

Caring for Patients With Ebola: A Challenge in Any Care Facility

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The largest outbreak of Ebola virus continues unabated in West Africa. With the recent death of a patient with Ebola virus disease at a hospital in Dallas, Texas, and the sobering reality that nosocomial spread has occurred in a U.S. facility, U.S. medical centers are coming to grips with the need to prepare for care of patients with this devastating disease. The Centers for Disease Control and Prevention has developed a hospital preparedness checklist, and the latest guidelines continue to express confidence that patients with Ebola can be cared for safely in a conventional medical facility by using barrier methods (standard, contact, and droplet precautions) as the primary means of protecting medical staff (1, 2). Recent experience with several Ebola-infected patients in the United States provides validation that such patients can be cared for safely in a facility that is adequately prepared.

Since the first reported outbreaks of Marburg (1967) and Ebola (1976), there has been an evolution in our thinking about the optimal personal protective measures for medical staff caring for patients infected with these viruses. From 1972 to 2010, a high-level containment care (HLCC) unit at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), often called "the slammer," was considered the gold standard for such care. The unit's engineering controls were modeled after a biosafety level-4 (BSL-4) laboratory, with positive-pressure "space" suits, compressed in-line air, HEPA filtration, a decontamination shower, ultraviolet light pass boxes, an airlock, and antiseptic dunk tanks for movement of items in and out of the containment area. Toilet waste was discharged into the laboratory sewer system, and the facility possessed its own autoclave, operating room, and bedside laboratory. These built-in capabilities significantly reduced logistics challenges and provided reassurance that nosocomial spread could be reduced to near zero. Given the relatively high percentage of caregivers who have died of filoviral and other BSL-4 virus infections in the field, and the prior uncertainty in whether such high infection rates might be caused by droplet or airborne spread, utilization of such a containment facility seemed reasonable. Although used on occasion to quarantine field workers potentially exposed to highly hazardous viruses, the unit was used primarily for isolating individuals exposed to a BSL-4 virus in the laboratory. During the unit's 38 years of operation, 21 patients were quarantined after potential exposures—and none became ill (3).

Over time, we learned that the spread of filoviruses occurs primarily by direct contact with blood and body fluids (1). Thus, it was determined that a patient care facility with the full panoply of BSL-4 laboratory-like features was no longer needed. The facility was de-

commissioned and refurbished as a training facility for scientists working in the institute's containment laboratories.

If the USAMRIID HLCC is no longer needed because patients with filoviruses may be managed safely using barrier methods, one might ask whether any HLCC or biocontainment patient facilities are needed at all (4). Currently, 4 such facilities exist in the United States, operating at a higher level of containment (and possessing more sophisticated engineering controls) than a conventional hospital isolation room but lacking some BSL-4 features present in the USAMRIID HLCC: Emory University Hospital, Atlanta, Georgia; University of Nebraska Medical Center, Omaha, Nebraska; Saint Patrick's Hospital, Missoula, Montana; and the National Institutes of Health Clinical Center, Bethesda, Maryland. All except the University of Nebraska serve as referral centers for laboratories that work with BSL-4 viruses. Although patients infected with such diseases as Lassa and Marburg have been safely managed in conventional settings, the serious nature of filoviral and arenaviral infections, their rarity and unfamiliarity to clinicians in developed settings, the lack of effective treatments and vaccines, their propensity to infect health care staff, and the infection control challenges they present argue for, in our opinion, specialized containment and treatment facilities.

As many medical centers are no doubt learning in their preparation drills, caring for patients with filovirus and arenavirus infections in a conventional setting presents enormous challenges (5), many of which can be mitigated through the use of specialized facilities with highly trained staff practiced in the nuanced art of safely delivering HLCC. However, even in such facilities, it is impossible to completely engineer out human error, eliminate the risk for sharps or needlestick injury, or prevent inadvertent contact contamination. Care for such patients in a conventional setting, therefore, is more than checklists and standard operating procedures. The training, policies, procedures, and logistics necessary for the provision of such care are significant, cannot be assumed, are optimally in place well in advance of actual need, and must be continually reinforced through repetitious training. Every piece of the care continuum must be well-choreographed with significant attention to detail. At a minimum, preparations must be made for patient entry and movement pathways, optimal patient location and access control, safe donning and doffing of personal protective equipment (PPE), handling and testing laboratory specimens, disposal of significant volumes of waste, safe and unexpected cleanup of spills and bodily waste, and minimizing use of sharps. Donning and doffing PPE need to be regimented and monitored, with plans in place for peer

policing. Lapses inevitably occur in infection control routines in conventional medical settings, but once a patient enters the facility, there is no margin for error. Significant risk for infection control errors occurs especially during doffing potentially contaminated PPE (6).

While the physical features of high-containment isolation units like that previously housed at USAMRIID (3) are formidable, low-tech measures, such as checklists and the use of doffing partners, may be as important to optimizing the safety of health care workers, whether in an HLCC unit or in a conventional facility. Owing to the very limited number of existing HLCC beds and the fact that patients with highly contagious diseases can present unannounced, conventional facilities may be required to triage these patients and even provide definitive care, despite the enormous challenges they would inevitably face. Immediate and thorough preparation is thus imperative.

Despite this necessary reliance on conventional facilities, we recognize the challenges inherent in maintaining a high nationwide state of readiness over the long term. Hence, we envision the need for a network of strategically located regional referral centers serving designated catchment areas tied to BSL-4 laboratories or airport quarantine stations. As such, transport of patients to these referral centers would constitute the preferred clinical option (4). These units would be associated with major medical centers and provide day-to-day routine care, but they would have the capability for rapid conversion to an HLCC unit without adversely affecting their primary activities. These could serve as national resources, coordinated through the Department of Health and Human Services and Centers for Disease Control and Prevention, with certification (much like trauma centers) to provide a higher level of care. As such, their focus would be on continuous preparation for the next emerging outbreak.

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