

Supplementary Materials for

A Bacteriophage-based Validation of a Personal Protective Equipment Doffing Procedure to be Used with High Consequence Pathogens

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2 Supplementary Table 1: Analysis of Movie – Adherence to Doffing Protocol

HCP	Deviations
HCP 1	Did not take off outer gloves before undoing PAPR ties
HCP 2	Poor hand sanitization (duration)
HCP 3	Poor hand sanitization (duration and technique)
	Excessive contact with PAPR hood at most steps
	Skipped hand sanitization at multiple steps
HCP 4	None
HCP 5	Poor hand sanitization (duration)
	Poor gown rolling
	Excessive contact with PAPR hood
HCP 6	None
HCP 7	Folding gown near body
	Unzipping coverall while touching PAPR
HCP 8	None
HCP 9	Gown touched PAPR

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4 **Supplementary Table 2. Critical densities for pathogens of concern**

Pathogen	High Limit of Pathogen Density Commonly Found in Patient Samples	Reported Minimum Infective Dose
<i>Ebolavirus spp.</i> [8, 9]	1x10 ⁷ PFU/mL	1 to 10 Virions
<i>Alphainfluenzavirus sp.</i> [10, 11]	5x10 ⁵ PFU/mL	4 Virions
<i>Mycobacterium tuberculosis</i> [12, 13]	5x10 ⁵ CFU/mL	1 to 200 Bacteria
<i>Betacoronavirus MERS-CoV</i> [14, 15]	1x10 ⁷ PFU/mL	200 to 1000 Virions
<i>Orthopoxvirus Variola virus</i> [8, 16]	5x10 ⁵ CFU/mL	10 to 100 Virions
<i>Yersinia pestis</i> [17, 18]	1x10 ⁹ CFU/mL	1 to 10 Bacteria

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6 **Supplementary Table 3. Donning Stepwise Procedure**

7 Steps written in bold font indicate updated steps in the new donning procedure.

Step Number	Original Donning Procedure	Updating Donning Procedure
1	Qualified monitor is present.	Qualified monitor is present.
2	Set up cart for donning and doffing.	Set up cart for donning and doffing.
3	Remove personal effects (phone, keys, badges, pens, etc.).	Remove personal effects (phone, keys, badges, pens, etc.).
4	Put on inner gloves.	Put on inner gloves.
5	Secure belt snug around waist with clip facing up. Place excess belt into clip and loop.	Don clear inner boot liners over shoes and pants.
6	Secure the battery on the left side of the belt.	Secure belt snug around waist with clip facing up. Place excess belt into clip and loop.
7	Connect helmet to battery.	Secure the battery on the left side of the belt.

8	Check that 3 LED lights are green to ensure battery is fully charged.	Connect helmet to battery.
9	Adjust temple holder (top hole for larger head, 2nd hole works for most though).	Check that 3 LED lights are green to ensure battery is fully charged.
10	Put helmet on head and size to fit by turning ratchet knob to adjust the headband.	Adjust temple holder (top hole for larger head, 2nd hole works for most though).
11	Bend over to ensure helmet is tight enough to stay on without slipping.	Put helmet on head and size to fit by turning ratchet knob to adjust the headband.
12	Ensure long hair is in a low bun or ponytail is above shoulders.	Bend over to ensure helmet is tight enough to stay on without slipping.
13	Adjust fan speed to comfort.	Ensure long hair is in a low bun or ponytail is above shoulders.
14	Disconnect the battery.	Adjust fan speed to comfort.
15	Open the hood bag.	Disconnect the battery.
16	Set aside outer heavy loading filter.	Open the hood bag.

17	Orient the hood so markings face you and are in upward direction and flat edge is at top.	Set aside outer heavy loading filter.
18	Hold the upper corners and shake the hood until it fully unfolds.	Orient the hood so markings face you and are in upward direction and flat edge is at top.
19	Connect the center hole of the hood to the center hook on the front of the helmet. Once you are hooked, keep pushing until you hear a snap.	Hold the upper corners and shake the hood until it fully unfolds.
20	Connect the right and left sides of the hood to the helmet in the same way until you hear a snap.	Connect the center hole of the hood to the center hook on the front of the helmet. Once you are hooked, keep pushing until you hear a snap.
21	Grab the bottom of the hood and pull it back and over the helmet until it fits.	Connect the right and left sides of the hood to the helmet in the same way until you hear a snap.
22	Take the heavy loading filter and fit it fully over the top of the hood.	Grab the bottom of the hood and pull it back and over the helmet until it fits.

