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Brief Report

Contamination of health care personnel during removal of contaminated gloves



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In simulations of contaminated glove removal, 37% of health care personnel using their typical doffing technique contaminated their skin with a fluorescent solution. The frequency of contamination was significantly lower when the technique recommended by the Centers for Disease Control and Prevention was used versus not used (8 of 34, 24% vs 29 of 66, 44%). In simulations in which only the palm of the glove was contaminated, a modified doffing technique, to minimize the risk for contact with contaminated surfaces, reduced contamination of personnel.

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Contamination of the skin and clothing of health care personnel can contribute to the dissemination of pathogens and place personnel at risk for acquisition of infection.⁰¹ Studies of patients in contact precautions for multidrug-resistant bacteria or *Clostridium difficile* have demonstrated that such contamination may occur even when personnel wear gowns and gloves.^{2,3} Simulation studies have demonstrated that contamination of personnel occurs frequently during removal of gloves and gowns.¹ High risk exposures, such as handling contaminated body fluids, prolonged exposure, and failure to correctly use personal protective equipment increases the risk of contamination.¹

During patient care activities, health care personnel often wear gloves without wearing gowns. The Centers for Disease Control and Prevention (CDC) recommend a specific technique for glove removal to reduce the risk for self-contamination.⁴ In contrast to glove and gown removal, relatively little information is available on glove removal techniques used by health care personnel, and on the frequency of contamination during glove removal.^{5,6} Thus, we

conducted simulations of contaminated glove removal to examine removal techniques among personnel in our facility and to assess the potential for self-contamination.

METHODS

The study protocol was approved by the Cleveland VA Medical Center's institutional review board. During a 6-week period, a convenience sample of 100 health care personnel participated in simulations of contaminated glove removal. Participants donned nitrile gloves using their usual technique. After donning, 0.5 mL of fluorescent solution (Super Blue Invisible Ink, Black Light World, <http://www.blacklightworld.com/>) was placed in the palm of 1 hand and participants rubbed the solution over their gloved hands for 15 seconds or until dry. The personnel removed their gloves in their usual manner. The removal technique was observed and concordance with the technique recommended by the CDC was assessed.⁴ The technique is intended to ensure that bare skin does not touch the contaminated outside surface of the glove during removal. We also noted if personnel used a "beak" method that has been recommended as an alternative to the CDC method.⁷ Hand and wrist contamination with the fluorescent solution was assessed using a black light (UV Ultra Blacklight ULG 1, Ultra Light, Guangdong, China). After each simulation, the integrity of the gloves was assessed to ensure that there was no evidence of perforations or tears that might result in contamination.

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For a second cohort of 20 personnel, simulations were performed in which 10^8 plaque-forming units of *Escherichia coli* bacteriophage MS2 15597-B1 (American Type Culture Collection, Manassas, VA) was mixed with the fluorescent solution to determine concordance of results for the fluorescent solution and a live virus. Bacteriophage MS2 was propagated in *E. coli* 15597, as previously described.¹ To detect the virus, both hands and wrists were wiped with a sterile, pre-moistened 4 × 4 gauze pad that was placed into a sterile container containing 10 mL of phosphate-buffered saline solution and vortexed for 1 minute to elute the bacteriophage.

A third cohort of 20 personnel participated in an evaluation of a modified glove removal technique. The modified technique was developed based on observations that in most clinical interactions, only the palmar surface of gloves contacts patients or surfaces. Thus, it was hypothesized that contamination would be reduced if step 4 of the CDC-recommended removal technique was modified such that the second glove was removed by inserting fingers inside the glove posterior rather than anterior to the wrist.⁴ The 20 participants were randomized to remove contaminated gloves using the CDC-recommended method or the modified method; after the initial assessment the participants removed contaminated gloves using the alternate method.

Data were analyzed using R software version 3.1.1 (R Foundation for Statistical Computing, Vienna, Austria). Fisher exact test was used to compare the percentages of contamination among different groups.

