

**Infection prevention and control measures for Ebola and Marburg Virus disease: A series of rapid reviews**

**KQ5 Head/Neck Covers- Initial Summary**

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### **Key Question**

KQ5: Should Health workers in direct contact and/or indirect contact to patients with Ebola Virus Disease (EVD) or Marburg virus disease cover head and neck skin and mucous membranes or just cover mucous membranes?

### **Methods Summary**

This is one of a series of rapid reviews answering 12 key questions related to three themes on infection prevention and control measures for filoviruses: (i) transmission/exposure (n=3 questions), (ii) personal protective equipment (PPE) (n=5), and (iii) decontamination and disinfection (n=4). Data sources include Medline, Embase, bio/medRxiv pre-print servers, Global Medicus Index, Epistemonikos, China National Knowledge Infrastructure (CNKI) and Wangfang database. We used an automation tool (CAL® tool) for titles/abstracts screening for relevant systematic reviews and primary comparative studies. Full-text screening, data extraction, risk of bias assessment, and GRADE (Grading of Recommendations Assessment, Development and Evaluation) for the certainty of evidence were completed independently by two reviewers with any disagreements resolved by consensus, with arbitration by a third reviewer, when needed.

### **Initial findings**

We present study characteristics in Table 1 and a summary of findings in Tables 2-4.

Initially, 137 studies were screened in the CAL tool software and 42 studies were included for full-text screening. Four studies met the eligibility criteria and were included (Appendix 2). A list of excluded studies with reasons for exclusion can be found in Appendix 1.

No studies provided direct information on the transmission or incidence of EVD or Marburg virus disease related to the use of personal protective equipment (PPE) for head and neck skin protection. We included two simulation studies that addressed outcomes related to heat stress for health care workers (HCW) donning extra head/neck covering PPE (hoods). Additionally, we included two crossover randomized controlled trials that simulated contamination events for HCWs while doffing PPE ensembles with and without neck covering.

Overall, for heat tolerance outcomes, we found very low certainty evidence that PPE ensembles with additional head/neck covering increased both physiological and subjective measures of heat exhaustion, compared to PPE with no cover of the head and neck. We found low to very low certainty of evidence that PPE ensembles with head/neck covering resulted in less contamination than PPE with no cover for the head and neck. We found low to very low certainty evidence that PPE ensembles that covered the head/neck resulted in more human errors during donning/doffing of equipment, compared to ensembles without head/neck cover.

**Table 1. Characteristics of Included Studies**

Citation [Author, Year]	Study Design	Funding Source	Virus Species	Setting	# Total Health Workers	# Health Care Facilities	Description of Health Worker Care/contact with patients	Study Objectives [as reported by study authors]
Coca, 2017 <sup>1</sup>	Non-randomized simulation study	Not reported	N/A	Simulated ambient conditions for West African countries <sup>a</sup>	6 healthy individuals to simulate HCWs	N/A; one environmental chamber	Exercise intensity was set to the average for nursing care <sup>b</sup>	Evaluate the human physiological and subjective responses to continuous light exercise within environmental conditions similar to those in West Africa while wearing 3 different, commonly used PPE ensembles.
Coca, 2015 <sup>2</sup>	Non-randomized simulation study	Not reported	N/A	Simulated ambient conditions for warmest months in West African countries <sup>c</sup>	N/A; sweating thermal manikins	N/A; one environmental chamber	Metabolic work rate (work intensity) was set to the average for nursing care <sup>d</sup>	The focus of the present study was to provide a baseline heat stress analysis of some of the PPE

								ensemble options used in West Africa in the fight against the spread of Ebola.
Suen, 2018 <sup>3</sup>	Crossover randomized controlled trial	Public university funded	Fluorescent solution <sup>e</sup> on the PPE surface to simulate Ebola virus	Air-conditioned room with an average temperature of 23 °C ± 2 °C and a relative humidity of 60% ± 3%	59 HCWs (all evaluated in each of PPE ensembles)	N/A; one air-conditioned room	Fluorescent solution sprayed on PPE at the length of a stethoscope to simulate usual working distance between a patient and an HCW <sup>f</sup> ; contamination events monitored during doffing	Compare the efficacy of three PPE ensembles for routine patient care and performing aerosol-generating procedures to prevent EVD transmission by measuring the degree of contamination of HCWs and the environment.
Zamora, 2006 <sup>4</sup>	Crossover randomized controlled trial	Physicians' Services Incorporated Foundation and the Clinical Teachers' Association	Fluorescent solution <sup>g</sup> on the PPE surface to simulate HID	Not reported	50 HCWs	N/A	Participants' front face shield, torso, hands, forearms and elbows were contaminated with	Examine the difference in self-contamination rates and the level of contact and droplet

		of Queen's University					fluorescent solution/ paste	protection-associated with E-RCP and the PAPR system.
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Abbreviations: HCW, health care workers, HID, highly infectious diseases, NR, not reported, PPE, personal protective equipment

- a. For each testing protocol, three periods with different conditions were simulated: 15-minute pre-exercise stabilization period (22°C, 50% relative humidity) and a 60-minute exercise period (32°C, 92% relative humidity), followed by a 30-minute recovery period in ambient conditions (22°C, 50% relative humidity).
- b. The exercise protocol consisted of 60 minutes of continuous walking, within an environmental chamber, on a treadmill at an intensity of three METs (2.5 mph, 0% grade). This exercise intensity was chosen to represent the working intensity seen in hospital nurses during patient care, such as walking, standing, and carrying light objects.
- c. Two conditions were simulated. Condition A consisted of 32°C, 92% relative humidity, Condition B consisted of 26°C, 80% relative humidity
- d. Average work intensity for nursing corresponded to patient care that includes standing and walking slowly [2.5 mph] and carrying light objects [ $<11.3$  kg] of 3 METs (metabolic equivalent, or the measure of the intensity of aerobic exercise) over 80 min of continuous activity
- e. UV GERM Hygiene Spray, Glow Tec Ltd., London, England
- f. Three strokes of fluorescent solution were sprayed onto the face shield, two upper limb/ gloves and anterior surfaces of the gown at a distance of 60 cm from the participants (total 12 strokes per case). There was an average of 1.99 g fluorescent solution/per stroke.
- g. Fluorescein solution (1 mL of a 25% solution in 100 mL of sterile water). A Devilbiss atomizer (model DV15-RD, Sunrise Medical Products, Carlsbad, Calif.) was used to apply 5 mL of solution to each participant's front face shield and torso. "Invisible" Detection Paste (15 mL; Sirchie, Youngsville, NC) was applied from the forearms to the elbow and to the palmar aspects of participants' hands

