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## Infectious Diseases of High Consequence and Personal Protective Equipment: A Didactic Method to Assess the Risk of Contamination

*To the Editor*—Infectious diseases of high consequence are serious threats to human health with no specific prophylaxis or treatment available. Patients may develop severe symptoms and require critical care. The protection of healthcare workers (HCWs) through personal protective equipment (PPE) and isolation of contagious patients are the 2 main principles to reduce the risk of spreading of infectious diseases of high consequence.<sup>1</sup> Since March 2014, more than 27,000 cases of Ebola virus disease and 11,000 deaths have been reported in West Africa.<sup>2</sup> Healthcare workers are between 21 and 32 times more likely to be infected with Ebola virus than people in the general population.<sup>3</sup> In light of this current outbreak and its high case-fatality rate, a broad range of challenges were reported, including conflicting PPE removal protocols and gaps in training and supplies.<sup>4</sup> This is of major concern because Ebola virus can persist on surfaces for up to 5 days<sup>5</sup> and the skin and clothing of HCWs can become contaminated. The fear of undetected contamination may result in increased stress levels for HCWs. In this context, the need for adherence to safe and validated protocols for removal of PPE is clear. Moreover, it has been shown, by evaluation of the errors, that repeated training achieved better proficiency.<sup>6</sup> However, to the best of our knowledge, the impact of training courses has not yet been assessed by an objective method.

During an educational training program, we undertook a systematic evaluation of the risk of contamination with a fluorescent powder (Hygikit; Voussert). We conducted a series of 47 care simulations. Nurses, nursing assistants, and physicians from 3 different wards (the infectious disease unit, emergency department, and intensive care unit) who use PPE and interact with highly contagious patients were voluntarily included. The study was conducted at a university hospital with a specialized treatment center for infectious diseases of high consequence. The standard components of PPE included

TABLE 1. Risk Factors for Healthcare Worker Contamination

Variable	Univariate analysis		Multivariate analysis	
	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P
Healthcare workers				
Nurses	1 [Reference]		1 [Reference]	
Nursing assistants	0.2 (0.03–0.9)	.04	1.5 (0.1–15.6)	.75
Physicians	0.4 (0.03–5.85)	.5	2.1 (0.1–43.9)	.6
Hospital ward				
Infectious diseases	1 [Reference]		...	
Emergency dept.	0.5 (0.07–3.2)	.45	...	
Intensive care unit	0.4 (0.05–2.6)	.3	...	
Previous training(s)				
0	1 [Reference]		1 [Reference]	
1	6.7 (0.6–74.5)	.1	6.55 (0.5–81.3)	.1
>1	100 (5.15–1,941)	.002	111 (3.6–3,449)	.007
Time since previous training, d				
<30	1 [Reference]		...	
≥30	1.5 (0.4–5.8)	.6	...	

NOTE. The Pearson  $\chi^2$  test was used to perform 2-group comparisons for qualitative variables; the Fisher exact test was used when the expected count was <5. A multivariate analysis using logistic regression was performed to identify independent risk factors for contamination.  $P < .05$  was considered statistically significant. All analyses were performed with R statistical package, version 2.15.1.

boots, a full-body impermeable suit, a hood with a surgical cap and mask, double gloves, and an impermeable protection apron. This equipment corresponded to the enhanced PPE, in line with current recommendations.<sup>7</sup> Enhanced PPE is proposed for patients secreting fluids (eg, hemorrhage, vomiting, diarrhea) with a high risk of soiling and exposure for HCWs. We used black light to identify sites on skin contaminated with the fluorescent powder after PPE removal.

Of the 47 PPE removal simulations, there were 11 cases of contamination (23%). The frequency of contamination did not differ between the 3 medical wards. Nursing assistants were at higher risk for contamination ( $P = .04$ ). Training was associated with a dramatic reduction in the rate of contamination (Table 1). This association was quantitative with at least 2 previous trainings independently reducing contamination ( $P = .007$ ).

Our findings suggest that HCW training in the safe use of PPE, including simulation of contamination, represents a promising teaching aid. Furthermore, this training could help HCWs to better prepare practically to avoid secondary transmission of infectious diseases of high consequence and to reduce stress when involved in patient care.

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