Overview of Online Resources and Literature for PPE Training and Occupational Safety in Ebola Care

Prepared by the Ebola Working Groups of the Dalla Lana School of Public Health at the University of Toronto, and l’école des hautes études en santé publique (EHESP).

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1. Introduction

The Ebola Working Group was established in September 2014 at the University of Toronto’s Dalla Lana School of Public Health (DLSPH). The Ebola Working Group has collaborated with l’École des hautes études en santé publique (EHESP) in Paris, France and the not-for-profit organization Workplace Health Without Borders to present current information on occupational preparedness for Ebola care providers.

The 2013 Ebola epidemic in West Africa is a global public health crisis. Together, local healthcare systems and international relief efforts have been called to treat patients and contain the spread of the infection. Prevention of transmission of Ebola between patients and primary care providers is essential for a well-functioning healthcare system.

The aim of this report is to provide a general overview of available online resources for personal protective equipment (PPE) training and occupational safety practices. Further, this report is intended to provide guidance on measures to reduce the risk of occupational exposure to Ebola in healthcare workers. The resources presented here are not necessarily exclusive to the Ebola epidemic. The considerations made here can be applied in the context of other infectious disease outbreaks.
2. Donning/Doffing PPE

Centers for Disease Control and Prevention
http://www.cdc.gov/vhf/ebola/hcp/ppe-training/

- Provides short step-by-step video modules for both Donning and Doffing of:
  - N95 Respirator & Gown
  - N95 Respirator & Coverall
  - PAPR & Coverall
  - Trained Observer for All PPE

- Comments: Structure of the module is organized in a highly sequential manner. Might be easy to follow, but at the same time, tedious. Context of the video scenarios are American or Western Hospitals.

Public Health Agency of Canada
Infection prevention and control expert working group: Advice on infection prevention and control measures for Ebola virus disease (EVD) in healthcare settings.

PPE recommendations
- Suggested sequence for donning
- Proper use during patient care
- Suggested sequence for doffing

Canadian Critical Care Society
Ebola Clinical Care Guidelines

- Personal Protective Equipment Considerations (pp.22)
  - Selecting PPE should be based upon clinical task and risk of exposure
  - Donning/Doffing procedures require input from clinicians using PPE; will result in best plans and safest care while boosting clinicians’ confidence in caring for patients
  - PPE should be packaged together, and all components must be compatible with one another
  - Consideration for heat stress must be made
  - Of critical importance is a specifically trained safety officer or ‘buddy’ to oversee donning and especially doffing (when the healthcare worker is hot, fatigued and anxious to remove their PPE)

University of Nebraska Medical Center

- Donning biological PPE:
  https://www.youtube.com/watch?v=yAljqBcqnP4/
  http://app1.unmc.edu/nursing/heroes/mpv.cfm?updateindex=105&src=yt

- Doffing biological PPE in a buddy system through verbal cues:
  https://www.youtube.com/watch?v=D95r0dEETIs
Medécins sans frontières

- Dressing PPE (no sounds, video made for training purposes to be shared in the field without language barriers): http://vimeo.com/108334387#comment_12817343

CDC Guidance for donning and doffing PPE – 3 key principles


1. Prior to working with EVD patients, all healthcare workers involved in the care of EVD patients must have received repeated training and have demonstrated competency in performing all EVD-related infection control practices and procedures, and specifically in donning/doffing proper PPE.

2. While working in PPE, healthcare workers caring for EVD patients should have no skin exposed.

3. The overall safe care of EVD patients in a facility must be overseen by an onsite manager at all times, and each step of every PPE donning/doffing procedure must be supervised by a trained observer to ensure proper completion of established PPE protocols

http://www.cdc.gov/media/releases/2014/fs1020-ebola-personal-protective-equipment.html (further elaborates on the three principles)

PRINCIPLE #1: Rigorous and repeated training

Focusing only on PPE gives a false sense of security of safe care and worker safety. Training is a critical aspect of ensuring infection control. Facilities need to ensure that all healthcare providers practice numerous times to make sure they understand how to appropriately use the equipment, especially in the step-by-step putting on and taking off of PPE.