**Table 2. Summary of Findings: Heat Tolerance**

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Mean (<math>\pm</math> SD) in intervention group</i>	<i>Mean (<math>\pm</math> SD) in comparator group</i>	<i>Pairwise comparison</i>	<i>Quality Assessment<sup>d</sup></i>	<i>GRADE</i>	<i>Notes</i>
<b>Time (min) to reach critical core temperature of 39°C under condition A<sup>b</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	62 $\pm$ 6 min	78 $\pm$ 7 min	P = 0.04	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	65 $\pm$ 3 min	78 $\pm$ 7 min	P = 0.04			
	E4 <sup>c</sup>	E1 <sup>f</sup>	62 $\pm$ 6 min	+80 min	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	65 $\pm$ 3 min	+80 min	P <0.05			
<b>Body surface skin temperature (°C) time to reach critical core temperature of 39°C under condition A<sup>b</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	38.4 $\pm$ 0.8	37.7 $\pm$ 0.2	NS	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	38.3 $\pm$ 0.2	37.7 $\pm$ 0.2	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	38.4 $\pm$ 0.8	37.3 $\pm$ 0.3	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	38.3 $\pm$ 0.2	37.3 $\pm$ 0.3	P <0.05			
<b>Heat sensation<sup>g</sup> at time to reach critical core temperature of 39°C under condition A<sup>b</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	3.8 $\pm$ 0.1	3.5 $\pm$ 0.2	NS	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	3.7 $\pm$ 0.1	3.5 $\pm$ 0.2	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	3.8 $\pm$ 0.1	3.6 $\pm$ 0.2	NS			
	E3 <sup>e</sup>	E1 <sup>f</sup>	3.7 $\pm$ 0.1	3.6 $\pm$ 0.2	NS			
<b>Discomfort<sup>h</sup> at time to reach critical core temperature of 39°C under condition A<sup>b</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	- 3.4 $\pm$ 0.1	- 3.2 $\pm$ 0.1	NS	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	- 3.4 $\pm$ 0.1	- 3.2 $\pm$ 0.1	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	- 3.4 $\pm$ 0.1	- 3.2 $\pm$ 0.1	NS			
	E3 <sup>e</sup>	E1 <sup>f</sup>	- 3.4 $\pm$ 0.1	- 3.2 $\pm$ 0.1	NS			
<b>Core temperature (°C) after 80 minutes of activity under condition B<sup>i</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	38.9 $\pm$ 0.2	38.33 $\pm$ 0.1	P <0.05	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	38.7 $\pm$ 0.1	38.33 $\pm$ 0.1	P <0.05			
	E4 <sup>c</sup>	E1 <sup>f</sup>	38.9 $\pm$ 0.2	38.05 $\pm$ 0.1	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	38.7 $\pm$ 0.1	38.05 $\pm$ 0.1	P <0.05			
<b>Body surface skin temperature (°C) after 80 minutes of activity under condition B<sup>i</sup></b>								

<i>Study details</i>	<i>Intervention (cover head/neck and mucous membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Mean (<math>\pm</math> SD) in intervention group</i>	<i>Mean (<math>\pm</math> SD) in comparator group</i>	<i>Pairwise comparison</i>	<i>Quality Assessment<sup>f</sup></i>	<i>GRADE</i>	<i>Notes</i>
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	37.6 $\pm$ 0.4	36.4 $\pm$ 0.4	P <0.05	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	36.9 $\pm$ 0.2	36.4 $\pm$ 0.4	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	37.6 $\pm$ 0.4	35.8 $\pm$ 0.6	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	36.9 $\pm$ 0.2	35.8 $\pm$ 0.6	NS			
<b>Heat sensation<sup>g</sup> after 80 minutes of activity under condition B<sup>i</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	3.2 $\pm$ 0.6	2.5 $\pm$ 0.6	NS	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	2.5 $\pm$ 0.4	2.5 $\pm$ 0.6	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	3.2 $\pm$ 0.6	2.4 $\pm$ 0.5	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	2.5 $\pm$ 0.4	2.4 $\pm$ 0.5	NS			
<b>Discomfort<sup>h</sup> after 80 minutes of activity under condition B<sup>i</sup></b>								
Coca, 2015 <sup>2</sup>	E4 <sup>c</sup>	E2 <sup>d</sup>	- 3.2 $\pm$ 0.2	- 2.6 $\pm$ 0.4	P <0.05	Moderate risk of bias	⊕○○○ Very low	None
	E3 <sup>e</sup>	E2 <sup>d</sup>	- 3 $\pm$ 0.2	- 2.6 $\pm$ 0.4	NS			
	E4 <sup>c</sup>	E1 <sup>f</sup>	- 3.2 $\pm$ 0.2	- 2.3 $\pm$ 0.3	P <0.05			
	E3 <sup>e</sup>	E1 <sup>f</sup>	- 3 $\pm$ 0.2	- 2.3 $\pm$ 0.3	NS			
<b>Core Temperature (°C) at end of exercise</b>								
Coca, 2017 <sup>1</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	38.91 $\pm$ 0.29	38.18 $\pm$ 0.46	P <0.05	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	38.78 $\pm$ 0.36	38.18 $\pm$ 0.46	P <0.05			
<b>Skin Temperature (°C) at end of exercise</b>								
Coca, 2017 <sup>1</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	37.94 $\pm$ 0.15	36.12 $\pm$ 0.65	NS	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	37.21 $\pm$ 0.21	36.12 $\pm$ 0.65	NS			
<b>Heart Rate (beats per minute) at end of exercise</b>								
Coca, 2017 <sup>1</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	163 $\pm$ 17.52	135.57 $\pm$ 15.05	P <0.05	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	156 $\pm$ 16.71	135.57 $\pm$ 15.05	P <0.05			
<b>Average sweat weight loss (kg) per hour</b>								
Coca, 2017 <sup>1</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	1.48 $\pm$ 0.47 kg	0.94 $\pm$ 0.40 kg	P = 0.000	High risk of bias	⊕○○○	None



