# Use of Simulation to Gauge Preparedness for Ebola at a Free-Standing Children's Hospital

Elizabeth A. Biddell, MD;
Brian L. Vandersall, MBA;
Stephanie A. Bailes, BS, RRT;
Stephanie A. Estephan, BSN;
Lori A. Ferrara, BSN;
Kristine M. Nagy, BSN;
Joyce L. O'Connell, BS;
Mary D. Patterson, MD

**Summary Statement:** On October 10, 2014, a health care worker exposed to Ebola traveled to Akron, OH, where she became symptomatic. The resulting local public health agencies and health care organization response was unequalled in our region. The day this information was announced, the emergency disaster response was activated at our hospital. The simulation center had 12 hours to prepare simulations to evaluate hospital preparedness should a patient screen positive for Ebola exposure. The team developed hybrid simulation scenarios using standardized patients, mannequin simulators, and task trainers to assess hospital preparedness in the emergency department, transport team, pediatric intensive care unit, and for interdepartmental transfers. These simulations were multidisciplinary and demonstrated gaps in the system that could expose staff to Ebola. The results of these simulations were provided rapidly to the administration. Further simulation cycles were used during the next 2 weeks to identify additional gaps and to evaluate possible solutions.
(*Sim Healthcare* 11:94–99, 2016)

**Key Words:** Ebola, Simulation, Disaster preparedness, Personal protective equipment training, Latent safety threats, Emergency preparedness

Downloaded from https://journals.lww.com/simulationinhealthcare by BhDMf5ePHKav1zEoum1tQfN4a+kJLhEZgbsIHo4XMi0hCywCX1AWnYQp/IlQrHD3PxsyRRxX7FpM4CTHLvYMprOR6oZTbmuF6bmR1V9hL7XaR3hSNGs87g== on 03/13/2020

Ebola is a deadly virus that has plagued West Africa with periodic epidemics for more than 40 years.[1] The current outbreak has resulted in cases in the United States and several countries in Europe.[2] This illness is spread by bodily fluids and requires health care workers to don and doff appropriate personal protection equipment (PPE) to safely care for affected patients. In the United States, 2 health care workers have contracted Ebola from a single patient that was cared for in Dallas, TX. These 2 health care workers' illnesses have raised questions regarding US hospitals' preparedness to safely care for Ebola patients.[1] However, simulation is an excellent method to prepare health care workers and systems for potential Ebola cases.[3]

When a health care worker visited Northeast Ohio and subsequently became ill with Ebola, our hospital mobilized to evaluate our preparedness to care for pediatric Ebola patients. (The index patient had contact with a number of children during her visit to the area.) Our hospital has previously recognized simulation's value in preparing for disaster response. Therefore, shortly after our hospital discovered that a pediatric Ebola patient could present at any moment, our chief medical officer and assistant chief nursing officer requested that we perform simulations to prepare for an Ebola patient beginning the next morning. Our simulation center was given approximately 12 hours to develop the first simulation session. The simulations were to take place at possible entry points for patients including, the emergency department (ED) and transport teams as well as possible inpatient care locations including the pediatric intensive care unit (PICU) and a newly designated isolation wing. A number of simulations were progressive and involved initial screening through admission to an inpatient unit.

Six different simulation sessions were conducted during a 2-week iterative quality improvement project occurring from October 16 through October 31, 2014. Each simulation session acted as the "Do" portion of the Plan-Do-Study-Act (PDSA) cycle. Potential threats, breaches, and key observations were identified and communicated with our administration via either written or verbal reports within hours of completing the simulations. The reports and debriefing with hospital leadership represented the "Study" portion of the PDSA cycle. Identified threats were then addressed, and approximately 1 to 2 days later, simulations were repeated to evaluate solutions and identify unrecognized consequences of the solutions as well as to identify further threats. The follow-up simulations represent the "Act" portion of the PDSA cycle.