PRINCIPLE #2: No skin exposure when PPE is worn

Given the intensive and invasive care that U.S. hospitals provide for EVD patients, the tightened guidelines are more directive in recommending no skin exposure when PPE is worn.

CDC is recommending all of the same PPE included in the August 1, 2014 guidance, with the addition of coveralls and single-use, disposable hoods. Goggles are no longer recommended as they may not provide complete skin coverage in comparison to a single-use, disposable full-face shield. Additionally, goggles are not disposable, may fog after extended use, and healthcare workers may be tempted to manipulate them with contaminated gloved hands. PPE recommended for U.S. healthcare workers caring for patients with EVD include:

- Double gloves
- Boot covers that are waterproof and go to at least mid-calf, or leg covers
- Single-use fluid resistant or impermeable gown that extends to at least mid-calf or coverall without integrated hood
• Respirators, including either N95 respirators or powered air purifying respirator (PAPR)
• Single-use, full-face shield that is disposable
• Surgical hoods to ensure complete coverage of the head and neck
• Apron that is waterproof and covers the torso to the level of the mid-calf (and that covers the top of the boots or boot covers) should be used if EVD patients are experiencing vomiting or diarrhea

The guidance describes different options for combining PPE to allow a facility to select PPE for their protocols based on availability, healthcare personnel familiarity, comfort, and preference while continuing to provide a standardized, high level of protection for healthcare personnel. The guidance includes having:

• Two specific, recommended PPE options for facilities to choose from. Both options provide equivalent protection if worn, put on, and removed correctly
• Designated areas for putting on and taking off PPE. Facilities should ensure that space and layout allows for clear separation between clean and potentially contaminated areas
• Trained observer to monitor PPE use and safe removal
• Step-by-step PPE removal instructions that include:
  − Disinfecting visibly contaminated PPE using an EPA-registered disinfectant wipe prior to taking off equipment
  − Disinfection of gloved hands using either an EPA-registered disinfectant wipe or alcohol-based hand rub between steps of taking off PPE

**PRINCIPLE #3: Trained monitor**

CDC is recommending that a trained monitor actively observe and supervise each worker putting PPE on and taking it off. This is to ensure each worker follows the step-by-step processes, especially to disinfect visibly contaminated PPE. The trained monitor can spot any missteps in real-time and immediately address them.

**Journal of Continuing Education in Nursing**


• An evaluation of EVD emergency response preparedness training and education (T&E) of staff at North Shore LI-J Integrated Health System in NY.
  • Rapid, focused role-specific training for workers, also based on level of exposure risk.
  • Training and education plan required an inter-professional team
  • T&E plan went from general to specific (EVD signs, symptoms, and transmission, to Level 3 PPE)
  • Multi-pronged approach to T&E; included:
    − E-learning modules & intranet posting of protocols, policies and videos
    − Demonstration and practice sessions for PPE competence
- Technical skill proficiency training while in PPE
- High-fidelity simulation scenarios (discussed in Pt.II)

• Evaluation of E-learning and Intranet use
  - Effective reach to every physician and staff member across the system
  - Use of an internal learning management system allowed for highly efficient deployment of training and tracking of completion
  - Limitation: need for frequent revision when new information or changes to existing protocol occurs


• PPE use training
  - “Based on a risk-stratified approach, staff were validated on type of protection most relevant to their role”
  - A validated checklist with step-by-step procedures for each PPE level ensured standardization of training. Additional checklists were available for observers and users of L3 equipment

• Technical skill and proficiency training
  - Demonstrative PPE were reused to save resources
  - A portal system was used to assess progress of staff competence in PPE over time. The portal allows each site to enter their training statistics by unit and job classification on a daily basis

• High-Fidelity simulations
  - Opportunities for practice built team confidence and competence
  - Allowed teams to define their own workflow
  - Learning objectives focused on safe and efficient care while wearing L3 PPE
  - TeamSTEPPS(R) concepts were practiced
    - Safety cross-checks
    - Closed-loop communication

• Follow up evaluation affirmed:
  - 1. Workers felt safe operating in their environments
  - 2. Workers felt more prepared to care for an EVD patient
3. PPE Cueing Practices