<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Mean (<math>\pm</math> SD) in intervention group</i>	<i>Mean (<math>\pm</math> SD) in comparator group</i>	<i>Pairwise comparison</i>	<i>Quality Assessment<sup>f</sup></i>	<i>GRADE</i>	<i>Notes</i>
	E2 <sup>l</sup>	E1 <sup>k</sup>	1.26 $\pm$ 0.53 kg	0.94 $\pm$ 0.40 kg	P = 0.032		Very low	
<b>Heat Sensation<sup>g</sup> at end of exercise</b>								
Coca, 2017 <sup>l</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	3.86 $\pm$ 0.38	3.29 $\pm$ 0.49	P <0.05	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	3.86 $\pm$ 0.38	3.29 $\pm$ 0.49	P <0.05			
<b>Thermal Comfort<sup>m</sup> at end of exercise</b>								
Coca, 2017 <sup>l</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	2.71 $\pm$ 2.56	2.71 $\pm$ 0.76	NS	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	3.57 $\pm$ 0.79	2.71 $\pm$ 0.76	P <0.05			
<b>Rated perceived exertion<sup>n</sup> at end of exercise</b>								
Coca, 2017 <sup>l</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	15.29 $\pm$ 2.50	11.86 $\pm$ 2.12	P <0.05	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	14.43 $\pm$ 3.10	11.86 $\pm$ 2.12	P <0.05			
<b>Breathing comfort<sup>o</sup> at end of exercise</b>								
Coca, 2017 <sup>l</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	5.14 $\pm$ 0.69	3.57 $\pm$ 1.27	P <0.05	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	5.29 $\pm$ 1.11	3.57 $\pm$ 1.27	P <0.05			
<b>Wetness<sup>p</sup> at end of exercise</b>								
Coca, 2017 <sup>l</sup>	E3 <sup>j</sup>	E1 <sup>k</sup>	2.86 $\pm$ 0.38	2.86 $\pm$ 0.38	NS	High risk of bias	⊕○○○ Very low	None
	E2 <sup>l</sup>	E1 <sup>k</sup>	2.86 $\pm$ 0.38	2.86 $\pm$ 0.38	NS			

Abbreviations: NS, non-significant (P>0.05); SD, standard deviation

- Quality assessment of studies was completed using the ROBINS-I scale for observational/non-randomized studies. For the mannequin simulation study (Coca et al. 2015), quality assessment was performed under assumption that mannequin could be treated as a volunteer and humanized.
- Condition A consisted of 32°C, 92% relative humidity
- Ensemble 4 (E4): medical scrubs, socks, and rubber boots, impermeable coverall, Tyvek hood with an integrated splash-resistant surgical mask; rubber surgical apron, splash-resistant goggles, surgical nitrile inner gloves, heavy-duty nitrile outer gloves, N95 mask, a fluid-resistant surgical cap. The Tyvek hood provided the head and neck cover.
- Ensemble 2 (E2): medical scrubs, socks, rubber boots with a mid-calf-length, disposable, fluid-resistant surgical gown, a polyethylene surgical apron, a face shield, disposable nitrile examination inner gloves, N95 mask, a fluid-resistant surgical cap. The cap provided some head covering, but the majority of head and neck skin remained exposed.

- e. Ensemble 3 (E3): medical scrubs, socks, rubber boots with a Tyvek coverall, Tyvek hood with an integrated splash-resistant surgical mask; a rubber surgical apron, splash-resistant goggles, surgical nitrile inner gloves; heavy-duty nitrile outer gloves, a duckbill N95 filtering face piece respirator, and a fluid-resistant surgical cap. The Tyvek hood provided the head and neck cover.
- f. Ensemble 1 (E1): medical scrubs, socks, rubber boots with a mid-calf-length, disposable, fluid-resistant surgical gown, a fluid-resistant 3-ply surgical mask, a disposable polyester lens face shield, disposable nitrile examination gloves. Head and neck skin was exposed.
- g. Heat sensation (rated from -4 [very cold] to 4 [very hot])
- h. Thermal comfort rated from -4 [very uncomfortable] to 4 [very comfortable])
- i. Condition B consisted of 26°C, 80% relative humidity
- j. Ensemble 3 (E3): medical scrubs, socks and rubber boots, Tychem QC highly impermeable coverall (DuPont), Médecins Sans Frontières (MSF) custom-made Tyvek (DuPont) hood with integrated splash-resistant surgical mask, rubber surgical apron, splash-resistant goggles, surgical nitrile inner gloves, heavy-duty nitrile outer gloves, duckbill N95 filtering face piece respirator and fluid-resistant surgical cap
- k. Ensemble 2 (E2): medical scrubs, socks and rubber boots, Microgard coverall, Tyvek hood with integrated splash-resistant surgical mask, rubber surgical apron, splash-resistant goggles, surgical nitrile inner gloves, heavy-duty nitrile outer gloves, duckbill N95 filtering face piece respirator, fluid-resistant surgical cap
- l. Ensemble 1 (E1): medical scrubs; socks and rubber boots; a midcalf-length disposable, fluid-resistant surgical gown, Performance Surgical Gown 7696C; polyethylene surgical apron, face shield, disposable nitrile examination inner gloves, duckbill N95 surgical filtering face piece respirator, and fluid-resistant surgical cap
- m. Subjective thermal comfort was measured on a scale of 1 to 4 (where 1 = not uncomfortable and 4 = very uncomfortable)
- n. Rate of perceived exertion was measured by using the OMNI 6-20 exertional scale
- o. Breathing comfort was measured by using a scale of 1 to 7 (where 1 = no discomfort and 7 = intolerable discomfort)
- p. Subjective wetness was measured by using a scale of 1 to 5 (where 1 = dry and 5 = soaked)

