efficient ways of operating. Involvement of clinical department administrators and clinicians in the development of the relative-resource-consumption measures is expected to result in increased ownership by the clinical departments.

Although a substantial number of providers have adopted internal cost-measurement systems and have progressed to methods such as relative-value-unit costing, the overall level of cost-measurement and cost-management sophistication in the U.S. health care industry has not, in our view, moved beyond the early stages. Meaningfully using internal cost data to achieve efficiency improvements is a heavy lift for health care providers. There are still important barriers to obtaining complete buy-in from the physician community. Introducing strong incentives tied to metrics that capture the production of cost data, integration of cost data with existing clinical and utilization data, and use of cost data in clinical decision making may be necessary to overcome the hurdles, especially given the competing objectives that hospital administrators are currently facing.

Disclosure forms provided by the authors are available at NEJM.org.

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DOI: 10.1056/NEJMp1900329

Imaging an Outbreak — Ultrasound in an Ebola Treatment Unit

Patricia C. Henwood, M.D.

Half my patients died. They died from one disease, but so many different deaths.

After a decade of honing my ability to quickly determine "sick or not sick" and allocating time and resources accordingly, I learned that when managing a ward of patients with Ebola, clinical appearance did not always predict survival.

Layers of impermeable and stifling personal protective equipment (PPE) constitute an enormous physical barrier to patient care, complicating management of Ebola virus disease (EVD). The ability to auscultate is gone, you cannot smell, and layers of gloves blunt your tactile sense. You cannot risk touching your face to readjust your PPE, so visual cues can also be a challenge.

In the extreme heat and humidity of our tarpaulin facility on a rural Liberian hilltop, my N-95 mask would sometimes collect enough condensation to drink — a clear signal that it's time to wrap up bedside care, since your breathing needs to be composed for the methodical doffing of PPE. The fog collecting in my goggles during rounds in the "suspect" ward (housing patients with suspected EVD) usually condensed, permitting a clear view by the time we began rounds in the "confirmed" ward, allowing us to use a bedside tool that offered a window into unfolding pathophysiology.

As we cared for roughly 100 patients during my first weeks in an Ebola treatment unit (ETU) in 2014, the varied manifestations of this poorly defined disease left us stumped. Many patients who seemed to be recovering would suddenly decompensate and die. We lacked on-site diagnostic capacity, so as I worked to secure critical resources to improve overall care, I also sought and received approval to incorporate point-of-care ultrasonography (see photo).

Mr. A. was roomed at the far end of the confirmed ward with

Using Point-of-Care Ultrasonography in an Ebola Treatment Unit.

his wife and children — they all had EVD. One day, his diarrhea stopped, and we thought he was turning the corner. Then he developed hiccups, which often foreshadowed death in our ETU (a link confirmed by subsequent studies[1]).

The next morning, I found Mr. A. looking awful: febrile to 40 degrees, breathing 40 times a minute, and barely conscious. We started IV fluids, and I placed the ultrasound transducer on his chest. I found an A-line pattern with lung sliding, indicating no pulmonary edema, no pneumonia, no pneumothorax. As I moved the probe to his boardlike abdomen, I was surprised to find diffusely dilated bowel loops with bowel-wall edema and no peristalsis, without obvious signs of perforation. I considered ileus more likely than mechanical obstruction, particularly given that he had no relevant medical or surgical history. Days of profuse diarrhea, followed by a paralytic ileus. Hiccups — from the ileus? Peritonitis and fever, possibly from bacterial translocation across his inflamed bowel wall. Central tachypnea from metabolic acidosis. Mr. A. was not just "dying from Ebola." He might be dying from bacterially mediated septic shock.

Mr. A. did not survive. But my scans of many similarly ill patients that day revealed similar findings. Our ambulance team purchased broad-spectrum IV antibiotics in town for other patients with suspected secondary bacterial infections, while our logisticians worked on procuring additional antibiotic supplies.