23	Set assembled PAPR hood aside.	Take the heavy loading filter and fit it fully over the top of the hood.
24	Put on coveralls outside room. Feet in first. Open-end faces your front. Do not zip up yet.	Set assembled PAPR hood aside.
25	Ensure proper mobility of arms and legs within coveralls.	Put on coveralls outside room. Feet in first. Open-end faces your front. Do not zip up yet.
26	Tape coverall and wrist of the gloves, forming a release tab at end of the loop.	Ensure proper mobility of arms and legs within coveralls.
27	Put on pair of extended cuff outer gloves.	Tape coverall and wrist of the gloves, forming a release tab at end of the loop.
28	Don booties.	Don booties.
29	Sanitize gloves and touched dispenser.	Sanitize gloves and touched dispenser.
30	Insert PAPR power cord connector into the battery.	Insert PAPR power cord connector into the battery.
31	Put the helmet on, letting the hood drape around your	Put the helmet on, letting the hood drape around your

	shoulders over the coveralls. Last chance to adjust the helmet.	shoulders over the coveralls. Last chance to adjust the helmet.
32	Tuck the cord into your coverall.	Tuck the cord into your coverall.
33	Zip up the front of the coveralls.	Zip up the front of the coveralls.
34	Insert fingers into facial liner and tug it around your face until it tucks under your chin.	Insert fingers into facial liner and tug it around your face until it tucks under your chin.
35	Find both neck ties and bring them to the front and tie a shoelace knot close to neck.	Find both neck ties and bring them to the front and tie a shoelace knot close to neck.
36	Grab both torso ties off of back, bring them around and insert them through the front of the hood insertion holes, then tie into shoelace knot.	Grab both torso ties off of back, bring them around and insert them through the front of the hood insertion holes, then tie into shoelace knot.
37	Tear neck loop of apron.	Don gown.
38	Tie apron on around neck. Hood should be underneath apron.	Secure neck of gown, making sure neck tie of hood is covered.
39	Tie apron around waist.	Tie gown at waist in back.
40	Monitor completes 360° check of PP.	Put on pair of extended cuff outer gloves, securing gown

		sleeve inside of the extended cuff glove.
41	Sanitize gloves and touched dispenser.	Monitor completes 360° check of PP
42	Enter room. Do not enter room without proper fit of the PAPR system.	Sanitize gloves and touched dispenser.
43	Do not touch or re-adjust PAPR system inside the room.	Enter room. Do not enter room without proper fit of the PAPR system.
44		Do not touch or re-adjust PAPR system inside the room.

9 **Supplementary Table 4. Doffing Stepwise Procedure**

10 Steps written in bold font indicate updated steps in the new donning procedure.

Step Number	Original Doffing Procedure	Updating Doffing Procedure
1	Check that your partner outside of the room is aware you are preparing to doff.	Check that your partner outside of the room is aware you are preparing to doff.
2	Inspect PPE for obvious soiling or contamination. Have your partner inspect your back through the window on the door.	Inspect PPE for obvious soiling or contamination. Have your partner inspect your back through the window on the door.
3	Wipe away contamination with EPA-approved disinfectant wipes.	Wipe away contamination with EPA-approved disinfectant wipes.
4	Place a non-slip chuck pad in front of the door.	Place a non-slip chuck pad in front of the door.
5	Ensure that you have sanitizer and trash can within reach of pad.	Ensure that you have sanitizer and trash can within reach of pad.
6	Sanitize gloves and touch dispenser.	Sanitize gloves and touch dispenser.

7	Grab the apron under the arms at the base of each tie.	With one hand, reach up to back of helmet and remove heavy loading filter from top of PAPR hood, throw into trash.
8	Pull forward until back ties break.	Sanitize gloves and touched dispenser.
9	Pull apron down until neck ties break.	Gently pull the sleeves of the gown free from each outer glove cuff.
10	Bring your hands together until the apron folds vertically.	Sanitize gloves and touched dispenser.
11	Roll up while keeping arms extended.	Grasp gown at sides over waist tie, pull forward to break tie.
12	Discard apron into trash.	Cross your arms to grasp gown at upper arm/ shoulder, avoid touching PAPR hood.
13	Sanitize gloves and touched dispenser.	Uncross your arms slowly, inverting the gown and extending your arms outward until they are outstretched. Keeping arms extended away

		from your body, bundle the gown and discard.
14	Choose one hand to remove one bootie. As you remove it, step with that foot onto pad. Throw bootie away.	Sanitize gloves and touched dispenser.
15	Use same hand to remove other bootie, if you can balance properly. Use CPR stand or tall trash can to aid in balance and step onto pad. Throw bootie away.	Choose one hand to remove one bootie. As you remove it, step with that foot onto pad. Throw bootie away.
16	Sanitize gloves and touched dispenser.	Use same hand to remove other bootie, if you can balance properly. Use CPR stand or tall trash can to aid in balance and step onto pad. Throw bootie away.
17	Remove outer gloves using beaking technique and throw away.	Sanitize gloves and touched dispenser.

