some level. While there was no response to the letter requesting information, all of the centers were welcoming and ready to provide the available information during the face-to-face conversations during the annual evaluation visit.

Staffing plans for emergency departments and inpatient areas were requested. Some assessment centers decided to keep a patient with a suspected special pathogen diagnosis in the emergency department for the duration of their stay and only have plans for that area.

The treatment centers provided plans which included all of the recommended elements related to staffing plans suggested by the CDC interim guidance.[1] Treatment centers began to formulate their plans in mid-2014, when EVD transmission was escalating outside the borders of the United States. Adaptations of existing emergency management plans were made to meet the needs of this highly infectious population of patients and have been further adapted to meet the predicted needs of other special pathogen populations (Table 1).

A search of the Ovid MEDLINE database and the PubMed database was conducted for literature published from 2010 to present. All articles selected were case studies, descriptive studies, or expert opinion.[2, 3, 4, 5, 6, 7, 8] Most of the articles were based on perceptions of healthcare professionals who either cared for or trained in some manner to prepare for the care of special pathogens patients; in this case Ebola.

Based on the literature the study identified unique and undetermined characteristics in the available staffing plans. Undetermined characteristics were defined as characteristics that were vague and could not be classified as met or not met. Follow-up with the designated contact to discuss these characteristics was done with a goal of considering the possible application at other centers. These characteristics assisted with defining best practices for both assessment and treatment centers. Several critical elements were considered important during the review of available information. Principle to the success of delivering care to this population is having a large enough team of healthcare workers to deliver ongoing care. It is also important to develop mechanisms for front-line caregiver feedback into the care delivery process.

Every effort was made to maintain the anonymity of each center during the evaluation of staffing plan characteristics. This descriptive study did not involve human subjects and was waived the Institutional Review Board prior to commencement.

Results

Each assessment center was able to provide limited written detail regarding their staffing plans. Of note, assessment centers were not evaluated for initial designation until mid-2015 and, for the most part, have not cared for an EVD patient or a patient under investigation (PUI). This could explain the limited details in the staffing plans, but it is important to note that all of the assessment centers stated that their staffing plans continue to be a sustained effort to achieve their objective.

Most assessment centers plan to care for the EVD population and possibly all special pathogen populations in the emergency department to avoid risks associated with the movement of patients through the hospital to other care areas. This has led to a predominance of emergency

department personnel on the care team. Many are supplemented by intensive care unit nurses as needed.

Though many of the assessment centers could not produce a detailed written staffing plan, all were able to verbally provide some detail related to the number of team members, the various roles of the team members, care rotation, notification of team members and how input from the team members forms and changes the plan (Table 2). Most centers were not able to articulate the inclusion of some support staff roles (i.e., social work, nutrition, human resources, or chaplaincy), which resulted in an undetermined result for each of the centers. It should be noted that assessment centers are expected to care for patients for less than 96 hours. Most, if not all, patients would be transferred to a treatment center within the first 72 hours or as soon as a diagnosis is confirmed. This may negate the need for extensive involvement from several of the non-direct care or support services in designated assessment centers.

Teams in designated treatment centers are comprised of a core group of healthcare workers across all disciplines including direct and non-direct caregivers. Plans include treatment modalities in both emergency department and intensive care unit settings. Both treatment centers plans have been developed to include several weeks of clinical care in a secure setting that can meet the needs of the patient in any phase or level of care. Staff input related to the process of care was encouraged and used to improve care delivery and ensure the safety of caregivers.

Common to all of the centers is the concern related to maintaining a core team to care for this population. All organizations experience turnover whether related to resignation, promotion, or role change. Most centers spoke to the challenges associated with care providers that choose to opt-out of caring for special pathogens population, but all centers honor those choices.

