Ebola and Other Highly Pathogenic Infections: Promoting Workplace Safety through Planning, Preparation & …. Novel Training Technologies

Collaborators

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  • WWAMI Institute for Simulation in Healthcare (WISH) Ross Ehrmantraut, RN, HRET Sr. Fellow, and Simulation Lab staff
Collaborators

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• Virginia Tech Carilion Research Institute
  • Sarah Parker, PhD

• Context VR
  • Dmitri Bouianov

Disclosure

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Background

**When:** during the height of the 2014 Ebola outbreak

**Who:** healthcare professionals, simulation experts, risk assessors and training developers

**What:** combine our collective expertise to address methods for developing training tools that offer best practices in both clinical care and occupational health

Purpose of our project

- **Case study:** outbreak of highly contagious infectious disease
- Multiple factors contribute to difficult work environment
- Reality of wearing high level PPE (HL-PPE)
- Focus on **occupational safety** of the HCP as clinical care protocols being developed
Purpose of our project

- **Case study**: outbreak of highly contagious infectious disease
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EVD in the United States
“There was no training, no explanation, nobody around to help them,” said Dr. Pierre Rollin, an Ebola expert from the C.D.C.

“That first night in the I.C.U., nurses wore two gowns to cover front and back, shoe covers, a surgical mask, two layers of gloves and a face shield”, a hospital spokesman, said. By the next night, after Mr. Duncan tested positive for Ebola, they added Tyvek suits with hoods and respirators. Then came plastic aprons and triple layers of bootees and gloves.

The C.D.C. later said too much gear may have increased risk.

--NYTimes, 10/25/14

Key actions  (from HMC ED director):

• Rapid development of safe, effective protocols
• Communication/education → corrects misinformation
• Training → normalizes the work
• Be ready to modify all of the above on a daily basis
• Preparing for the long-haul…and the next epidemic
The Project

• Design and carry out recorded simulations
• Use the recordings to execute an FMEA: Failure Mode Effects Analysis risk assessment
• Use the FMEA to analyze steps and develop/refine safer protocols
• Develop training tools

Steps of the Project

• Develop a “problem” and a simulation scenario
• Map the process
• Conduct and record the simulation—multiple times, possibly—iterative process
• Convene the team and conduct the FMEA
• Develop protocols for the target procedure
• Develop 2 training apps—JIT for hand-held and a virtual reality tool
• Develop a training “course” to teach the technologies
What this CAN BE

• A case study for using risk analysis, simulation and virtual reality tools to develop protocols
• A way to train HCPs in a familiar format

What this REALLY IS

• Used in any complex situation where carefully determined protocols will help minimize the risk of occupational injury or illness
treating a potential ebola patient is a **low frequency, high acuity event**. In other words, it isn’t likely to happen often, but when it does happen, it presents profound risks of harm and potentially severe consequences.

*From the Joint Commission ECNews, 2016*
FMEA: Failure Mode & Effects Analysis

A structured approach to
• Identify the ways in which a product or process can fail
• Estimate and quantify the risk associated with specific causes
• Prioritize the actions that should be taken to reduce the risk

Problem

Wearing HL-PPE can
• limit peripheral vision,
• Impair communication
• impair gross and fine motor skills and spatial awareness, contributing to
  • Needlesticks
  • Fluid contamination
  • Falls
  • Heat stress

Use a risk analysis process—FMEA— to identify protocol challenges and mitigate them BEFORE they occur in practice.
FMEA: Failure Mode & Effects Analysis

Purpose of our exercise:
- to create effective occupational safety training protocols for personnel using unfamiliar and uncomfortable HL-PPE equipment to prevent healthcare exposure to infectious agents, bodily fluids and other occupational injuries or illnesses

FMEA Overview

- Select/Define the process
- Assemble the team
- Design simulation
- Identify steps in the process
- Identify failure modes for each step
- Identify effect of each failure mode
- Assign a risk priority score
- Develop mitigation strategies
- Implement and re-evaluate
Clinical Focus: Fecal Management

• Simulate hygiene care for a patient with a highly infectious disease, losing copious amounts (≥10 L/day) of bodily fluids via watery stool and vomit
  • Changing the linens
  • Disposing of contaminated materials and disinfect/clean the room

What is Simulation?