## METHODS

There were 2 objectives of these simulations: first, to identify latent safety threats and conduct PDSA cycles for rapid improvement; second, to provide an opportunity for deliberate practice of donning and doffing PPE and passive training of previously mastered skills while donned in PPE. Our institution opted to train a targeted response team of volunteer providers; therefore, each provider participated in multiple simulations to allow for deliberate practice of these

From the Pediatrics (E.A.B., M.D.P.), and Simulation Center for Safety and Reliability (B.L.V., S.A.B., S.A.E., L.A.F., K.M.N., J.L.O., M.D.P., E.A.B., M.D.P.), Akron Children's Hospital, Akron, OH.

Reprints: Elizabeth A. Biddell, MD, 1 Perkins Square, Akron, OH 44308 (e-mail: ebiddell@chmca.org).

M.D.P. reports occasional consulting for SimHealth Group. None of the other authors has any financial disclosures or conflicts of interest associated with this work.

Copyright © 2016 Society for Simulation in Healthcare

DOI: 10.1097/SIH.0000000000000134



Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.

high-risk procedures. All volunteer participants were excused from clinical duties for simulation activities. All simulation sessions included a mixture of task training and hybrid scenarios using standardized patients and mannequin-based scenarios. Because of the time-sensitive nature of these simulations, the standardized patients were not formally scripted but rather were coached on their roles. Most mannequin-based simulations were modified from existing preprogramed scenarios "on the fly." When simulations occurred within the public view, large bright yellow signs indicating that testing was in process were placed in clear view. The substantial local media attention concerning the infected health care worker likely made this less shocking to families and patients who visited the facility during this time.

These simulations were supported by our 253-bed pediatric hospital and performed by our hospital-based simulation program consisting of 7 interdisciplinary staff members who report to the vice president of safety and quality. The initial simulations were planned with approximately 12 hours' notice. Given the short notice, a formal needs assessment was not performed. However, informally, the simulation center staff worked with high-level administrators, infection control (infectious disease experts), critical care providers (both physician and nursing), transport team (some disaster preparedness experts who were a part of a disaster-medical assistance team and a member of the Army National Guard), and the ED providers (both physician and nursing) to design initial simulation experiences. These initial simulations were designed to address each department's concerns and evaluate their processes and equipment available to care for a possible Ebola patient. These initial simulations targeted teams that were believed to be at highest risk and/or the locations that were believed to represent likely entry points to the hospital.

Because in situ simulations have been shown to be effective in identifying latent safety threats and have been used in previous quality improvement initiatives,[4–6] we opted to conduct these simulations in situ. For each simulation, there were 1 or 2 trained facilitators observing and recording notes in real time. After each simulation (or immediately after a transition in the case of progressive simulations), a debriefing was performed with the participating team members. All simulations were video recorded. Facilitators focused on absent or inadequate equipment, processes (including absence of standard work instructions), and risk of or observed health care provider breach with exposure to potentially infectious materials. Members of hospital staff with expertise in disaster preparedness served as subject matter experts for these debriefings.

The debriefing and subsequent report out were roughly based on the SEIPS system model [Systems Engineering in Patient Safety], encompassing patient, provider, technology and tools, environment, organization, and process elements.[7] The SEIPS model was especially appropriate for this work because it includes "employee and organization outcomes" as one of its considerations. Facilitator notes were rapidly organized by the facilitators and turned over to the hospital administration and the critical incident team composed of administration, infection control, and disaster preparedness personnel, within a few hours of the simulation. The critical incident team then prioritized the latent safety threats identified by the facilitators and quickly acted to make system changes in time for the next simulation session. In addition, simulation staff were invited and participated in most critical incident team meetings to help identify further simulation needs. Each subsequent simulation was designed to reevaluate processes and equipment where latent safety threats were previously identified. This project was reviewed by the institutional review board and deemed exempt after these simulations were completed. In addition, the Centers for Disease Control sent a team to Akron, which observed some of the simulations while they were at the hospital; however, this team was not involved in the planning or evaluation of these simulations.