Based on information obtained for this study direct care teams range from 10-100+ members. Table 3 demonstrates the minimum number of direct care providers and support personnel for one EVD patient in the early phase of the disease based on recommendations and the experience from one of the treatment centers.[9] Later phases of the disease would require additional direct care providers to meet the clinical needs of the patient and to ensure an adequate rotation of direct care providers as the patient acuity increases. It is important to note that all team members require extensive training over several days in infection control practices and the use of PPE. Most centers have a plan for training and re-training, but all verbalized the use of just-in-time training for reinforcement.

Some unique characteristics were identified from both treatment and assessment centers (Tables 4 and 5). Many of these characteristics were either unrelated to direct care or had no relationship to the staffing plan. One of the assessment centers noted that their plan was to have the caregiver spend no more than 20 minutes delivering direct care to a patient. This could result in more donning and doffing procedures resulting in increased cost and the likelihood for error during the donning and doffing procedures. It should be noted that the patient in an assessment center may be less acute and does not require continuous care.

Another assessment center has a plan for a PUI patient for up to seven days. Assessment centers typically provide care for up to four days, but this center has the capacity to reach out to other hospitals in their system for additional trained personnel. While it would be rare that a PUI would not be diagnosed as positive or negative within a few days, it is possible that there could be some barriers to diagnosis.

One assessment center made the decision to hire and train a dedicated person for special pathogen preparedness. The person in this position manages all aspects of the program and has

oversight for planning, training, and staffing operations. Other centers rely on their emergency management personnel, as well as managers and directors of care areas to work together as a team to manage specific functions of the plans.

A staffing plan at one assessment center scheduled nurses for a four-hour shift and rotated new staff in every four hours. Most centers however continue to plan for a twelve-hour shift with staff rotation every two hours.

At least three of the assessment centers include one round of life-saving drugs and defibrillation for patients. All centers refrain from performing manual cardiac compressions as a life-sustaining measure.

Nearly all of the centers rely on transitional space to care for this population. The area is used on a day-to-day basis for normal operations, but the space can be converted quickly to meet the needs of the special pathogen population. One treatment center uses a dedicated space for the special pathogens population. Their Unique Pathogen Unit, or UPU, is set up in a constant state of readiness. The space is used for training, drills, and some simulations when not being used to care for patients.

An unanticipated result of the study was recognized during the visits to each center. While most centers developed and operationalized their plans based on the needs of that center, the discussions led to an open dialogue related to what other centers were experiencing. These discussions provided an opportunity for networking among the centers and offered a common conduit for information and introduction to key people in other centers. One notable example was an invitation for team members of one assessment center to participate in the training program at one of the treatment centers. This resulted in both centers learning from each other and opened the door for continued collaboration.

Discussion

All of the designated assessment and treatment centers in the Commonwealth of Virginia have dedicated multiple resources and personnel to prepare for the EVD population. Today all of the centers are thinking more broadly and have adapted their programs to prepare for other special pathogens that have been identified as potential problems for healthcare systems.

Maintaining engagement and overcoming challenges related to turnover are recognized by all of the centers. Some preliminary discussion has begun to explore the possibilities of sharing resources among the centers, but geographical distance between centers and other challenges to maintain staffing in all areas of the hospital are difficult to overcome.

Many of the centers discussed other challenges related to caring for the special pathogen population. Patient transport external to the centers or between centers has been a challenge for many of the centers. Most of the centers have worked with local Emergency Medical Services (EMS) to provide this service, but a few continue to face the challenge of providing consistent services. Only one treatment center has developed an internal program to provide transportation for patients. This program provides transport from any local or regional area as well as transport from an assessment center to their treatment center.

Another challenge discussed at each visit was related to decedent care. Few, if any, of the centers have had meaningful discussions with their local funeral homes regarding disposition of the deceased patient. Nearly all of the centers have contacted local funeral home directors, but most are not interested in managing the deceased patient due to the associated community stigma related to special pathogen patients. One treatment center has had success collaborating with two local funeral homes to manage the deceased patient. The center provides the transport of the

patient to the funeral home location and the crew moves the patient to a designated area of the facility negating the need for funeral home staff to handle the body. There may be some advantages to adopting a state-wide coordination of the disposition of deceased patients, but this would require a dedicated transport network to reduce the risk associated with the population.