• Any technology or process that recreates the contextual (clinical) background
Effectiveness of OH&S training

NIOSH OH&S Training Report

A meta-analysis of methods found that the higher the level of engagement—requiring MORE active participation—the training resulted in:

• A measurable increase in knowledge acquisition
• A decrease in accidents, injuries and illness in workers


Standardized Patients

(CONTINUING EDUCATION PROGRAMS
NORTHWEST CENTER FOR OCCUPATIONAL HEALTH AND SAFETY
DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH SCIENCES
University of Washington School of Public Health)
Standardized Patients

- Communication
- Family interaction
- Physical exam interaction
- Need for a “moving” patient

Task Trainers

- Practicing a specific task
- Can combine with other modalities
Full-body Mannequins

- Resuscitations
- Care of an ill patient
- Painful procedures
- Teamwork
- Multi-unit care

Virtual Reality

- “Immersive”
- Can incorporate multiple people
- Potential for “distributed” learning
Advantages of Simulation-based Training

• Deliberate

• Allows opportunity for feedback

Advantages of Simulation

• Simulation provides a standardized setting for training and assessment

• Understand barriers to implementation of protocols / therapies

• Evaluate equipment and environmental factors
Simulation Design

A 23 year old female 2 days into her hospitalization for EVD has increasing watery diarrhea. She is alert and oriented, but overall feels weak. Her vital signs have been stable and reflect ongoing dehydration, with a HR of 110. The patient has 2 IVs, and a foley catheter, and is receiving replacement fluid through one IV.

The team needs to change her linens. She can cooperate and assist with rolling but is too weak to stand safely. She continues to have active diarrhea during the first half of the changing process. Her vital signs if checked do not change during the process.

The simulation ends with clean-up after the linen change.

FMEA Overview

Select/Define the process → Assemble the team → Design simulation

Identify steps in the process → Identify failure modes for each step → Identify effect of each failure mode

Assign a risk priority score → Develop mitigation strategies → Implement and re-evaluate
Hygienic Care Simulation

Behaviors

- Gather linens
- Arrange waste receptacles
- Ensure adequate disinfectant
- Execute pre-brief
- Roll patient
- Position devices/tubes
- Remove head/foot
- Release fitted sheet
- Prepare new linens
- Create barrier on floor
- Discuss fecal management system
- Revisit Event 2
- Ensure supplies duplicated on other side
- Gross contamination check
- Repeat Event 2
- Remove all materials from floor
- Bleach floor
- Clean tubing/equipment

The Simulation Suite: Patient Care Room
Event-based Simulation Design

- Utilizes triggered events that require specific behavioral responses from the participants

Considerations

• PPE necessary
• Equipment needed in the room
  • Waste receptacles
  • Extra PPE
  • Disinfectants
  • Medical devices and supplies
  • Communications

Determine Your Simulation Technology
Data Collection

- Video / Audio
- Metrics (measurement tool)
  - Patient Care metrics
  - Teamwork metrics
- Direct observation
- Participant comments
Video / Audio

FMEA Overview

Select/Define the process → Assemble the team → Design simulation

Identify steps in the process → Identify failure modes for each step → Identify effect of each failure mode

Assign a risk priority score → Develop mitigation strategies → Implement and re-evaluate
### Process