- Based on CDC guidelines with emphasis on the use of a buddy or a side monitor system to share in the responsibility of ensuring his or her partner’s safety, especially when donning/doffing


Complete operational guide outlining all procedures, roles, and responsibilities related to infection prevention and control measures for acute care in EVD (including PPE)

- Infection prevention and control measures III:
  - Utilize 3-person team approach:
    a. Primary: health care worker(s) who are entering the patient room to provide patient care
    b. Assistant: healthcare worker who is physically assisting with the donning and doffing of personal protective equipment
    c. Monitor: healthcare worker who is guiding donning and doffing processes, as well as observing processes within the patient room, to monitor for and prevent possible breaches
  - Also includes official documentation forms


- Most EVD transmission to health care workers occurs before recognition of the cause of illness
- This can be interrupted with simple interventions that focus on basics, such as improvement in basic health care infrastructure and providing adequate supply of PPE based on Centre for Disease Control (CDC) requirements, along with routinely practiced processes of donning and doffing a PPE
- Adequate systems to ensure safety that were successfully implemented by Médecins Sans Frontieres (MSF) in the recent EVD outbreak include: Separate exits for health care workers entering and leaving the red zone, limited working hours to avoid fatigue and exhaustion, and provision of a side observer at each exit to guide health care workers doffing PPE for the purpose of ritualizing the process
- Protection of health care workers in EVD outbreaks should not be the result of chance, but guaranteed through provision of adequate PPE as well as systems that enforce the safe use and removal of PPE
4. Disinfection/Decontamination

Medécins sans frontières
- Video describing disinfection and decontamination protocols

Centers for Disease Control and Prevention
- How to prepare and use chlorine solutions
- Tailored for general healthcare settings in West Africa

- Addresses the importance of soluble chlorine disinfectants to halt and prevent the spread of the EVD in workers and community members responsible for the removal and disposal of the bodies of deceased EVD patients
- Primary EVD infections and secondary infections both pose a very high risk
- With the progression of the epidemic, the use of chlorine has shifted from liquid chlorine to soluble chlorine disinfectants
- Soluble chlorine disinfectants have a wide array of advantages, including: Ease of portability and storage; considerably lower risk of spillage, harm, and handling during transportation; much longer shelf life; adaptability to numerous environments; reduction of subsequent costs; relatively higher temperature tolerance; availability of different formulations with varying effectiveness against pathogens; and efficiency in the presence of high organic matter and against secondary risk microbes (e.g. TB)

- The goal of the study was to determine whether pulsed xenon ultraviolet (PX-UV) disinfection prior to doffing can reduce the risk of contamination when doffing the PPE
- PX-UV decontamination is done while PPE is still worn, in order to reduce the pathogen load prior to doffing
- Exposure to PX-UV significantly decreased the viral load
- PX-UV decontamination decreases the risk of contamination due to human error
- PX-UV should be used as a supplementary precaution, but should not be considered sterilization (all PPE are still to be treated as contaminated)
5. Ensuring PPE Compliance


- One of the best ways to illustrate the importance of PPE is through the use of visual examples, e.g. have trainees put shaving cream on a glove and ask to take it off without splashing any on their hands
  - alternatively done with a lotion that shows up under blacklight, to show how easy it is to contaminate oneself, and why proper hygiene (i.e. handwashing) must also be practised in conjunction
- Have workers soak different types of gloves in different chemicals, then leave overnight and observe which have been eaten through – this shows why selecting the right type of glove is important
- Surveillance program in place to ensure workers are wearing PPE or that is not defective


- Workers should know that PPE needs to be worn even if danger is not obvious/imminent
- Workers should demonstrate an understanding of the training specified before being allowed to work
- Workers should know that gloves have half-lives, and that they should be disposed of as soon as they have chemical contact
- Workers should be made aware of decontamination practices, e.g. wearing respirator strap outside of coverall is more comfortable, but decontamination of the straps is near impossible
- Workers should know what to do in case of PPE failure; such knowledge has been shown to decrease accidents and increase productivity
- Workers are more likely to wear PPE if components are connected, e.g. ear plugs connected to safety glasses via lanyard
- Workers more likely to wear PPE if it allows expression of individuality