This descriptive study is the first to examine the characteristics of staffing plans in designated assessment and treatment centers in the Commonwealth of Virginia related to care of the EVD and special pathogens populations. This study identified gaps and variations in the plans and provided an initial understanding of the variances among assessment and treatment centers.

The study identified the benefits of networking and combining resources when possible to offset some of the challenges related to training, equipment, and engagement. There may be some opportunities to explore reducing the costs of maintaining readiness, especially in the domain of direct care provider numbers.

The chance of an EVD patient entering the healthcare system in the U. S. has diminished since early 2015. There have been several PUIs, but no diagnosed EVD patients. The preparedness that all designated centers has undertaken cannot be dismissed.

Maintaining team numbers and training were highlighted at every center visit. Added to that is the realization that there have been no events in nearly two years resulting in some indifference to the need for preparedness. Nearly all of the centers are challenged to maintain a state of readiness, but all realize the necessity of continued training despite the lack of actual events.

Caring for the EVD population requires special training, special equipment, and a special environment. In an effort to ensure the safety of patients, healthcare professionals, and

communities, organizations are compelled to provide the healthcare provider with the necessary equipment and training to maintain a safe environment. Staffing plans are an important part of the equation and must take all elements into consideration. Training, equipment, and environment are important, but it is equally important that staffing plans are designed to account for an adequate number of caregivers in each role. Plans should also provide recommendations for length of time in direct care and define the need for supportive personnel. The omission of even one element can lead to a catastrophic event. This study also supports the development of best practice in the future related to other special pathogens.

For this study characteristics were not analyzed for content or comprehensiveness. The expectation that variation existed between assessment and treatment centers was supported. Treatment centers were the first to plan for and manage this patient population and typically operate from long-standing emergency preparedness programs that have been tested and implemented many times. Assessment centers had less time to develop comprehensive plans.

The number of assessment hospitals is larger and demonstrated more variation in staffing plan characteristics. These facilities may be the first contact for an EVD patient making it more important that any gaps be identified quickly.

A limitation of the study was the ability of each center to provide a detailed and complete staffing plan. Most designated assessment centers have not cared for a PUI or confirmed case of EVD and as a result may have less comprehensive plans. The study is also limited to one state which limits its application to other states without adaptation to a different state environment.

Information from the study will inform policy makers and contribute to future planning for EVD and other special pathogens. The strength of the study is the ability to identify gaps in the plans and make recommendations related to the current best practice. The study also

broadens the network of stakeholders to designated assessment and treatment centers, public agencies, non-profit hospital associations and other jurisdictions to collaborate and problem-solve solutions for advancing preparedness and maintaining readiness as a steady state.

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Table 1

Results for Treatment Centers **Key** **P = present, NP = not present, U = undetermined**			Center #7	Center #8
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing	P	P
		Physician/LIP	P	P
		Respiratory Therapy	P	P
		Patient Transportation	P	P
	Support services	Emergency Mngmt.	P	P
		Environmental Srvcs.	P	P
		Laboratory Services	P	P
		Nutrition	P	P
		Supply Chain	P	P
		Pharmacy	P	P
		Social Work	P	P
		Human Resources	P	P
		Security	P	P
		Technology services	P	P
		Facilities services	P	P
Plan has been developed to manage several weeks of clinical care. Staffing includes dedicated critical care nurses, physicians, environmental services, infection control practitioners, laboratory staff, and respiratory services personnel designed to minimize the number of staff with direct patient contact (treatment center)		Emergency department and critical care nurses	P	P
		Physician/LIP	P	P
		Environmental Services	P	P
		Infection Control Practitioner	P	P
		Laboratory Staff	P	P
		Respiratory Therapy	P	P
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns		Direct Care providers	P	P
		Indirect Care providers	P	P
		Employee Union	n/a	n/a
		Safety concerns addressed	P	P