18	Sanitize gloves and touched dispenser.	Remove outer gloves using beaking technique and throw away.
19	Remove the heavy loading filter into the trash can.	Sanitize gloves and touched dispenser.
20	Sanitize gloves and touched dispenser.	Untie the necktie of the PAPR hood, gathering it together, and discard.
21	Undo or break just the neck ties and throw into trash.	Sanitize gloves and touched dispenser.
22	Sanitize gloves and touched dispenser.	Grab torso ties of hood and undo or break those ties and throw into trash.
23	Grab torso ties of hood and undo or break those ties and throw into trash.	Sanitize gloves and touched dispenser.
24	Sanitize gloves and touched dispenser.	Remove tape from both wrists using tabs and throw into trash.
25	Remove tape from both wrists using tabs and throw into trash.	Sanitize gloves and touched dispenser.
26	Sanitize gloves and touched dispenser.	Zip down coveralls.

27	Zip down coveralls.	Grasp coveralls around lower back area and pull down.
28	Grasp coveralls around lower back area and pull down.	Remove coveralls from shoulders and pull down below knees, touching only inside to inside.
29	Remove coveralls from shoulders and pull down below knees, touching only inside to inside.	March and stomp out of the coveralls. Do not use your hands to remove.
30	March and stomp out of the coveralls. Do not use your hands to remove.	Step off and leave coverall for next person to pick up.
31	Step onto leg of coverall and slowly kick backwards to get each foot out.	Sanitize gloves and touched dispenser.
32	Step off and leave coverall for next person to pick up.	Observer opens door.
33	Sanitize gloves and touched dispenser.	Exit patient room.
34	Observer opens door.	Sanitize gloves and touched dispenser.

35	Exit patient room.	Place both hands under the PAPR hood at the shoulders. Grasp the back portion of the PAPR hood and gather the material by rolling it together, touching the inside only.
36	Sanitize gloves and touched dispenser.	Continue to roll the hood material up across the back and top of the helmet until you reach the top of the head, in line with the ears.
37	Grab shoulders of the hood, pull back, and lift over head.	Move fingers to the edge of the face shield and unsnap the hood and shield from the PAPR visor, folding the shield away from the PAPR.
38	Find edges of the visor and pop out the sides.	Do not touch your face.
39	Tilt head down and pull visor up and away from you and throw it away.	Sanitize gloves and touched dispenser.

40	Do not touch your face.	Remove inner gloves (beak method).
41	Sanitize gloves and touched dispenser.	Sanitize hands and touched dispenser.
42	Remove inner gloves (beak method).	Observer holds battery.
43	Sanitize hands and touched dispenser.	Observer unbuckles belt.
44	Observer holds battery.	Observer removes helmet motor from behind, avoiding the face.
45	Observer unbuckles belt.	Wash hands and arms thoroughly with soap and water.
46	Observer removes helmet motor from behind, avoiding the face.	Talk with your infection prevention team about showering protocols.
47	Wash hands and arms thoroughly with soap and water.	
48	Talk with your infection prevention team about showering protocols.	

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14 **Supplementary Table 5. PPE Ensemble and Purpose**

Item	Ref Number	First/ Second/ Both Protocols	Purpose
Disposable Scrubs	Halyard, USA, Pants: 47790, 47791, 47792, 47793; Tops: 47786, 47787, 47788, 47789	Both	Disposal of potentially hazardous outer garments
Shoe Covers	MedLine, USA, #NON31859	Both	Prevent bodily fluids from contaminating shoes of HCP
Shoe Liners	Uline, USA, S- 19250	Second	Facilitate easier removal of coveralls from shoes
Inner Gloves	Halyard, USA, GLV2304	First	Exam gloves, prevent contamination from spreading to hands of HCP

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	Halyard, USA, #55095	Second	Long cuff gloves, provide additional protection to forearms of HCP
Outer Gloves	Halyard, USA #53141,	Second	Long cuff gloves, prevent contaminants from reaching inner cuff of coveralls
	Halyard, USA, 50602	First	Long cuff gloves, prevent contaminants from reaching inner cuff of coveralls
Tape	Grainger, USA #H6195	Both	Seal outer gloves to coveralls
Gown	Life Science Products, USA, #GO-633VPE,	Second	Provide complete coverage to outer layer of protection to patient- facing surfaces
Apron	Halyard, USA, #A7779	First	Provide a front outer layer of protection to patient-facing surfaces

Coveralls	International EnviroGuard, USA, W2501	Both	Complete body covering
PAPR Belt Pack	MaxAir, USA, Belt: 2000-76; Battery: 2500- 36TSC Li-Ion Battery	Both	Hold PAPR battery to supply power to respirator
PAPR Helmet	MaxAir, USA, 2084- 03 Helmet - Helmet, Liner, Power Cord	Both	Provide shape and mount for PAPR hood
PAPR Hood	MaxAir, USA, 2281PR-100	Both	Prevent contamination to head and mucosal membranes of HCP
PAPR Heavy Loading Filter	MaxAir, USA, 2172-97	Both	Provide an additional filtration to PAPR