McPherson, D. 2008. PPE compliance. ISHN 42(2): 60

- According to a survey, main reason for noncompliance is discomfort, followed by: PPE not being deemed necessary for the task, being too hot, of poor fit, unattractive, and not easily accessible from work site
- Matela (2006)* suggests providing slightly oversized garments beyond ANSI standards to reduce stress on certain areas (torso, shoulders). Garments should fit both genders, have an elastic waist to improve fit, and stretch panels under arms for better movement
- Majority of safety professionals surveyed said that safety should be practiced 24/7 and not just while on the job, thus keeping safety culture engrained
Huelke, E. 2008. Improve PPE compliance: Follow this model for putting your plan together. ISHN 42(3): 30

- Maintain education and training records for all employees
- Be sure to provide refresher training
- Managers/supervisors should know hazards, appropriate PPE, and enforce PPE usage
- Employees should know how to maintain, clean, and store PPE; change out once it wears out


- Found that online training was effective in improving PPE compliance, mostly in nurses with <1 year experience (Vancouver General Hospital, 30-minute online course as part of 4-day orientation)


- Authors created a study to measure safety climate in a large hospital (for blood borne pathogens, but could also be applicable to other body fluid exposures)
- This new hospital safety climate scale sub-factored into 6 different organizational dimensions:
  1. senior management support for safety programs
  2. absence of workplace barriers to safe work practices
  3. cleanliness and orderliness of the work site
  4. minimal conflict and good communication among staff members
  5. frequent safety-related feedback/training by supervisors
  6. availability of PPE and engineering controls
- Based on a score of “strict compliance” – the employees were to rate their exposure and one exposure would place them in the “exposed” group
- The lowest scores were found for departmental conflict and workplace cleanliness
- The highest scores were given to PPE availability and management support
- Compliance to safety practices was poorest for recapping contaminated needles, wearing face masks, and wearing protective eye shields
- Cleanliness of the worksite, senior management support, and absence of workplace barriers were most strongly correlated with compliance
- Senior management support and frequent safety-related feedback/training were significantly correlated with reduced frequency of exposures
- The authors argue that there will be far-reaching effects of improving administrative support of safety climates including cost-effectiveness and employee satisfaction
- Administrators must be prepared to act on the results of the anonymous survey and devise a risk management system
6. Considerations for Selecting PPE

Centers for Disease Control and Prevention
http://www.cdc.gov/niosh/npptl/topics/protectiveclothing/

Factors to consider when selecting PPE for protection against microorganisms and body fluids:

- Must select PPE based on their barrier properties
- EVD patients can release up to 8L/day of body fluids
  - Risk assessment of exposure to contaminated fluids is required in selecting appropriate PPE
- Gowns vs coveralls?
  - the material and seam barrier properties are essential for defining protection
  - the coverage provided by the material used in the garment design, as well as certain features including closures, will greatly affect protection
  - coveralls give 360 coverage
  - gowns are easier to put on and healthcare workers are more familiar with them (more likely to be used correctly)
- Fabric and clothing properties of impermeable/fluid resistant garments
  - must consider factors such as strength of fabric; seams/closures; ability to withstand stress applied during wear/use (actions such as kneeling, leaning on a chair/table)
  - appropriate size: according to ANSI 101-2014 (too large a garment can catch objects)
- Discusses different methods to test garments


- Reviews the recommendations for surgical masks for use as respiratory protection for healthcare workers against EVD contamination
- The use of a facemask or a respirator depends primarily on the way the virus is transmitted, which has previously been debated. Currently, guidelines are based on the idea that EVD transmission does not involve aerosol transmission
- The presumed mode of transmission is not the sole factor to take into account when editing guidelines for healthcare workers. Considerations should be made for the severity of the outcome, the uncertainty around modes of transmission, the availability of pre- and post-exposure prophylaxis or treatment, immune status, and comorbidities in healthcare workers
- Recommendations for masks do not apply risk analysis methods appropriately
- Laboratory staff are better protected due to precautionary measures and sterile environments, therefore there is inequity in the guidelines
• Only MSF recommends respirators for their healthcare workers and they have not experienced any cases of EVD within their staff
• Future guidelines should address the best practices within the most ideal setting, followed by contingency methods if this situation is unfeasible