Table 2

Results for Assessment Centers

Key **P = present, NP = not present, U = undetermined**			Center #1	Center #2	Center #3	Center #4	Center #5	Center #6
Includes input from a multidisciplinary team of all potentially affected facility departments, including clinical and nonclinical departments, and staff	Direct Care providers	Nursing	P	P	P	P	P	P
		Physician/LIP	P	P	P	P	P	P
		Respiratory Therapy	P	P	P	P	P	NP
		Patient Transportation	P	P	P	P	P	P
	Support services	Emergency Management	P	P	P	P	P	P
		Environmental Services	P	P	P	P	P	P
		Laboratory Services	P	P	P	P	P	P
		Nutrition	U	U	U	U	U	U
		Supply Chain	P	P	P	P	P	P
		Pharmacy	U	P	U	P	P	U
		Social Work	U	U	U	U	U	U
		Human Resources	U	U	U	U	U	U
		Security	P	P	P	P	P	P
		Technology services	P	P	P	P	P	P
		Facilities services	P	P	U	P	P	P
Plan has been developed and scheduled to support 96 consecutive hours of clinical care. Sufficient physician and nursing staff should be available to handle the patient's care needs (assessment center)	0-24 hours	Nursing	P	P	P	P	P	P
		Physician/LIP	P	P	P	P	P	P
	25-48 hours	Nursing	P	U	P	P	P	P
		Physician/LIP	P	U	P	P	P	P
	49-72 hours	Nursing	P	U	P	P	P	P
		Physician/LIP	P	U	P	P	P	P
	73-96 hours	Nursing	P	U	P	P	P	NP
		Physician/LIP	P	U	P	P	P	NP
The facility has a process for continuous staff input from those who may or may not be directly involved in care of patients with EVD, including from employee unions, and has addressed employee safety questions and concerns		Direct Care providers	P	P	P	P	P	P
		Indirect Care providers	P	U	P	U	P	P
		Employee Union	n/a	n/a	n/a	n/a	n/a	n/a
		Safety concerns addressed	P	U	P	P	P	P

Table 3

Minimum staffing requirements for EVD patients

Direct care # of patients	EVD 1	EVD 2
RN - day shift	2	4
RN - evening shift	2	4
RN - night shift	2	4
Total RN FTEs per week*	8.4	16.8

Support role # of patients	EVD 1	EVD 2
Safety officer - day	1	1
Safety officer - evening	1	1
Safety officer - night	1	1
Total FTEs per week*	4.2	4.2

One EVD patient would require a total of 12.6 FTEs

Two EVD patients would require a total of 21 FTEs

Assumptions
36 worked hours per week*
Use of N95 mask
Patient(s) in early (dry) phase
Full garb with donning and doffing tolerance
Time in PPE not to exceed 3 total hours
(includes donning and doffing)

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Table 4

Results for Assessment Centers, Unique characteristics

Characteristic #1 (one center)	Facility has a dedicated part-time position for special pathogen management
Characteristic #2 (one center)	Nurses work 4-hour shift and rotate every four hours
Characteristic #3 (one center)	Nurses only in contact with patient for a maximum of twenty minutes
Characteristic #4 (one center)	Plan for PUI up to seven days
Characteristic #5 (one center)	Quarterly education for direct caregivers
Characteristic #6 (one center)	Inclusion of first round of life saving drugs or defibrillation, but no compressions

Table 5

Results for Treatment Centers, Unique characteristics

Characteristic #1 (one center)	Facility has a dedicated unit for special pathogens populations
Characteristic #2 (one center)	Facility has own ambulance transport system. All personnel trained with other direct care providers.
Characteristic #3 (one center)	Facility has a detailed plan for decedent affairs and has collaborated and held drills with two local funeral homes.