**Table 3. Summary of Findings: Contamination during doffing of PPE**

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Statistical test</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
<b><i>Overall contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	5.00	7.00	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = 0.05	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	7.00	7.00		Low risk of bias	⊕⊕○○ Low	None
<b><i>Hair and head contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	1.00	2.50	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = 0.68	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	2.00	2.50		Low risk of bias	⊕⊕○○ Low	None
<b><i>Neck (anterior) contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient	2.50	11.00	ANOVA: PPE1 vs. PPE2 vs.	Low risk of bias	⊕⊕○○ Low	None

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Statistical test</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
		care and performing AGPs			PPE3 : p-value = 0.095			
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	5.00	11.00		Low risk of bias	⊕⊕○○ Low	None
<b><i>Neck (posterior) contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	2.00	18.50	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = 0.824	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	1.00	18.50		Low risk of bias	⊕⊕○○ Low	None
<b><i>Overall contamination during doffing of PPE: Extra large sized contaminated patches (≥ 5cm<sup>2</sup>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	39.00	47.00	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = < 0.001*	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	43.00	47.00		Low risk of bias	⊕⊕○○ Low	None

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Statistical test</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
<b><i>Hair and head contamination during doffing of PPE: Extra large sized contaminated patches (<math>\geq 5\text{cm}^2</math>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	0.00	0.00	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = N/A	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	17.00	0.00		Low risk of bias	⊕⊕○○ Low	None
<b><i>Neck (anterior) contamination during doffing of PPE: Extra large sized contaminated patches (<math>\geq 5\text{cm}^2</math>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	0.00	24.00	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = N/A	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	0.00	24.00		Low risk of bias	⊕⊕○○ Low	None
<b><i>Neck (posterior) contamination during doffing of PPE: Extra large sized contaminated patches (<math>\geq 5\text{cm}^2</math>), median</i></b>								
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	0.00	0.00	ANOVA: PPE1 vs. PPE2 vs. PPE3 : p-value = N/A	Low risk of bias	⊕⊕○○ Low	None

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Statistical test</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>e</sup> - HA isolation gown for routine patient care and performing AGPs	0.00	0.00		Low risk of bias	⊕⊕○○ Low	None
<b><i>Overall contamination during doffing of PPE, any size, n (%)</i></b>								
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	13 (26%)	48 (96%)	Mainland–Gart: p <0.001	Some concerns	⊕○○○ Very low	None
<b><i>Face contamination during doffing of PPE, any size, n (%)</i></b>								
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	0	2 (4%)	Mainland–Gart: p=1	Some concerns	⊕○○○ Very low	None
<b><i>Back of the head contamination during doffing of PPE, any size, n (%)</i></b>								
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	0	0	Mainland–Gart: undefined	Some concerns	⊕○○○ Very low	None
<b><i>Neck (anterior) contamination during doffing of PPE, any size, n (%)</i></b>								
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	3 (6%)	48 (96%)	Mainland–Gart: p<0.001	Some concerns	⊕○○○ Very low	None
<b><i>Neck (posterior) contamination during doffing of PPE, any size, n (%)</i></b>								
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	1 (2%)	9 (18%)	Mainland–Gart: p=0.012	Some concerns	⊕○○○ Very low	None

- a. Quality assessment of studies was completed using the Cochrane RoB 2 for randomized trials.
- b. Hospital Authority Standard Ebola PPE set (PPE 1): a neck-to-ankle overall with an overlying water-resistant gown double and long nitrile gloves, boots, hood, disposable face shield and N95 respirator. Order of doffing: gloves, gown, boots, hood, N95.
- c. HA isolation gown for routine patient care and performing AGPs (PPE3): pure cotton surgical scrub suit, appropriate size gowns and gloves and the known best-fitted respirator model (3 M 1860, 1860s and 1870). Order of doffing: gloves, gown, full face shield, cap, N95 respirator.

- d. DuPont™ Tyvek®, Model 1422A (PPE2): head-to-ankle overall with a zipper on the front. The whole outfit includes double gloves, boots, disposable face shield and an N95 respirator. A plastic apron was used to cover up the front zipper before use. Order of doffing: apron, hood, coverall/outer gloves, face shield, N95 respirator, boots, inner gloves.
- e. PAPR (powered air-purifying respirator): Tyvek hood, Bouffant hair cover, Economy impact goggle, Air-mate breathing tube, face-shield, HEPA filter unit, N95 mask - any of several modes (8210, 1860s, PFR95, 7210, 695), Gloves (Non-latex, latex, latex surgical), Tyvek coveralls with hood, Tyvek boot covers, Astound impervious surgical gown
- f. E-RCP (Enhanced respiratory and contact precautions) contains a bouffant hair cover, economy impact goggle, face-shield, N95 mask - any of several modes (8210, 1860s, PFR95, 7210, 695), gloves (Non-latex, latex), astound impervious surgical gown

**Table 4. Summary of Findings: Human factors: Deviation rate (%) during donning and doffing of personal protective equipment**

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
<b><i>Overall deviation rate (%) during donning of PPE</i></b>							
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	6.06	3.70	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	6.00	3.70			
<b><i>Deviation rate (%) during donning of hood</i></b>							
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	20.00	N/A	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	3.33	N/A			
<b><i>Deviation rate (%) during donning of faceshield</i></b>							
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	11.67	6.67	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	15.00	6.67			
<b><i>Overall deviation rate (%) during doffing of PPE</i></b>							



