Special Report

Laboratory Test Support for Ebola Patients Within a High-Containment Facility

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Two adult United States (US) nationals contracted the Ebola virus while on a humanitarian mission in Africa amidst a large Ebola outbreak there. They were admitted to our medical center (Emory University Hospital in Atlanta, GA) during the first week of August 2014 for treatment. Both survived their illness and were released after approximately 3 weeks of inpatient care. We received approximately 3 days' advance notice that the first patient would be transported from Africa to our medical center; the second patient arrived 3 days after the first. The diagnosis in each case had been confirmed virologically by detecting Ebola-specific nucleic acid in blood specimens sent to a World Health Organization laboratory in Europe; however, few details of either patient's condition had been available to us before their arrival. Herein, we summarize the approach we used to plan for and provide laboratory diagnostic testing during their treatment.

Both patients were admitted to a specialized isolation unit that had been established at our hospital 12 years previously, in collaboration with the Centers for Disease Control and Prevention (CDC), as a resource for safely quarantining, evaluating, and caring for small numbers of patients with unidentified or highly contagious infectious diseases. At the core of this unit are 3 patient rooms that are physically separate from other patient-care areas of the hospital, are maintained under negative air pressure, and have highly restricted access. A small, specially trained team of volunteer caregivers (primarily infectious disease physicians and critical care nurses) who have planned and rehearsed for incidents of this type for more than a decade staffs the facility.

The degree of containment afforded by this facility substantially exceeds CDC guidelines for managing Ebola,[1] a nonairborne pathogen that is transmitted principally via bodily fluids or direct contact and is readily inactivated by conventional disinfectants. The risk and routes of contagion with Ebola are judged to be comparable to those of human immunodeficiency virus (HIV) or of the hepatitis B or C viruses, pathogens that are handled safely and routinely in conventionally equipped hospitals and clinical laboratories using universal, contact, and droplet precautions. Given the availability of this specialized quarantine facility at our institution, however, it was deemed appropriate to use it in caring for these patients in order to afford maximal safety and reassurance to our hospital staff and patients, to avoid disrupting other hospital operations, and to respect the heightened public and media attention prevailing at the time, as these were the first cases of Ebola infection to be treated in North America.

The previously established operating procedures for the isolation facility anticipated that the subspecialist nurses working within it would perform all venipunctures and other specimen collection procedures. Also, these nurses would perform a limited menu of assays using standard point-of-care (POC) instruments situated inside the unit. It had been

Abbreviations

US, United States; CDC, Centers for Disease Control and Prevention; HIV, human immunodeficiency virus; POC, point-of-care; DIC, disseminated intravascular coagulation; INR, international normalized ratio; CBC, complete blood count; PCR, polymerase chain reaction

Keywords

Ebola Virus, high-containment unit, point-of-care laboratory testing, infection prevention, personal protective equipment

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anticipated that other diagnostic testing for most types of infectious agents could be performed safely in the clinical laboratories of the hospital using established protocols. During final preparations for the arrival of these patients, however, it was agreed, in an abundance of caution, that no diagnostic specimens of any kind would leave the unit for testing, with the exception of any that might be collected by and delivered to the CDC or other appropriate government health agencies. That policy was communicated to laboratory staff and physicians before the arrival of the 2 patients infected with Ebola. We believe, in retrospect, that this policy was highly effective and beneficial in alleviating any initial concerns about potential exposure among phlebotomists and laboratory personnel. Nevertheless, it created the need for us to offer a broader range of POC tests within the unit that might be required for optimal care of patients infected with Ebola. In addition, this policy made it impractical for us, within the limited time available, to train clinician staff to calibrate, validate, and operate the instruments necessary to perform those additional tests.

