Triage in the Time of Ebola: Research Across the Plexiglas Partition

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Although Ebola has faded from the 24-hour news cycle, at this writing in July 2015 the epidemic continues in West Africa. A significant milestone was met when the World Health Organization (WHO) declared Liberia Ebola free on May 9.[1] For a country to be declared Ebola free, there must be no new cases for twice as long as the incubation period of the virus,[2] which, for Ebola virus disease, is 42 days. The epidemic will finally be declared over when the entire region including Liberia, Guinea, and Sierra Leone is Ebola free.

There was good reason to celebrate in the Liberian capital of Monrovia in May 2015. When I was a front-line Ebola worker, my Sierra Leonean colleagues would tell me I must return and experience the full flavor of the country when the epidemic was over. More than a year of checkpoints, quarantine houses, rumors of new outbreaks, cessation of international commercial flights, and closure of mining operations had taken an economic and psychological toll beyond that of the mortality statistics. The increasing number of teen pregnancies in the capital of Freetown had led to speculation that this was a by-product of the yearlong closure of public schools.[3] Unfortunately, in May 2015, the celebrations in Liberia were muted by Ebola's again appearing in the news, with reports of increasing numbers of cases in neighboring Sierra Leone near the Guinea border.[4]

The article in this issue of *Annals* titled "Derivation of Internal Validation of the Ebola Prediction Score for Risk Stratification of Patients With Suspected Ebola Virus Disease" by Levine et al[5] represents an evolution from much of the previous literature on the epidemic. The authors sought to empirically derive a clinically useful prediction model for risk stratifying patients presenting to an Ebola treatment unit. Previous reports have largely been descriptive of the clinical and epidemiologic facts of the disease or rooted in basic science.[6] Although these reports and investigations have led to our clinical understanding of the disease, there has been a dearth of studies that inform clinical decisionmaking in an Ebola treatment unit.

Standing in the heat, waiting for a patient to arrive by ambulance, in Wellington boots on crushed gravel in the Ebola treatment unit, my colleagues and I were faced with the most difficult clinical task of our careers. Does this patient with suspected Ebola have signs, symptoms, and a history consistent with Ebola virus? Do we admit the patient to the Ebola treatment unit's suspected or probable ward for further testing? Or do we send the patient who may be experiencing another febrile illness such as malaria to one of the few open facilities in a largely nonexistent health care system? The stakes are unbelievably high: if we admit a patient without Ebola to a ward in the Ebola treatment unit to wait for the results of a test that may take 1 to 2 days, we risk exposing an Ebola-negative patient to the deadly disease. Conversely, if we send a patient who has Ebola away from the Ebola treatment unit, transmission continues and the patient will likely die in his or her village without a sanitary burial. The absence of an available point-of-care test, sensitive early in the disease, makes relying on an evidenced-based triage algorithm crucial. The authors of this study attempted to improve on the widely used triage algorithm in Ebola treatment units by identifying which characteristics on presentation predicted Ebola virus disease.

How did patients reach our Ebola treatment unit? A village chief called the National Emergency Response Center for a sick person in his chiefdom, and, if credible, the call was routed to a local District Emergency Response Center in Port Loko. At the district center, representatives from the British and Sierra Leonean military screened the call and made a decision about whether Ebola infection was likely. If the patient had recent sick contacts or symptoms suggesting Ebola, the District Emergency Response Center military commander called an Ebola treatment unit with capacity in the district and sent the patient over by ambulance with a nurse. When the patient arrived at the

Ebola treatment unit by ambulance, the most important triage process began, taking place within a large Plexiglas partition. On one side, bewildered patients arrived by ambulance, welcomed by staff in full personal protective equipment who were spraying the area with bleach. On the other side of the partition, medical providers shouted questions across the Plexiglas that were translated into the local languages of Temne or Mende. In accordance with this exchange of information, the medical providers were faced with the task of following a triage algorithm.