<table>
<thead>
<tr>
<th>Potential Failure Mode</th>
<th>Effect of Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item not available in close proximity to provider</td>
<td>Procedure takes too long and patient declines</td>
</tr>
<tr>
<td>Becoming contaminated (feet)</td>
<td>Increased risk of agent spreading</td>
</tr>
<tr>
<td>becoming contaminated, aprons/gowns too long hitting floor</td>
<td>HCW exposure</td>
</tr>
<tr>
<td>Spreading agent by kicking towels</td>
<td>HCW exposure</td>
</tr>
<tr>
<td>tripping over towels</td>
<td>Physical injury and difficulty assisting provider</td>
</tr>
<tr>
<td>incontinence pads don’t stay rolled and only absorbant on one side</td>
<td>Increased splatter and unrecognized gross contamination</td>
</tr>
</tbody>
</table>

### Risk Priority Number: RPN

Calculate risk priority score for each failure mode

- **Severity** (1 = not severe ➔ 10 = most severe)
- **Occurrence** (1 = rare ➔ 10 = very common)
- **Detectability** (1 = easily detected ➔ 10 = undetectable)

\[ \text{RPN} = (\text{severity}) \times (\text{occurrence}) \times (\text{detectability}) \]
<table>
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<th>Process</th>
<th>Potential Failure Mode</th>
<th>Effect of Failure Mode</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detectability</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set up blankets on floor to dam liquids (do on both sides of bed)</td>
<td>Item not available in close proximity to provider</td>
<td>Procedure takes too long and patient declines</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>Becoming contaminated (feet)</td>
<td>Increased risk of agent spreading</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>becoming contaminated, aprons/gowns too long hitting floor</td>
<td>HCW exposure</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Spreading agent by kicking towels</td>
<td>HCW exposure</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>tripping over towels</td>
<td>Physical injury and difficulty assisting provider</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>incontinence pads don’t stay rolled and only absorbant on one side</td>
<td>Increased splatter and unrecognized gross contamination</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>16</td>
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</tbody>
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**What Now?**

- **Rules of thumb**
  - Prioritize highest RPN
  - If failure has severity of 10, deal with it even if the overall RPN is low
  - Discuss & list mitigation strategies
### Process

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<thead>
<tr>
<th>Potential Failure Mode</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detectability</th>
<th>RP N</th>
<th>Possible Mitigation Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item not available in close proximity to provider</td>
<td>7</td>
<td>8</td>
<td>3</td>
<td>168</td>
<td>set up/laundry cart on both sides</td>
</tr>
<tr>
<td>Becoming contaminated (feet)</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>possible speak aloud? Additional layer?</td>
</tr>
<tr>
<td>Becoming contaminated, aprons/gowns too long hitting floor</td>
<td>5</td>
<td>5</td>
<td>8</td>
<td>200</td>
<td>tie it up? Additional layer? Relies on observer.</td>
</tr>
<tr>
<td>Spreading agent by kicking towels</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>192</td>
<td></td>
</tr>
<tr>
<td>Tripping over towels</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>50</td>
<td>observer come around? Positioning of observer for each step? (is there an SOP if someone goes down?)</td>
</tr>
<tr>
<td>Incontinence pads don't stay rolled and only absorbent on one side</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>16</td>
<td>checklist and procedures for how to dam</td>
</tr>
</tbody>
</table>

### Example(s) of Process Steps

**Removing dirty linens**
- Roll patient onto side
- Towel barrier on floor
- Placing incontinence pad under patient
- Removing fitted sheet
- Unrolling clean linens
- Clean floor to remove contaminated linens

**Removing fitted sheet**
- Roll patient onto side
- Towel barrier on floor
- Placing incontinence pad under patient
- Removing fitted sheet
- Unrolling clean linens
- Clean floor to remove contaminated linens

**Removing dirty linens**
- Roll patient onto side
- Towel barrier on floor
- Placing incontinence pad under patient
- Removing fitted sheet
- Unrolling clean linens
- Clean floor to remove contaminated linens

**Removing dirty linens**
- Roll patient onto side
- Towel barrier on floor
- Placing incontinence pad under patient
- Removing fitted sheet
- Unrolling clean linens
- Clean floor to remove contaminated linens

### Occasion of Failure Mode

**Hygienic care for EVD patients generally requires additional steps and supplies than what is routinely needed, especially if patient continues to contaminate clean materials.** It is easy for HCPs to forget to gather required items prior to initiating the process. This poses a threat as it means repeatedly leaving the bedside with dirty gloves/gown to move across the room.