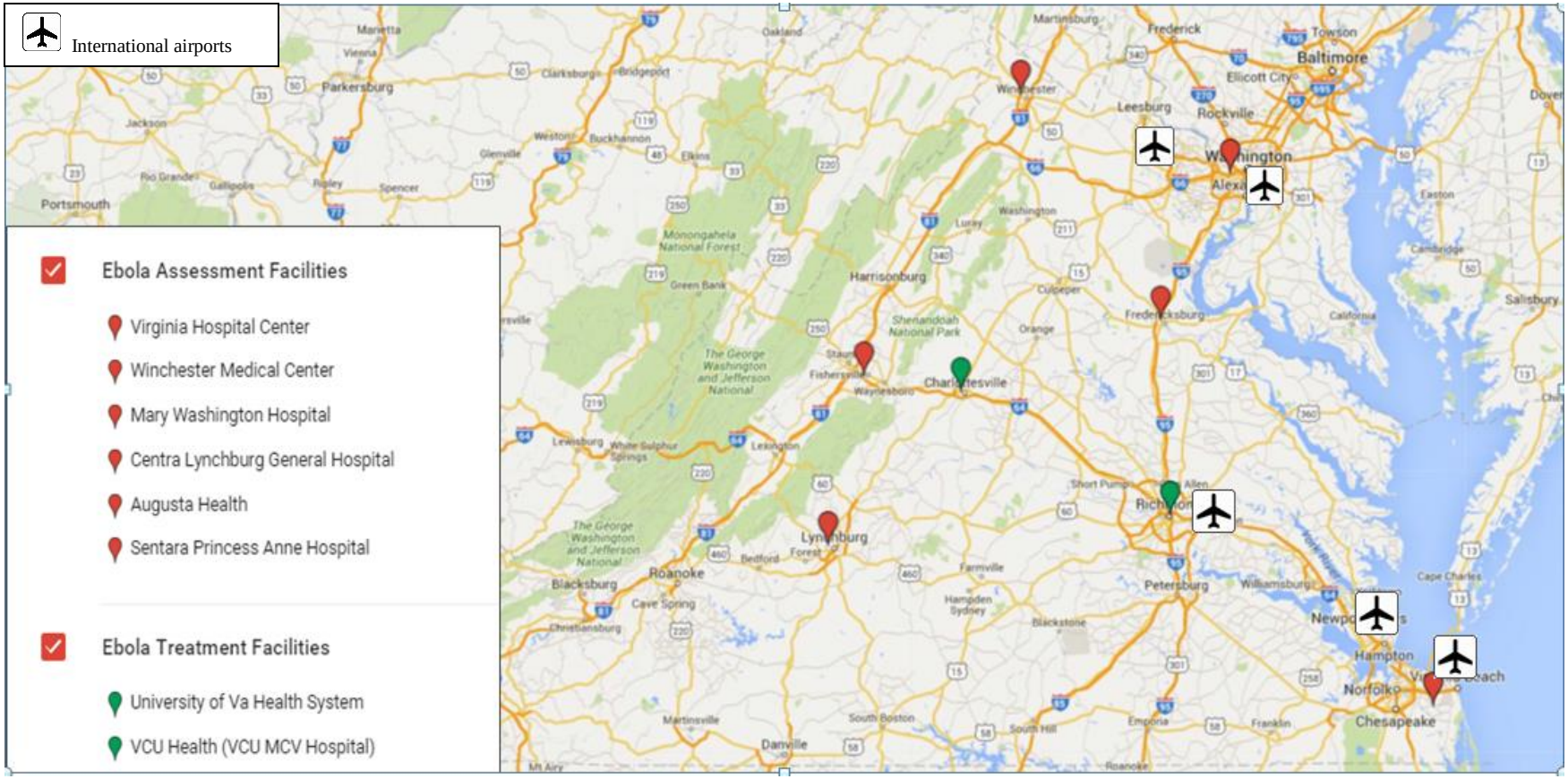

Figure 1. Map of international airports, assessment facilities, treatment facilities, and interstate highways