• When treating hospitalized EVD patients, the question of whether to use N95 masks or PAPR is asked
• Glossary:
  • Aerosol-generating procedures (AGP) are procedures that stimulate coughing and promote the generation of aerosols. Additional infection prevention and control precautions are required for some AGP where an increased risk of infection has been identified
  • N95 Masks filter at least 95% of particles < 5μm in diameter and are not resistant to oil. They block aerosol (<5 μm) and droplet-size (5μm- 50 μm) particles
  • Powered Air-Purifying Respirators (PAPR) are battery- powered blowers that provide positive airflow through a filter, cartridge, or canister to a hood or face piece
  • High-efficiency particulate air filters (HEPA) can be used in PAPRs. They filter at least 99.97% of particles 0.3 μm in diameter and are oil proof

### Characteristics of N95 and PAPR

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<thead>
<tr>
<th></th>
<th>N95</th>
<th>PAPR</th>
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<tbody>
<tr>
<td><strong>Filter</strong></td>
<td>Less powerful; Filters at least 95% of particles &lt; 5μm in diameter but is not resistant to oil</td>
<td>More powerful; When using HEPA, they filter at least 99.97% of particles 0.3 μm in diameter and are oil proof</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>Not required</td>
<td>Uses batteries. The rechargeable battery must be tested routinely by a designated individual</td>
</tr>
<tr>
<td><strong>Disposable</strong></td>
<td>Completely disposable</td>
<td>Reusable</td>
</tr>
<tr>
<td><strong>Wearing procedure/Before use</strong></td>
<td>Relatively simple</td>
<td>One must ensure that the HEPA filter and gasket are in place. The black tube connects to the PAPR and the blower is tested by placing a nipple in the tube and ensuring that it rises according to manufacturer’s specification</td>
</tr>
<tr>
<td><strong>Communication problems</strong></td>
<td>Better in comparison to PAPR</td>
<td>Sound isolation and machine noises</td>
</tr>
<tr>
<td><strong>After wearing</strong></td>
<td>Discard in a biohazard bag</td>
<td>Filter placed in a biohazard bag. Machine needs to be cleaned, which places additional personnel at risk</td>
</tr>
</tbody>
</table>
• Conclusion:

  • The use of PAPRs, although effective in the PPE armamentarium (similar to the other respirators) has its advantages and disadvantages. Its use has not yet found a specific niche, EVD being no exception

  • More specific policies on the use of this equipment need to be developed


  • The study targets agricultural workers but the findings can be applied to healthcare workers with direct patient contact

  • The sample size is rather small, with researchers utilizing questionnaires, observations, measurements of heart rate, and body temperature as indicators of individual thermal comfort of study subjects with the PPE gear and without the PPE gear

  • PPE is effective, but there is only a small time window before the worker begins experiencing thermal discomfort and impeded thermoregulation

  • The material components of the PPE equipment render it impermeable and therefore protect the health care worker. However, for long periods of time, i.e. longer than 20 minutes, PPE can become uncomfortable and thus lower proper adherence to PPE while donning

  • The authors found that subjects would only need about 15 minutes to raise their body temperature by 1 degree Celsius in comparison to 40 minutes without any PPE gear. These results are particularly worrisome as the temperatures in West Africa are relatively hot during six months or more of the year

  • This raises concerns of proper gowning and consistent adherence to PPE by health care workers, which can experience adverse health effects by keeping the gear on for more than approximately 20 minutes depending on the body and surrounding climate
TRANSPORTATION OF PATIENTS


This article discusses the effectiveness of the Grady EMS Biosafety Transport Program at Emory University Hospital Serious Communicable Disease Unit; established more than a decade ago to support the CDC.