**Providing hygienic care requires the HCP to move from one side of the patient to the other.** Having easily accessible supplies regardless of which side of the bed the HCP is working from is important. This includes sanitizing gel.

**When providing hygienic care to patients with copious watery diarrhea there is increased risk of having stool leak onto the floor.**

**HCP is often in close contact with the patient.** Multiple steps require the HCP to directly handle soiled materials or use tools (e.g.: tongs) or materials (e.g.: towels) that are not well-designed for the task. Despite best efforts, observers were not able to notice all high-risk exposures due to positioning or inattention how about something.

**Areas with no obvious gross contamination are at risk for direct exposure to infectious agent.** Limited visibility resulting from the process is to create a dam of towels on the floor to limit spread of agent. This presents risk to the HCP especially considering limited mobility and vision related to high level PPE.

**This is a lengthy procedure.** With patients having copious watery stools, there is a high risk of recontamination of clean linens before the procedure is over.

**One recommended method to handle active stooling during this process is to create a dam of towels on the floor to limit spread of agent.** This presents risk to the HCP especially considering limited mobility and vision related to high level PPE.

**This risk is similar to risks encountered for all patients.** What is unique for EVD patients is the relative line number of HCP in the room and difficulty in obtaining help. This was seen as a big problem for high-risk intubated patients.

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Results

• 30 discrete steps identified in the process
• 16 identified failure modes related to EVD patient hygienic care
• same failure mode was often associated with multiple steps
  • e.g., provider contamination
• Failure modes ranged in RPN from 6 – 400

Summary

• FMEA is a useful tool for rapidly evaluating risks of a new process

• Event-based simulation allows us to see the new process in action and develop a more accurate FMEA
### iOS Device (iPhone or iPad)

2. If necessary, login with your Apple ID and password.
3. Open the app once downloading is complete.
4. You will be prompted with a login screen. Use the following login information:
   - Username: uwashington
   - Password: uw2016

5. Login is only required when you first download the app.

### Android Device

2. If necessary, login with your Gmail account and password.
4. Open the app once downloading is complete.
5. You will be prompted with a login screen. Use the following login information:
   - Username: uwashington
   - Password: uw2016

6. Login is only required when you first download the app.

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**Treating Patients with Highly Contagious Infectious Diseases:**

**Using Technology to Advance Safety**

April 6, 2016 Harborview Medical Center, Seattle, WA

**COURSE MANUAL**

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NORTHWEST CENTER FOR OCCUPATIONAL HEALTH AND SAFETY
DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH SCIENCES
University of Washington School of Public Health
https://osha.washington.edu/pages/infectious-ppe

What is VR?

• A computer-generated environment consisting of 3D images and sounds experienced by users through sensory stimuli and in which user actions partially determine what happens in the environment

• Static vs more active
Pilot Study Using VR to Train Physicians

• Used VR to conduct an intensive 1-hour CME module on type 2 diabetes
• All responding participants (n=12) felt this was an effective means of education
• All felt this was superior to other online training
• All would recommend this method
• 10/12 felt this method was superior to live CME


VR Demos

• Walk-around room-scale
  • More fully immersive

• Google cardboard:
  • 360 photos/videos
Thank you

Sponsor

• Washington State Department of Labor & Industries

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• Nancy Simcox, MS
• Scott (John) Meschke PhD, JD
• Bryan Kim, BA
• Steven Mitchell, MD
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• Robin Collier, RN, MN
• Brandi Ward, BA