<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	2.95	3.52	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	9.48	3.52			
<b><i>Deviation rate (%) during doffing of hood</i></b>							
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	5.00	N/A	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	8.33	N/A			
<b><i>Deviation rate (%) during doffing of faceshield</i></b>							
Suen, 2018 <sup>3</sup>	PPE1 <sup>b</sup> - Hospital Authority Standard Ebola PPE set	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	6.67	10.00	Low risk of bias	⊕⊕○○ Low	None
	PPE2 <sup>d</sup> - DuPont™ Tyvek®, Model 1422A	PPE3 <sup>c</sup> - HA isolation gown for routine patient care and performing AGPs	11.67	10.00			
<b><i>Total donning errors, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>e</sup>	E-RCP <sup>f</sup>	19 (38%)	2 (4%)	Some concerns	⊕○○○ Very low	None
<b><i>Total doffing errors, n (%)</i></b>							

<i>Study details</i>	<i>Intervention (cover head/neck and mucus membranes)</i>	<i>Comparator (cover mucous membranes only)</i>	<i>Outcome in intervention group</i>	<i>Outcome in control group</i>	<i>Quality Assessment<sup>a</sup></i>	<i>GRADE</i>	<i>Notes</i>
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	6 (12%)	12 (24%)	Some concerns	⊕○○○ Very low	None
<b><i>Error in application of goggles during donning, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	2 (4%)	0	Some concerns	⊕○○○ Very low	None
<b><i>Failure to zip up coveralls or put hood over head during donning, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	1 (2%)	N/A	Some concerns	⊕○○○ Very low	None
<b><i>Error in application of bouffant hair-cover during donning, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	N/A	1 (2%)	Some concerns	⊕○○○ Very low	None
<b><i>Error in removal of face shield during doffing, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	N/A	1 (2%)	Some concerns	⊕○○○ Very low	None
<b><i>Error in removal of hair-cover during doffing, n (%)</i></b>							
Zamora, 2006 <sup>4</sup>	PAPR <sup>c</sup>	E-RCP <sup>f</sup>	N/A	2 (4%)	Some concerns	⊕○○○ Very low	None

- a. Quality assessment of studies was completed using the Cochrane RoB 2 for randomized trials.
- b. Hospital Authority Standard Ebola PPE set (PPE 1): a neck-to-ankle overall with an overlying water-resistant gown double and long nitrile gloves, boots, hood, disposable face shield and N95 respirator. Order of doffing: gloves, gown, boots, hood, N95.
- c. HA isolation gown for routine patient care and performing AGPs (PPE3): pure cotton surgical scrub suit, appropriate size gowns and gloves and the known best-fitted respirator model (3 M 1860, 1860s and 1870). Order of doffing: gloves, gown, full face shield, cap, N95 respirator.
- d. DuPont™ Tyvek®, Model 1422A (PPE2): head-to-ankle overall with a zipper on the front. The whole outfit includes double gloves, boots, disposable face shield and an N95 respirator. A plastic apron was used to cover up the front zipper before use. Order of doffing: apron, hood, coverall/outer gloves, face shield, N95 respirator, boots, inner gloves.
- e. PAPR (powered air-purifying respirator): Tyvek hood, Bouffant hair cover, Economy impact goggle, Air-mate breathing tube, face-shield, HEPA filter unit, N95 mask - any of several modes (8210, 1860s, PFR95, 7210, 695), Gloves (Non-latex, latex, latex surgical), Tyvek coveralls with hood, Tyvek boot covers, Astound impervious surgical gown

- f.** E-RCP (Enhanced respiratory and contact precautions) contains a bouffant hair cover, economy impact goggle, face-shield, N95 mask - any of several modes (8210, 1860s, PFR95, 7210, 695), gloves (Non-latex, latex), and impervious surgical gown

## **Citations:**

1. Coca A, Quinn T, Kim JH, et al. Physiological Evaluation of Personal Protective Ensembles Recommended for Use in West Africa. *Disaster Med Public Health Prep.* 2017;11(5):580-586. doi:10.1017/dmp.2017.13
2. Coca A, DiLeo T, Kim JH, Roberge R, Shaffer R. Baseline Evaluation With a Sweating Thermal Manikin of Personal Protective Ensembles Recommended for Use in West Africa. *Disaster Med Public Health Prep.* 2015;9(5):536-542. doi:10.1017/dmp.2015.97
3. Suen LKP, Guo YP, Tong DWK, et al. Self-contamination during doffing of personal protective equipment by healthcare workers to prevent Ebola transmission. *Antimicrob Resist Infect Control.* 2018;7(1):157. doi:10.1186/s13756-018-0433-y
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## **Appendix 1. Excluded Studies List – By Reason for Exclusion:**

### **Abstract Only**

Abela N, Bonnici ET, Parascandalo A, Borg M. Lessons learnt and challenges in adopting the ECDC and who Ebola guidelines at Mater Dei Hospital. *Antimicrob Resist Infect Control*. 2015;4(S1):P5, 2047-2994-4-S1-P5. doi:[10.1186/2047-2994-4-S1-P5](https://doi.org/10.1186/2047-2994-4-S1-P5)

### **Commentary**

MacIntyre CR, Chughtai AA, Seale H, Richards GA, Davidson PM. Response to Martin-Moreno et al. (2014) Surgical mask or no mask for health workers not a defensible position for Ebola. *International Journal of Nursing Studies*. 2014;51(12):1694-1695. doi:[10.1016/j.ijnurstu.2014.10.004](https://doi.org/10.1016/j.ijnurstu.2014.10.004)

MacIntyre CR, Chughtai AA, Seale H, Richards GA, Davidson PM. Uncertainty, risk analysis and change for Ebola personal protective equipment guidelines. *International Journal of Nursing Studies*. 2015;52(5):899-903. doi:[10.1016/j.ijnurstu.2014.12.001](https://doi.org/10.1016/j.ijnurstu.2014.12.001)

### **Narrative review**

Franklin SM. A Comparison of Personal Protective Standards: Caring for Patients With Ebola Virus. *Clinical Nurse Specialist*. 2016;30(2):E1-E8. doi:[10.1097/NUR.0000000000000183](https://doi.org/10.1097/NUR.0000000000000183)