This was the fall of 2014, when the Liberian epidemic reached a crescendo, and our patient volumes were overwhelming. The evidence base for care was lacking, since there had never been an EVD outbreak of this magnitude and it's enormously challenging to complete research during a humanitarian emergency. We subsequently learned that secondary and concurrent bacterial infections play a more important role in Ebola-related deaths than had previously been recognized. Data we now have revealing the risks of intestinal ileus, loss of mucosal integrity, and bacterial translocation in EVD were not yet available.[2,3] Empirical treatment with broad-spectrum antibiotics, now recommended in patients with severe EVD, was not part of most protocols in 2014.[4]

Besides alerting clinicians to possible secondary infections, bedside ultrasonography aided in supporting obstetrical care, guiding IV access, and assessing respiratory and volume status in our sickest patients — helping us to improve care. These benefits persuaded me that point-of-care ultrasonography should be incorporated into a comprehensive approach to augmented ETU care. Ideally, such care would include integrated laboratory testing; fluid, electrolyte, and antimicrobial management; pain control; supplemental oxygen; and potentially, advanced critical care support for problems such as respiratory and renal failure. Ultrasonography can help clinicians quickly narrow a differential diagnosis and can guide management by revealing key pieces of the clinical puzzle,

Potential Applications of Ultrasonography in an Ebola Treatment Unit.

Obstetrical: Pregnancy-complication rates are high among patients with EVD. Ultrasonography can confirm fetal viability or death, estimate gestational age, and evaluate reasons for bleeding in patients with suspected or confirmed EVD. Particularly for pregnant EVD survivors, ultrasound dating may help facilitate delivery planning, given that Ebola virus remains detectable in the placenta, amniotic fluid, and fetus even after maternal viremia resolves.

Pulmonary: Dyspnea is associated with higher mortality in EVD.[5] A scan protocol combined with expert interpretation may help differentiate between clear lungs (indicating possible centrally mediated tachypnea) and signs suggesting edema, infection, hemorrhage, or acute respiratory distress syndrome. Given that many ETUs do not have ventilator capacity, if high-volume IV fluid resuscitation is possible, clinicians may consider serial lung evaluation as indicated by respiratory status.

Gastrointestinal: As described here, ultrasound may demonstrate paralytic ileus with edema, bowel distention, and lack of appropriate peristalsis. Its use should be considered when there is clinical suspicion of abdominal sources of secondary infection, including bacterial translocation across compromised bowel.

Hepatobiliary: Liver failure and synthetic dysfunction have been reported in patients with EVD. Ultrasound may reveal hepatomegaly and abnormal hepatic architecture suggesting inflammation or infection. The presence of ascites may indicate hepatic dysfunction or fluid third spacing (loss of intravascular fluid into the interstitium) or raise suspicion for secondary bacterial infection. Biliary ultrasonography should be considered if results are likely to change management.

Genitourinary: Patients with EVD may have difficulty urinating, and they frequently develop renal failure. Ultrasound can help differentiate among anuria, obstruction, and acute or chronic kidney injury.

Cardiovascular: Chest pain and tachypnea are common symptoms in EVD, and some patients may have evidence of fluid third spacing on exam. Cardiac ultrasound can be used to assess for signs suggesting EVD-related myocarditis, pericarditis, or pericardial effusion. Assessment of inferior vena cava collapsibility may complement other estimates of intravascular volume status. If pulmonary embolism is suspected, evaluation for deep vein thrombosis can be coupled with cardiac assessment for right ventricular dysfunction.

particularly in resource-limited settings lacking other diagnostic imaging tools.

If no experienced clinician-sonographer is available, bedside clinicians can be trained in protocol-based image acquisition. Having an expert interpret the images from outside the patient area can save bedside-PPE time while allowing images to be obtained by clinicians who may be less experienced with ultrasound but more experienced working in PPE. Handheld ultrasound devices linked to Wi-Fi can wirelessly send images to providers in the ETU's low-risk zone or to another location to leverage (real-time or asynchronous) expert assistance. (Even in remote ETU settings, Wi-Fi capacity is often attainable with a portable external modem.)