Table 1 presents further description of simulations that were performed, listed by day of incubation, during the 21-day Ebola incubation period. Therefore, day 0 indicates the day our index case developed symptoms and incident command requested simulation assistance late on day 2. Therefore, day 3 was the first day that simulations were conducted. The location, staff involved, and the resources needed for each session as well as the number of latent threats identified can be found in Table 2.

## RESULTS

A large number of threats were identified during the simulations, with a higher number of threats identified in early simulations (as would be expected) and relatively fewer threats identified in later simulations. In general, threats were identified in 3 main categories including inappropriate, inadequate or missing equipment, process threats, and protocol breaches. There are several threats noted in each of these categories with the most important of these threats noted later. The number of each type of threat identified for each simulation day is listed in Table 3. Appendix 1 gives examples of some specific latent threats that were identified and the solutions.

First, several threats were identified around equipment preparedness. Gowns that were initially believed to be fluid impermeable were found to be semipermeable, therefore allowing simulated vomit and diarrhea to penetrate the gown. The isolation ward's negative pressure rooms were located adjacent to a central hallway increasing the risk of contamination to other staff. Sufficient supplies of PPE to protect staff were not initially available. Of note, during the time that these simulations were conducted the CDC's own recommendations for the level of protection required by hospital staff evolved to require levels of protection higher than were initially recommended.[1] Our organization chose to use the higher levels of protection based on the results of our simulations even before the CDC revised its recommendations. This is an example of the PDSA cycle of simulations, allowing the organization to progress more quickly than even the official guidelines for PPE. Finally, there was the need for several types of communication equipment that were not initially in place. This communication equipment included telephones for the screeners at the hospital entrance



Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.

**TABLE 1.** Simulations Run by Day in Ebola Incubation Period

| Day | Department | Description of Simulations |
|---|---|---|
| Day 3 | ED | • Three standardized patients (2 children and 1 caregiver) presented to the ED with complaints of vomiting with a Ebola-positive contact. |
| | | • These patients tested the screening process for all patients presenting to the ED and the initial ED management. |
| | | • This simulation took approximately 2.5 h to perform and debrief. |
| | Transport | • Staff donned level 3 PPE and then cared for a mannequin-type simulator in hypovolemic shock with respiratory failure. |
| | | • This included drawing up and administering medications, programing the transport ventilator, and transporting the simulator while donned in PPE. |
| | | • This simulation took approximately 2.5 h to perform and debrief. |
| | Critical care | • Staff donned appropriate level 3 PPE and transported the mannequin-type simulator from the ED to the PICU. |
| | | • Once in the PICU, the simulated patient developed hypovolemic shock requiring intravenous placement, normal saline boluses, central line placement, an epinephrine drip, as well as endotracheal intubation. |
| | | • This simulation took approximately 3 h to perform and debrief. |
| Day 5 | Critical Care | • The staff performed repetitive deliberate practice of donning and doffing appropriate PPE. |
| | | o Members of our transport team who are part of a disaster-medical assistance team and a member of the Army National Guard coached staff and provided feedback on appropriate donning and doffing techniques during this time. |
| | | • Donning and doffing PPE practice occurred for approximately 1.5 h. |
| | Critical Care | • Although the staff was attired in level 3 PPE, they performed task training appropriate to their role including |
| | | o Drawing up rapid sequence intubation medications, operating the portable x-ray machine, starting intravenous lines, obtaining and packaging blood samples for Ebola testing, donning sterile gloves, placing urinary catheters, and endotracheal intubations. |
| | | • Task training occurred for approximately 2.5 h |
| | ED/critical care/security | • Two standardized patients (1 patient and 1 family member) presented to the ED with vomiting and a Ebola-positive contact. |
| | | • The patient was placed in a newly designated ED holding area where ED nurses responded. |
| | | • ED nurses then alerted the infectious disease consultant, who contacted the critical care staff. |
| | | • With the help of hospital security, critical care staff transported the patient from the ED holding area to the new isolation ward where the patient was admitted. |
| Day 7 | Critical care | • Critical care staff donned appropriate PPE, transferred a standardized patient from the ED holding area to the isolation ward. |
| | | • Once in the isolation ward, a simulator was used to run a critical care scenario. |
| | | • The simulated patient also experienced bouts of explosive diarrhea, which contaminated the bed and the floor, demonstrating the widespread contamination that could potentially occur. |
| Days 11–18 | ED/critical care | • Practice donning and doffing appropriate PPE. |
| | | • Transferring a standardized patient or mannequin-type simulator through the institution. |
| | | • Further task training as described on day 5. |