At this Plexiglas partition, deciding whom to let into the Ebola treatment unit lays the rationale for the present study. Answers to a single question such as time of onset of disease or attendance at a recent funeral could make the difference between admitting the patient to the Ebola treatment unit or sending him or her home. The triage instrument used in decisionmaking at Ebola treatment units in West Africa was developed by WHO.[7] To gather evidence, the authors derived the Ebola Prediction Score. The score is based on the presenting signs and symptoms of 382 patients presenting to an Ebola treatment unit in Liberia. Using an elegant multivariate logistic regression model, the Ebola Prediction Score identified 6 variables (Table 3 of the WHO article[7]) out of the 14 clinical variables in the WHO case definition (Table 2 of the WHO article[7]). In accordance with this model, patients were categorized as having an Ebola Prediction Score ranging from 0 (very low risk) to 4 (very high risk). When applied to the cohort at the Ebola treatment unit in Liberia, the Ebola Prediction Score had a positive predictive value of 46% for patients who tested positive for the Ebola virus. The positive predictive value was also 46% for the WHO algorithm. Similarly, for patients without Ebola virus the Ebola Prediction Score did not have a statistically significant different negative predictive value from the WHO algorithm (83% versus 81%, respectively).

Although these results may be seemingly negative in that the Ebola Prediction Score was not superior to the WHO algorithm in predicting disease, there are a number of important findings that expand our knowledge of Ebola virus disease. First, the authors found that the presence of abdominal pain was a negative predictor of a triaged patient's ultimately having Ebola virus. This is probably because typhoid or malaria was the cause of disease. Second, the Ebola Prediction Score performed similarly to the WHO algorithm without including hemorrhagic findings, which were only 8% sensitive for Ebola virus disease. Already the findings of this study are being used in Sierra Leone and Liberia to refine triage algorithms for screening and referral units (personal communication, Adam Levine, Brown University, July 2015), which are triage units

attached to an existing hospital or community health center to ensure that patients with Ebola virus are not entering these health facilities. Screening and referral units are a crucial step in the reopening of closed health facilities that were sources of transmission during the epidemic. The units need evidenced-based guidelines such as the Ebola Prediction Score to better identify which patients with a fever should be tested for malaria at a community health center or should be triaged by staff in personal protective gear because of having suspected Ebola. The health care infrastructure cannot be rebuilt in West Africa without confidence on the part of medical staff and patients that they will not contract Ebola either at work or when seeking care.

In May 2015, a series of meetings was held in Geneva, Switzerland, in which nongovernmental organizations that ran Ebola treatment units and the governments of West African nations agreed with the WHO on wide-ranging research collaboration (personal communication, A. C. Levine, May 2015). Data collected during the current Ebola virus epidemic will be shared among all of the nongovernmental organizations who ran Ebola treatment units. This unprecedented collaboration will allow researchers to have access to a large amount of data from different treatment locations. A national data archive repository will be a database created for each country to capture national statistics. A limitation of this study is that it included only patients from 1 Ebola treatment unit run by 1 nongovernmental organization. Work is ongoing to attempt to standardize data collected by each organization into a common framework for distribution.

In my first days working in the Ebola treatment unit in Lunsar, Sierra Leone, the dreaded "blue sheets" with which we painstakingly collected and transcribed data on our patients was seen as an annoyance compounded by the heat and discomfort in our personal protective gear. Why were we collecting data on complex forms about how many times a patient urinated during the day or how much intravenous fluid he or she received? Did this affect patient care? Often it seemed to have not. I received this article to review during my first month in Sierra Leone. Between 12-hour shifts in the Ebola treatment unit, and by the grace of a shaky Internet connection, I had the opportunity to submit a review. The efforts of nurses, physicians, logistic staff, cooks, and drivers—and most important, the patients who fought the disease—are represented in this article.

On July 1, 2015, Liberia, which had been Ebola free for fewer than 50 days, reported a case of a 17-year-old who died on the outskirts of Monrovia.[8] This young man may have infected others, and there is no clear index case from his infection. Subsequently, Liberia lost its privileged status as Ebola free. It seems that Ebola providers will continue

to make difficult triage decisions for some time to come. As the fight continues, so do the research and academic efforts to inform the difficult decisions made at the Plexiglas screen.

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