Honda H, Iwata K. Personal protective equipment and improving compliance among healthcare workers in high-risk settings: *Current Opinion in Infectious Diseases*. 2016;29(4):400-406. doi:[10.1097/QCO.0000000000000280](https://doi.org/10.1097/QCO.0000000000000280)

### **No information on PPE**

De Clerck H. Protecting the health care worker during outbreaks – The case of viral hemorrhagic fever outbreaks. *International Journal of Infectious Diseases*. 2016;45:67. doi:[10.1016/j.ijid.2016.02.194](https://doi.org/10.1016/j.ijid.2016.02.194)

Fischer WA, Hynes NA, Perl TM. Protecting Health Care Workers From Ebola: Personal Protective Equipment Is Critical but Is Not Enough. *Ann Intern Med*. 2014;161(10):753. doi:[10.7326/M14-1953](https://doi.org/10.7326/M14-1953)

Martin-Moreno JM, Llinás G, Hernández JM. Is respiratory protection appropriate in the Ebola response? *The Lancet*. 2014;384(9946):856. doi:[10.1016/S0140-6736\(14\)61343-X](https://doi.org/10.1016/S0140-6736(14)61343-X)

Martin-Moreno JM, Llinás G, Martínez-Hernández J. Response to “MacIntyre et al., 2014: Respiratory protection for healthcare workers treating Ebola virus disease (EVD): are facemasks sufficient to meet occupational health and safety obligations?” *International Journal of Nursing Studies*. 2014;51(12):1693. doi:[10.1016/j.ijnurstu.2014.10.005](https://doi.org/10.1016/j.ijnurstu.2014.10.005)

Savini H, Janvier F, Karkowski L, et al. Occupational Exposures to Ebola Virus in Ebola Treatment Center, Conakry, Guinea. *Emerg Infect Dis*. 2017;23(8):1380-1383. doi:[10.3201/eid2308.161804](https://doi.org/10.3201/eid2308.161804)

## No relevant comparisons

Den Boon S, Vallenas C, Ferri M, Norris SL. Incorporating health workers' perspectives into a WHO guideline on personal protective equipment developed during an Ebola virus disease outbreak. *F1000Res*. 2018;7:45. doi:[10.12688/f1000research.12922.2](https://doi.org/10.12688/f1000research.12922.2)

Doshi RH, Hoff NA, Bratcher A, et al. Risk Factors for Ebola Exposure in Health Care Workers in Boende, Tshuapa Province, Democratic Republic of the Congo. *The Journal of Infectious Diseases*. Published online 2020;jiaa747. doi:[10.1093/infdis/jiaa747](https://doi.org/10.1093/infdis/jiaa747)

Doshi RH, Hoff NA, Mukadi P, et al. Seroprevalence of ebola virus among health care workers in the Tshuapa district democratic republic of congo. *Am J Tropic Med Hygiene*. Published online 2016.

Dunn AC, Walker TA, Redd J, et al. Nosocomial transmission of Ebola virus disease on pediatric and maternity wards: Bombali and Tonkolili, Sierra Leone, 2014. *American Journal of Infection Control*. 2016;44(3):269-272. doi:[10.1016/j.ajic.2015.09.016](https://doi.org/10.1016/j.ajic.2015.09.016)

Chughtai AA, Chen X, Macintyre CR. Risk of self-contamination during doffing of personal protective equipment. *American Journal of Infection Control*. 2018;46(12):1329-1334. doi:[10.1016/j.ajic.2018.06.003](https://doi.org/10.1016/j.ajic.2018.06.003)

Grélot L, Koulibaly F, Maugey N, et al. Moderate Thermal Strain in Healthcare Workers Wearing Personal Protective Equipment During Treatment and Care Activities in the Context of the 2014 Ebola Virus Disease Outbreak. *J Infect Dis*. 2016;213(9):1462-1465. doi:[10.1093/infdis/jiv585](https://doi.org/10.1093/infdis/jiv585)

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Holt A, Hornsey E, Seale AC, et al. A mixed-methods analysis of personal protective equipment used in Lassa fever treatment centres in Nigeria. *Infection Prevention in Practice*. 2021;3(3):100168. doi:[10.1016/j.infpip.2021.100168](https://doi.org/10.1016/j.infpip.2021.100168)

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MacIntyre CR, Chughtai AA, Seale H, Richards GA, Davidson PM. Respiratory protection for healthcare workers treating Ebola virus disease (EVD): Are facemasks sufficient to meet occupational health and safety obligations? *International Journal of Nursing Studies*. 2014;51(11):1421-1426. doi:[10.1016/j.ijnurstu.2014.09.002](https://doi.org/10.1016/j.ijnurstu.2014.09.002)

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### **No relevant outcome data**

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## Appendix 2. Eligibility Criteria

**Question (5): Should Health workers in direct contact and/or indirect contact to patients with Ebola Virus Disease (EVD) or Marburg virus disease cover head and neck skin and mucous membranes or just cover mucous membranes?**

Setting	Health care facilities, ETU, <i>community (e.g. burial teams)</i>  *Contexts to consider: ETU use vs. healthcare facility; outbreak vs readiness vs. high alert scenario.
Population	Staff in HCF, ETU, community (e.g. burial teams)
Background interventions (Standard of care)	The mucous membranes of eyes, mouth and nose are covered by PPE. Use of a head cover that covers head and neck.
Intervention	Use a cover for the head and neck.
Comparator(s)	Not use a cover for head and neck.  <i>Direct contact, indirect contact</i>
Outcome	Infection with Ebola or Marburg, PPE breaches, compliance related to heat and comfort, <i>dehydration, heat tolerance, human factors, health worker confidence</i>  <b>Indirect evidence:</b> Lassa fever
Potential effect modifiers	<i>Frequency and type of exposure, vaccination</i>