Decision makers can select ultrasound devices that can be completely covered or can withstand frequent wiping with chlorine or other decontamination procedures between patients, particularly if the device is to be used serially within a confirmed-EVD ward. Devices that may be appropriate for last use in this setting may also be considered. Alternatively, CUBE systems or biosecure emergency care units — transparent plastic chambers for individual patients fitted with plastic glove inserts for health workers to interact with patients without extensive PPE — are another strategy being used in the Democratic Republic of Congo (DRC) that may allow for incorporating ultrasonography while minimizing risks to providers.

In clinical practice, ultrasound applications whose results would be anticipated to change patient care should be prioritized. Negative downstream effects on resources and provider time can be evaluated before incorporation. Ultrasonography can also be used in diagnostic assessments of patients with suspected EVD, particularly when self-contained biosecure units or multiple ultrasound devices are available.

Specific ultrasound applications to consider include obstetrical, pulmonary, abdominal, cardiovascular, and procedural uses (see box). Ultrasound-guided peripheral IV insertion may be particularly helpful in resuscitating hypovolemic patients and to obtain blood samples for EVD testing. Undiagnosed preexisting conditions or concurrent infections such as malaria, tuberculosis, HIV, cirrhosis, or heart failure may affect ultrasound findings, so clinical judgment should be used to determine chronicity.

More than 10 months into the second-largest EVD outbreak in history, the case fatality rate in the DRC stands at 67%. The containment struggle is ongoing, and new cases have just crossed into neighboring Uganda. As of early June, case numbers surpassed 2000 (including 1300 deaths), despite widespread administration of an effective vaccine. Insecurity is hampering the ability of response teams to quickly identify cases and create vaccination rings

around people at risk, and access to care has been drastically affected by violent attacks on health care workers and ETUs. As in the West African epidemic, other challenges faced by responders include mobile populations, health system and funding gaps, and problems with community engagement. As this outbreak unfortunately continues, it's important to focus on infection control, in addition to providing enhanced and compassionate patient care and conducting research to improve outcomes. A comprehensive approach incorporating ultrasound into ETU care may help tailor treatment to individual patients and improve our understanding of this grave disease.

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DOI: 10.1056/NEJMp1902830

Taking Note

Raphael Rush, M.D.

"Not so hard!" howled the man with abdominal pain, his body tense against his stretcher.

His skin looked sallow under the fluorescents illuminating the crowded emergency department (ED) hallway. My fingers had barely brushed his belly.

Although we'd just met, his records told a familiar story of months shuttling between EDs with various pains, no cause ever found. Old prescriptions in his chart had raised my suspicions. The normal preliminary ultrasound report seemed to confirm them. Still, I resigned myself to referring him to the surgeon on call. I wrote my note carefully, thinking about what to say.

Writing a history is as much a process of editing as composition. It takes a long time to learn what matters. As my training progressed, each note formed a rough draft for the next, another chance to focus on the bare facts of each case. My presentations became shorter, as online templates and the glazed eyes of senior residents taught me which questions to ask and which to ignore. Others' notes identified the relevant diagnoses and framed my perspective on each patient. Just as patients all changed into the same blue gowns, we fit everyone's life into the small set of stories we prewrote in our minds.

Brevity wasn't the only reason details were cut. One attending physician with the frown of a grammar teacher marked residents' notes in red pencil. One she returned to me bore a bold circle around a woman's social history.

"Take out her marijuana usage," she told me, as we sat side by side in her cramped examination room, reviewing my notes. "It's not relevant, and I don't want that staying in her chart."

The patient's marijuana use seemed unimportant to me, but I understood what concerned my attending. The words in a chart stay there forever, passed on to everyone a patient meets. If I wasn't careful, all kinds of conclusions might be drawn from my notes. Even then, during fellowship, I still wasn't sure what went into the record and what stayed out.

The details that are recorded can significantly affect how a story is perceived. Susan Sontag, writing about the stories conveyed by war photography, questioned the belief that photographs are meant "not to evoke but to show" — to state facts rather than imply conclusions. Sontag pointed out that whether intentionally or not, photographers choose which details