to inform ED staff of a positive screen result, a telephone to allow the ED staff in the holding area to activate communication with the infectious disease consultant, and a new group page to inform relevant staff members of an Ebola-positive screened patient. Although many health care workers often use cell phones to communicate with other health care workers, this was impossible when fully dressed in Level 3 PPE. In addition, the powered air purifying respirators create significant ambient noise when wearing PPE. This made verbal communication difficult and required the use of more

**TABLE 2.** Summary of Simulations Conducted by Day in Ebola Incubation Period

| | Location of Simulation (Progression) | Simulation Participants | Simulators Used | No. Latent Threats Identified | Length of Simulation |
|---|---|---|---|---|---|
| Day 3 | ED transport PICU | Nursing staff, physicians, respiratory therapist | 3 standardized patients, 5-yr-old HAL, central line trainer | 112 | 8 h |
| Day 5 | ED isolation ward | Nursing staff, physicians, respiratory therapist, security | 5-yr-old HAL, intravenous trainers, urinary catheter trainer, intubation trainers, standardized parents | 36* | 8 h |
| Day 7 | ED Isolation Ward | Nursing staff, physicians, respiratory therapist, security | Standardized parent, 5-yr-old HAL, central line trainer | 80 | 5 h |
| Day 15 | ED Isolation Ward | Nursing staff, physicians, respiratory therapist, security, environmental services | Standardized parent, 5-yr-old HAL | 35 | 3 h |
| Day 17 | ED Isolation Ward | Nursing staff, physicians, respiratory therapist, security, environmental services | Standardized parent, 5-yr-old HAL | 17 | 3 h |
| Day 18 | ED Isolation Ward | Nursing staff, physicians, respiratory therapist, security, environmental services | Standardized parent, 5-yr-old HAL | 7 | 3 h |

*Further threats were identified; however, a verbal report as well as the only complete written copy of the relevant notes were given to the administration for this simulation. A partial list of latent threats is what was available following the report out.



Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.

**TABLE 3.** Types of Threats Identified Listed by Day in Ebola Incubation Period

| | Equipment (Absent or Inadequate) | Processes (Absent or Inadequate) | Risk of Breach |
|---|---|---|---|
| Day 3 | 31 | 61 | 20 |
| Day 5* | 15 | 16 | 5 |
| Day 7 | 24 | 42 | 14 |
| Day 15 | 6 | 25 | 4 |
| Day 17 | 7 | 7 | 3 |
| Day 18 | 1 | 5 | 1 |

*Further threats were identified; however, a verbal report as well as the only complete written copy of the relevant notes were given to the administration for this simulation. A partial list of latent threats is what was available following the report out.

creative solutions to communicate effectively. For example, erasable white boards were helpful in this regard as were "baby monitors" that allowed staff outside the patient room to monitor events in the patient care room. These modifications evolved as a result of the PDSA simulation cycles during repeated simulations.