### Appendix 3. GRADE Assessment: Heat Tolerance

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
<b>Time (min) to reach critical core temperature of 39°C under condition A</b>												
1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD 16 min fewer (30.78 fewer to 1.22 fewer)	⊕○○○ Very low	
									-	MD 13 min fewer (25.2 fewer to 0.79 fewer)		
									-	MD 18 min fewer (27.7 fewer to 8.2 fewer)		
									-	MD 15 min fewer (20.06 fewer to 9.9 fewer)		
<b>Body surface skin temperature (°C) at time to reach critical core temperature of 39°C under condition A</b>												
1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD 0.7 C higher (0.62 lower to 2.02 higher)	⊕○○○ Very low	
									-	MD 0.6 C higher (0.14 higher to 1.05 higher)		
									-	MD 1.1 C higher (0.26 lower to 2.46 higher)		
									-	MD 1 C higher (0.42 higher to 1.57 higher)		
<b>Heat sensation at time to reach critical core temperature of 39°C under condition A</b>												
1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD 0.3 higher (0.05 lower to 0.65 higher)	⊕○○○ Very low	

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
									-	MD <b>0.2 higher</b> (0.15 lower to 0.55 higher)		
									-	MD <b>0.2 higher</b> (0.15 lower to 0.55 higher)		
									-	MD <b>0.1 higher</b> (0.25 lower to 0.45 higher)		

**Discomfort at time to reach critical core temperature of 39°C under condition A**

1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.2 lower</b> (0.42 lower to 0.02 higher)	⊕○○○ Very low	
									-	MD <b>0.2 lower</b> (0.42 lower to 0.02 higher)		
									-	MD <b>0.2 lower</b> (0.42 lower to 0.02 higher)		
									-	MD <b>0.2 lower</b> (0.42 lower to 0.02 higher)		

**Core temperature (°C) after 80 minutes of activity under condition B**

1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.57 C higher</b> (0.21 higher to 0.92 higher)	⊕○○○ Very low	
									-	MD <b>0.37 C higher</b> (0.14 higher to 0.59 higher)		
									-	MD <b>0.85 C higher</b> (0.49 higher to 1.2 higher)		
									-	MD <b>0.65 C higher</b> (0.42 higher to 0.87 higher)		

**Body surface skin temperature (°C) after 80 minutes of activity under condition B**

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>1.2 C higher</b> (0.29 higher to 2.1 higher)	⊕○○○ Very low	
									-	MD <b>0.5 C higher</b> (0.21 lower to 1.21 higher)		
									-	MD <b>1.8 C higher</b> (0.64 higher to 2.95 higher)		
									-	MD <b>1.1 C higher</b> (0.08 higher to 2.11 higher)		

**Heat sensation after 80 minutes of activity under condition B**

1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.7 higher</b> (0.66 lower to 2.06 higher)	⊕○○○ Very low	
									-	MD <b>0 higher</b> (1.15 lower to 1.15 higher)		
									-	MD <b>0.8 higher</b> (0.45 lower to 2.05 higher)		
									-	MD <b>0.1 higher</b> (0.92 lower to 1.12 higher)		

**Discomfort after 80 minutes of activity under condition B**

1	observational studies	not serious <sup>a</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.6 lower</b> (1.31 lower to 0.11 higher)	⊕○○○ Very low	
									-	MD <b>0.4 lower</b> (1.11 lower to 0.31 higher)		
									-	MD <b>0.9 lower</b> (1.47 lower to 0.32 lower)		

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
									-	MD <b>0.7 lower</b> (1.27 lower to 0.12 lower)		

**Core Temperature (°C) at end of exercise**

1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.73 C higher</b> (0.14 lower to 1.6 higher)	⊕○○○ Very low	
									-	MD <b>0.6 C higher</b> (0.33 lower to 1.53 higher)		

**Skin Temperature (°C) at end of exercise**

1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>1.8 C higher</b> (0.75 higher to 2.88 higher)	⊕○○○ Very low	
									-	MD <b>1.09 C higher</b> (0 higher to 2.18 higher)		

**Heart Rate (beats per minute) at end of exercise**

1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>27.43 BPM higher</b> (9.59 lower to 64.45 higher)	⊕○○○ Very low	
									-	MD <b>20.43 BPM higher</b> (15.61 lower to 56.47 higher)		

**Average sweat weight loss (kg) per hour**

1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.54 kg higher</b> (0.44 lower to 1.52 higher)	⊕○○○ Very low	
									-	MD <b>0.32 kg higher</b> (0.74 lower to 1.38 higher)		

**Heat Sensation at end of exercise**

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0.57 higher</b> (0.42 lower to 1.56 higher)	⊕○○○ Very low	
									-	MD <b>0.57 higher</b> (0.42 lower to 1.56 higher)		
<b>Thermal Comfort at end of exercise</b>												
1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0</b> (4.28 lower to 4.28 higher)	⊕○○○ Very low	
									-	MD <b>0.86 higher</b> (0.89 lower to 2.61 higher)		
<b>Rated perceived exertion at end of exercise</b>												
1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>3.43 higher</b> (1.82 lower to 8.68 higher)	⊕○○○ Very low	
									-	MD <b>2.57 higher</b> (3.45 lower to 8.59 higher)		
<b>Breathing comfort at end of exercise</b>												
1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>1.57 higher</b> (0.74 lower to 3.88 higher)	⊕○○○ Very low	
									-	MD <b>1.72 higher</b> (0.98 lower to 4.42 higher)		
<b>Wetness at end of exercise</b>												
1	observational studies	serious <sup>d</sup>	not serious	very serious <sup>b</sup>	serious <sup>c</sup>	none	3	3	-	MD <b>0</b> (0.86 lower to 0.86 higher)	⊕○○○ Very low	
									-	MD <b>0</b> (0.86 lower to 0.86 higher)		

CI: confidence interval; MD: mean difference

## Explanations

- a. Coca et al., 2015 was judged to be at moderate risk of bias. The mannequins were treated in the quality assessment, as if the mannequin were a volunteer. There was a lack of information reported for several ROBINS-I domains, including outcome measurement. There was no outcome assessor blinding, though outcomes were less vulnerable to bias, due to simulated nature of the study.
- b. Downrated due to simulation study and non-human participants, as well as other differences in evaluated PPE equipment other than just head/neck cover vs. no cover.
- c. Few participants and optimal information size (OIS) threshold not met.
- d. We rated Coca et al., 2017, at a high risk of bias because of no demonstration of data availability for all the study participants and lack of blinding of the outcome assessor. Outcomes like thermal comfort, heat sensation, rating of perceived exertion, breathing comfort, and wetness were subjective measures which could potentially be more vulnerable to bias.