In response, our strategy was to establish a self-contained POC laboratory that could support all requisite testing within the quarantine facility itself and to develop a team of volunteer clinical pathologists and laboratory technical staff with expertise in POC testing who could perform all assays on site. We designed our test menu in close consultation with the infectious disease specialists caring for these patients, taking into account the available literature on the natural history of Ebola disease. Fatal outcomes of Ebola hemorrhagic fever are most commonly linked to disseminated intravascular coagulation (DIC) eventuating in multiorgan failure, septic shock, or acute hepatic necrosis. We therefore selected the following instruments to provide core metabolic, coagulation, microbiologic, and other assays:

- Chemistry analyzer (Abaxis Piccolo Xpress [ABAXIS, Inc, Union City, CA]) to perform chemistry profiles; magnesium, phosphate, and liver-enzyme assays; etc)
- Arterial blood-gas analyzer (GEM Premier 4000 [Werfen, Barcelona, Spain])
- Automated urinalysis analyzer (CLINITEK Status [Siemens Corp., Munich, Germany)]
- Coagulation analyzer (CoaguChek [F. Hoffman-La Roche, Ltd, Basel, Switzerland]) for determinations of prothrombin time and international normalized ratio (INR)
- Hematology analyzer (pocH 100*i* [Sysmex Corporation, Kobe, Japan]) for complete blood count (CBC)
- Malaria POC device (Alere BinaxNOW [Alere, Inc, Waltham, MA])
- Polymerase chain reaction (PCR)–based microbiological analyzer (BioFire FilmArray [BioFire Diagnostics, Inc, Salt Lake City, UT]) designed to detect a panel of viral, bacterial, fungal, or parasitic pathogens, many of which might be found in patients returning from a resource-poor region and might complicate care. Among other pathogen-specific markers, this instrument detects Ebola viral RNA, a capability that we believe could have value for monitoring progression of and recovery from Ebola infection in this setting.

Most of these instruments were housed together within a 4-foot laminar flow biosafety containment hood located in a small, dedicated room in the isolation facility. The exceptions were the complete blood count (CBC) analyzer and the BioFire instrument, which were placed on a table adjacent to the hood. This configuration positioned all instruments a few feet outside the doors of the rooms that housed the 2 patients. The nurses collected specimens in those rooms, sealed the specimens in double bags, placed them in a plastic transport box, and delivered them to the laboratory room for testing. Results were reported manually using a networked laptop computer located on the table beside the hood. All testing was performed by a clinical pathologist or a clinical laboratory technologist experienced in POC testing; each of these individuals had been trained in the safe handling of infectious pathogens generally and in the specific operating procedures developed for this isolation facility. A total of 10 volunteers (2 pathology faculty and 8 laboratory staff) were trained to carry out laboratory testing in the isolation unit; 2 of them were present whenever testing was performed. All personnel wore disposable impermeable Tyvek suits (DuPont, Wilmington, DE), double gloves, foot covers, protective eyewear, and face shields. This personal protective equipment, like all other materials used or generated in the facility, was sterilized after use by autoclaving within the isolation unit before being disposed as regulated medical waste.

Other than the first day of admission for each of the 2 patients, the testing was conducted daily on a routine basis in a single morning session. Although our laboratory team was on call to provide after-hours service on a rotating basis around the clock, this type of service was not required during these 2 patients' hospital stay.

To minimize the risk of generating aerosols, we did not perform any centrifugation. Instead, we performed all separations of serum and plasma via gravity settling. Any blood or blood product transfusions would have been performed under emergency release criteria using available supplies

of universal donor products (eg, group-O red blood cells or group-AB plasma).

In this report we offer a description of, and our underlying rationale for, the approach we took in providing laboratory test support for our 2 patients infected with Ebola virus, given the particular circumstances and the facilities available to us. Our approach exceeded the requirements of the CDC for safe management of patients infected with Ebola. This description is not intended as a recommendation or endorsement of any specific instruments, tests, or procedures. The test menu and procedures we performed proved to be fully sufficient for the care of our 2 patients; however, the menu and procedures may require refinement over longer courses of treatment or for management of other cases. We feel privileged to have been able to contribute to the care of these patients and hope that this information will be useful to other healthcare professionals in addressing similar cases. LM

References

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