Many system threats were identified. First, there was an absence of standard work instructions related to a positive Ebola screen result. Initially, there were no standard instructions as to what the screeners outside of the hospital should do if they had a positive screen result and no work instructions for how a positively screened patient would be transferred from the ED to the isolation ward. Not surprisingly, there were also no standard processes for decontamination of the ED holding area, the isolation ward, or any other areas that were potentially contaminated. In addition, hospital leadership made a strategic decision to minimize the number of staff that would potentially be exposed to a Ebola-positive patient. This decision resulted in nursing and physician staff being responsible for tasks that they typically do not perform and other modifications to their usual work. For example, there was a need to develop standard work instructions for health care staff on the use of the portable x-ray machine (one of which was stationed in the designated isolation unit). In addition, a decision was made to perform only point-of-care testing to minimize the need for blood samples to leave the designated unit. It was also decided that should blood products be necessary, type O negative packed red blood cells would be provided rather than obtaining cross-matched blood products. Once work instructions for these and other tasks were developed, the new processes were tested with additional simulations.

An important and potentially unrecognized threat is the difficulty in performing patient care in high-level PPE. For example, visibility and mobility of the health care worker are severely limited when attired in Level 3 PPE. Placing intravenous and central lines is difficult when wearing 2 to 3 pairs of gloves. An older ultrasound machine was placed in the patient care room to facilitate vascular access. Discussion also occurred concerning the potential use of an intraosseous line because it would require less tactile sensation and skill than other types of vascular access. This was viewed as a viable option for acute fluid resuscitation needs. Endotracheal intubation using direct laryngoscopy was also observed to be difficult because of the visual and mobility limitations of the health care worker. This procedure was even more difficult when the health care worker was wearing glasses, especially bifocals. Alternatively, using indirect video laryngoscopy was substantially easier and more efficient; therefore, it was decided that a glideslope would be provided to the isolation unit, should an intubation be unavoidable.

Finally, our simulations demonstrated frequent unintentional and unconscious breaches in the PPE protocol, which would have resulted in an exposure of the health care workers to potentially infectious material. Moulage and other simulation aids were useful in the identification of potential breaches and contamination. For instance, when our simulator had explosive diarrhea that contaminated the floor of the isolation unit, we found that the health care workers unknowingly tracked this into the "warm" decontamination area, thus contaminating that area more heavily than initially believed. In addition, there were several areas of potential contamination noted in the PICU when that was initially considered as a treatment area for a potential Ebola patient. This resulted in the creation of an isolation unit that could be used in this situation. Doffing of PPE was noted to be an extraordinarily high-risk process for health care workers. This may reflect the fatigue of the health care worker who has just completed a shift in PPE. The doffing of PPE was most successful with a knowledgeable "helper" who assisted the health care worker in doffing as well as an observer who focused on potential and actual breaches that occurred during doffing. Therefore, our doffing policy changed to require knowledgeable helpers and observers to be present during all doffing.

The disposal of large amounts of contaminated biowaste was a significant concern that the organization was not initially prepared for. This threat raised issues of the most appropriate methods to prepare environmental health workers and the best ways to store and dispose of waste. The development of standard processes for disposal of biowaste took significantly longer than other processes and was not tested until late in the 21-day incubation period.

## DISCUSSION

We used multiple modes of simulation to assess our institution for Ebola preparedness, including standardized patients and parents, mannequin-type simulation and task training, as well as hybrids of these methods in an in situ setting. We used a number of PDSA cycles until our hospital staff was prepared for a possible Ebola patient. The process was iterative, and changes in process were often tested "on the fly." The simulations were not especially difficult to conduct from a programming perspective but were often lengthy, sometimes lasting from 7:00 AM till 5:00 PM and occurring on weekends as well as weekdays because of the perceived urgency of the situation. Members of our simulation staff put in voluntary overtime, and a number of previously scheduled simulation activities were postponed to make these simulations possible.