## Appendix 4. GRADE Assessment: Contamination during doffing of PPE

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
<b>Overall contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Hair and head contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Neck (anterior) contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Neck (posterior) contamination during doffing of PPE: Small sized contaminated patches (&lt; 1 cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Overall contamination during doffing of PPE: Extra large sized contaminated patches (≥ 5cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Hair and head contamination during doffing of PPE: Extra large sized contaminated patches (≥ 5cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Neck (anterior) contamination during doffing of PPE: Extra large sized contaminated patches (≥ 5cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	
<b>Neck (posterior) contamination during doffing of PPE: Extra large sized contaminated patches (≥ 5cm<sup>2</sup>), median</b>												
1	randomised trials	not serious	not serious	serious <sup>b</sup>	serious <sup>a</sup>	none	59	59	not estimable	not estimable	⊕⊕○○ Low	

Overall contamination during doffing of PPE, any size, n (%)



Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>a</sup>	none	13/50 (26.0%)	48/50 (96.0%)	<b>RR 0.27</b> (0.17 to 0.43)	<b>701 fewer per 1,000</b> (from 797 fewer to 547 fewer)	⊕○○○ Very low	
<b>Face contamination during doffing of PPE, any size, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>a</sup>	none	0/50 (0.0%)	2/50 (4.0%)	<b>RR 0.2000</b> (0.0098 to 4.0636)	<b>32 fewer per 1,000</b> (from 40 fewer to 123 more)	⊕○○○ Very low	
<b>Back of the head contamination during doffing of PPE, any size, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>a</sup>	none	0/50 (0.0%)	0/50 (0.0%)	not estimable	not estimable	⊕○○○ Very low	
<b>Neck (anterior) contamination during doffing of PPE, any size, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>a</sup>	none	3/50 (6.0%)	48/50 (96.0%)	<b>RR 0.1200</b> (0.0378 to 0.3533)	<b>845 fewer per 1,000</b> (from 924 fewer to 621 fewer)	⊕○○○ Very low	
<b>Neck (posterior) contamination during doffing of PPE, any size, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>a</sup>	none	1/50 (2.0%)	9/50 (18.0%)	<b>RR 0.1300</b> (0.0169 to 0.9804)	<b>157 fewer per 1,000</b> (from 177 fewer to 4 fewer)	⊕○○○ Very low	

CI: confidence interval; RR: risk ratio

## Explanations

- Few participants and optimal information size (OIS) threshold not met.
- Downrated due to simulation study: Fluorescent contamination as a surrogate outcome for EVD/Marburg Virus Disease, other differences in evaluated PPE equipment other than just head/neck cover vs. no cover.
- Downrated due to concerns with risk of bias. Unclear risk of bias for several domains, including allocation bias, blinding of participants, and unclear if all outcomes were reported.
- Downrated due to simulation study: Fluorescent contamination as a surrogate outcome, other differences in evaluated PPE equipment other than just head/neck cover vs. no cover.

## Appendix 5. GRADE Assessment: Deviation rate (%) during donning and doffing of personal protective equipment

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
<b>Overall deviation rate (%) during donning of PPE</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Deviation rate (%) during donning of hood</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Deviation rate (%) during donning of faceshield</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Overall deviation rate (%) during donning of PPE</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Deviation rate (%) during doffing of hood</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Deviation rate (%) during donning of faceshield</b>												
1	randomised trials	not serious	not serious	serious <sup>a</sup>	serious <sup>b</sup>	none	59	59	-	-	⊕⊕○○ Low	
<b>Total donning errors, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	19/50 (38.0%)	2/50 (4.0%)	<b>RR 9.50</b> (2.33 to 38.70)	<b>340 more per 1,000</b> (from 53 more to 1,000 more)	⊕○○○ Very low	
<b>Total doffing errors, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	6/50 (12.0%)	12/50 (24.0%)	<b>RR 0.42</b> (0.17 to 1.03)	<b>139 fewer per 1,000</b> (from 199 fewer to 7 more)	⊕○○○ Very low	
<b>Error in application of goggles during donning, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	2/50 (4.0%)	0/50 (0.0%)	<b>RR 5.00</b> (0.25 to 101.60)	<b>0 fewer per 1,000</b> (from 0 fewer to 0 fewer)	⊕○○○ Very low	

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	A cover for the head and neck	No cover for the head and neck	Relative (95% CI)	Absolute (95% CI)		
<b>Failure to zip up coveralls or put hood over head during donning, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	1/50 (2.0%)	N/A	not estimable	not estimable	⊕○○○ Very low	
<b>Error in application of bouffant hair-cover during donning, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	N/A	1/50 (2.0%)	not estimable	not estimable	⊕○○○ Very low	
<b>Error in removal of face shield during doffing, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	N/A	1/50 (2.0%)	not estimable	not estimable	⊕○○○ Very low	
<b>Error in removal of hair-cover during doffing, n (%)</b>												
1	randomised trials	serious <sup>c</sup>	not serious	serious <sup>d</sup>	serious <sup>b</sup>	none	N/A	2/50 (4.0%)	not estimable	not estimable	⊕○○○ Very low	

CI: confidence interval; RR: risk ratio

## Explanations

- Downrated due to simulation study: Fluorescent contamination as a surrogate outcome for EVD/Marburg Virus Disease, other differences in evaluated PPE equipment other than just head/neck cover vs. no cover.
- Few participants and optimal information size (OIS) threshold not met.
- Downrated due to concerns with risk of bias. Unclear risk of bias for several domains, including allocation bias, blinding of participants, and unclear if all outcomes were reported.
- Downrated due to simulation study: Fluorescent contamination as a surrogate outcome, other differences in evaluated PPE equipment other than just head/neck cover vs. no cover.