- A team of professionals specially trained on “serious communicable pathogens, methods of transmission, available vaccines, pre-exposure and post-exposure prophylaxis and treatment for specific infections, and importance of strict adherence to standard and transmission-based infection control practices”
- Discusses the ambulatory protocols for infectious diseases
  - Ambulance driver isolated in separate compartment and patients’ compartment lined with water-impermeable barriers that prevent contamination of surfaces
  - Working with EVD health care workers who wore Tyvek suit (DuPont); gloves; and a hooded, powered, air-purifying respirator
- Recommendations:
  - “A dedicated team is best suited for transport of patients with confirmed serious communicable illness”
  - “EMS agencies and hospitals would be prudent to implement measures to identify patients with communicable illness and ensure that their personnel can confidently and safely provide care anywhere and for all pathogens”

ENVIRONMENTAL INFECTION CONTROL


- The role of the environment in transmission has not been established. Limited laboratory studies under favorable conditions indicate that Ebola virus can remain viable on solid surfaces. Virus was detected on a blood-stained glove and bloody intravenous insertion site
- Recommendations:
  - Be sure environmental services staff wear recommended PPE
  - Use a U.S. Environmental Protection Agency (EPA)-registered hospital disinfectant with a label claim for a non-enveloped virus (norovirus, rotavirus, adenovirus, poliovirus) to disinfect environmental surfaces in rooms of patients under investigation or patients with confirmed EVD
  - Avoid contamination of reusable porous surfaces that cannot be made single-use
  - Practice routine cleaning and disinfection of the PPE doffing area
• To reduce exposure among staff, discard all linens, non fluid-impermeable pillows or mattresses, and textiles appropriately
• Ebola virus is a classified as a Category A infectious substance regulated by the U.S. Department of Transportation’s (DOT) Hazardous Materials Regulations (HMR, 49 C.F.R., Parts 171-180)
  – Any item transported offsite for disposal that is contaminated or suspected of being contaminated with a Category A infectious substance must be packaged and transported in accordance with the HMR

STETHOSCOPE USAGE CONSIDERATIONS

• The safe use of a traditional stethoscope without compromising the PPE shield necessary for treating EVD patients has not been adequately addressed by CDC protocols or other protocols
• PPE is compromised by the traditional stethoscope when a physician must remove the earpiece, or re-put the earpiece back into his or her ears
• The author recommends a digital stethoscope which transmits the sounds to bone conduction headphones, thus it does not block the ear canal, allowing for the doctor to listen to the patient without having to take the stethoscope earpiece in and out of his or her ear
• A patient could also be taught to appropriately apply the digital stethoscope and the doctor can listen remotely without having to don PPE to enter the patient’s area
• Cost for the system is 650 USD

ADDRESSING OCCUPATIONAL PSYCHOSOCIAL STRESS

• Psychological First Aid (PFA) describes a humane, supportive response to someone who is suffering and may need support
• PFA involves:
  • Providing non-intrusive, practical care and support
  • Assessing needs and concerns, including basic needs (food and water)
  • Listening, comforting people and making them feel calm
  • Helping people connect to information, services and social supports
    – In the case of EVD, information is vital: those providing PFA can help to dispel myths, share clear messages about healthy behaviour and improve people’s understanding of the disease
  • Protecting people from further harm
Overall motive of PFA involves helping people to:
- Feel safe, feel connected to others, remain calm and hopeful, receive access to social, physical and emotional support, and feel able to help themselves as individuals and communities
- This may also include people who have lost multiple family members and loved ones to EVD, particularly orphans
- PFA may also be useful for people who may be stigmatized by their communities, such as:
  - People who have recovered from EVD, health care providers, and frontline workers of Ebola operations (e.g., people involved in the management of deceased EVD patients)
- During the EVD outbreak, PFA can be offered:
  - during contact tracing
  - when delivering survival and hygiene kits
  - when supporting a health care provider experiencing distress
  - when supporting a family or community that has lost someone to EVD
  - when supporting a child whose parents are in hospital, who may be feeling confused and sad
  - when helping members of the community share their frustrations about travel restrictions
- The document gives reasons to use PFA during EVD outbreaks in “Why PFA?”
- Includes principles of respecting safety, dignity and rights
- Includes visual “Do's and Don'ts” and other posters
- It is important to know and share information about who is responsible for different parts of response action