One interesting challenge was the identification of the goals of the simulations. Initially, when the simulation team requested explicit goals for the simulation and requested


© 2016 Society for Simulation in Healthcare


Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.

clarification as to whether these were being conducted for training or to evaluate the system/processes, we were told "both." By holding in situ simulations, we were able to help train our targeted response team while identifying a large number of latent safety threats, which were subsequently addressed by incident command between each simulation activity. Then, PDSA cycles using simulations were able to assess for improvement or for unintended consequences of proposed solutions to previously identified latent safety threats.

Based on our experience, we would recommend the following when faced with an acute need for simulation in a disaster preparedness situation:

- Anticipate a number of days of simulation sessions to allow for testing, development, evaluation, and modification of the new processes that are likely to be needed for this type of threat.
- "Walk through" has value but will not provide information at the same level of granularity as a full-scale simulation, particularly related to processes and procedures.
- One to 2 individuals with experience in identifying latent threats should be designated solely to observe and make notes during the simulations. These observations not only are extremely valuable in the debriefing as in any other simulation but also provide the basis of reports to hospital leadership.
- Use simulated brightly colored bodily fluids liberally during the simulations. This allows for assessment of breaks in PPE and to easily appreciate areas of contamination.
- Use local experts from hazmat teams as subject matter experts. The National Guard and local military reserve units as well as institution employees are good sources for these individuals.
- Rapidly present reports to the administration to implement rapid improvement in processes and to address identified threats.
- Do not forget about biowaste and the environmental health workers who will handle the contaminated waste.

After this experience, we believe that days to weeks of simulation are crucial to appropriate disaster preparedness, whether it is related to an infectious disease or a mass-casualty event. Just as deliberate practice is important in task training to attain mastery-level competency, it is also important to ensure deliberate practice to prepare for disasters such as Ebola. Given the complexities of the situation and the lack of standard processes, this will not be accomplished by a "one and done" simulation experience. These simulations demonstrated that as an organization, we did not have the processes and resources in place to safely handle an Ebola-positive patient at the beginning of this crisis. After the first round of simulation, we identified a number of threats and absent processes. Many of these were addressed before the second round of simulations. There were additional threats identified in the second round of simulations, indicating the importance of an iterative process and ongoing evaluation of the proposed solutions. This speaks to the need to dedicate sufficient time not only for training but also as importantly for the evaluation of the system's preparedness and the ongoing process improvement required to address identified threats.

We found that rapidly preparing reports for administration allowed for rapid action by hospital leadership in terms of addressing needed resources. This allowed threats to be identified and resolved quickly, creating an environment where further simulations occurred rapidly and in an iterative manner. There are multiple health care organizations and simulation programs currently using simulation in a similar manner to evaluate Ebola preparedness in their institutions. Based on our recent experience, we feel a longitudinal simulation experience using an iterative approach is the best method for successful Ebola preparation

In retrospect, it would have been beneficial to involve security staff and the environmental health workers in earlier simulations so that their processes could be developed early in the process. If a positively screened Ebola patient had presented during the incubation period, these departments would have been at a greater risk because they were not involved in the earliest simulations and the processes related to their roles were not in place. Environmental health workers were especially believed to be at high risk but overall had less protective equipment and less training early in this crisis.

In addition, when working in a high-stress/time-sensitive environment, we found that it was imperative to allow for longer periods for simulations. Our simulations and debriefings tended to run longer than expected because of the high anxiety level of the participants and their concerns for their own safety. Participants were very invested in the simulation experience and the identified threats. The doffing process in particular was very frustrating because very few individuals were able to perform it correctly. The addition of a helper and an observer to the doffing process seemed to reassure staff.

As an organization, general discussions regarding the use of simulation to assess Ebola preparedness were initially entertained when the first health care workers returned from West Africa infected with Ebola. However, the urgency of this need was rapidly accelerated by the presence of an exposed health care worker in the region. It is a measure of the value of an integrated simulation program that our hospital-based simulation program was able to rapidly mobilize to conduct appropriate progressive in situ simulations within 12 hours of the hospital leadership's request. This was possible in large part because of the robust infrastructure of the simulation program and the simulation team's substantial experience especially with in situ simulation. The simulation team was already extremely comfortable with in situ simulation and was proficient with using simulation as a means to identify system and process threats. Appropriate critical scenarios were already a part of our simulation scenario library, and the simulation team was proficient at modifying these scenarios "on the fly." In addition, the creativity of the simulation team, especially the simulation technologist's ability to rapidly create simulated body fluids and ways of deploying these, was especially important for this situation. Daily report outs with leaders and administrators who have the



Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.

ability and resources to resolve identified issues facilitated rapid improvement and the opportunity to evaluate solutions for unintended and unanticipated consequences.

Although the rapidity of simulation deployment in this situation is somewhat unusual, it speaks to the value of the simulation program to the organization and the benefits of investment in a robust simulation program to the organization. This type of response is not possible without an investment in simulation educators, technologists, and a robust simulation infrastructure.

## REFERENCES


1. McCarthy M. US revamps domestic Ebola response. *BMJ* 2014;349:g6417.
2. BBC News; Ebola: Mapping the outbreak. Available at: http://www.bbc.com/news/world-africa-28755033. Accessed June 21, 2015.
3. Gaba DM. Simulation as a critical resource in the response to Ebola virus disease. *Simul Healthc* 2014;9:337–338.
4. Wheeler DS, Geis G, Mack EH, LeMaster T, Patterson MD. High-reliability emergency response teams in the hospital: improving quality and safety using in situ simulation training. *BMJ Qual Saf* 2013;22:507–514.
5. Wetzel EA, Lang TR, Pendergrass TL, Taylor RG, Geis GL. Identification of latent safety threats using high-fidelity simulation-based training with multidisciplinary neonatology teams. *Jt Comm J Qual Patient Saf* 2013;39:268–273.
6. Yajamanyam PK, Sohi D. In situ simulation as a quality improvement initiative. *Arch Dis Child Educ Pract Ed* 2015;100:162–163.
7. Carayon P, Xie A, Kianfar S. Human factors and ergonomics as a patient safety practice. *BMJ Qual Saf* 2014;23:196–205.


**APPENDIX 1.** Examples of Latent Threats Identified and Solutions Proposed

| Type of Latent Safety Threats | Description of Latent Threat | Solution to Latent Threat |
|---|---|---|
| Equipment (absent or inadequate) | The initial screener had to leave the positively screened family unattended while they notified the ED. | Initial screeners were provided a portable telephone to contact the ED. |
| | The initial proposed care area had limited space for donning and doffing, leading to common areas becoming contaminated. | A little used area of the hospital was transitioned into an isolation ward. |
| | There was a lack of equipment stocked in the patient room, creating the need for multiple trips in and out of the anteroom, making that area more contaminated. | Specially stocked carts were created and placed in the potential patient care room, including a procedure cart, linen, and an airway cart. |
| | The available sized boots were too large for the volunteer nurses causing tripping hazards. | Smaller boots were ordered. |
| Processes (absent or inadequate) | There was no process on how to handle the family's car, which was contaminated and left in front of the ED entrance. | We developed a set "parking space" for a car in this instance that was away from ED traffic. |
| | In transporting the patient from the ED to the isolation ward, the team was contaminating doors. | The path was blocked off from traffic until environmental services decontaminated the path. |
| | There was concern about exposing x-ray technicians to patients with Ebola. | A portable x-ray machine was identified, which could stay on the isolation ward if a positively screened patient arrived; standard work instructions on how to operate that machine were made, and nurses were trained on this process. |
| | There was no process on how to inform the volunteer response team that a positively screened patient had arrived. | A group paging system was set up to notify the team, and a call back procedure was developed. |


© 2016 Society for Simulation in Healthcare


Copyright © 2016 by the Society for Simulation in Healthcare. Unauthorized reproduction of this article is prohibited.