RESULTS

Of the 100 personnel participating in simulations of contaminated glove removal (cohort 1), only 34 (34%) used the technique recommended by the CDC. Contamination of the skin with the fluorescent marker occurred in 37 (37%) of the simulations. Only 1 participant used the “beak” method, and no contamination occurred. As shown in Table 1 (cohort 1), the frequency of contamination was significantly lower with the CDC-recommended versus the nonrecommended technique (8 of 34, 24% vs 29 of 66, 44%; $P < .01$). Figure 1 shows the distribution of sites of hand and wrist contamination during removal of contaminated gloves. Based on observations, contamination frequently occurred when the contaminated outside surface of the gloves was touched with bare hands during removal. The most frequently contaminated sites were the fingers and wrists.

Table 1 also provides results for the comparisons of skin contamination for the 20 participants whose gloves were contaminated with the fluorescent marker and bacteriophage MS2 (cohort 2), and for the 20 participants who completed simulations with the CDC-recommended versus the modified techniques. For cohort 2, the frequency of skin contamination was similar for the fluorescent marker and the virus. For cohort 3, the modified doffing technique was associated with a significant reduction in contamination. For all participants in each cohort, there was no evidence of perforations or tears in the gloves that might result in contamination.

Table 1
Comparison of the frequency of contamination of the hands or wrists during removal of contaminated gloves for the 3 study cohorts

Cohort 1. One hundred personnel participating in simulations of removal of gloves contaminated with the fluorescent marker		
CDC-recommended technique	8/34 (24%)	
CDC-nonrecommended technique	29/66 (44%)	$P < .01$
Cohort 2. Twenty personnel using the CDC-recommended technique during removal of gloves contaminated with the fluorescent marker and bacteriophage MS2		
Fluorescent marker	10/20 (50%)	
Bacteriophage MS2	11/20 (55%)	$P = .76$
Cohort 3. Twenty personnel using the CDC-recommended technique versus a modified technique during removal of gloves contaminated with the fluorescent marker		
CDC-recommended technique	7/20 (33%)	
Modified technique	2/20 (10%)	$P = .02$

NOTE. The modified technique was identical to the CDC-recommended technique, except step 4 that was modified such that the second glove was removed by inserting fingers inside the glove posterior rather than anterior to the wrist.
CDC, Centers for Disease Control and Prevention.

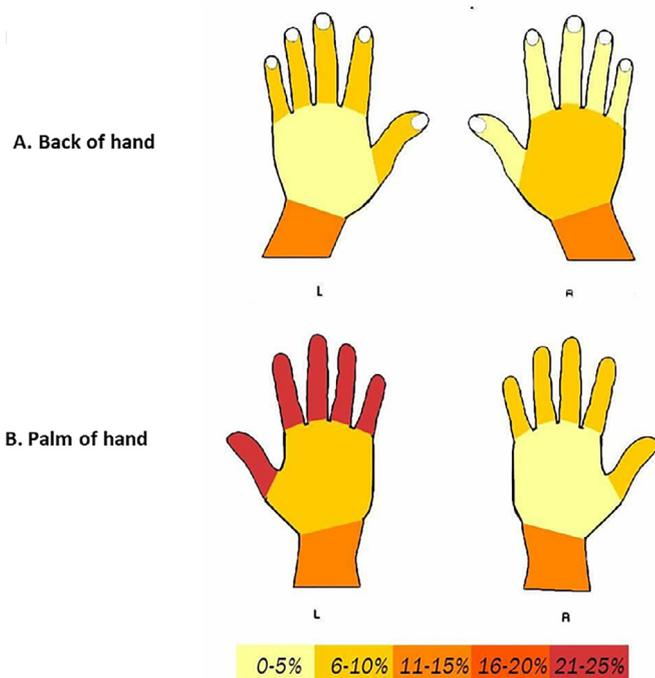


Fig 1. Frequency of contamination of skin sites during removal of gloves contaminated with fluorescent solution. (A) Percentage of contamination of sites on the back of the hands. (B) Percentage of contamination of sites on the palmar surface of the hands.

DISCUSSION

In simulations of contaminated glove removal, only 34% of health care personnel in our facility used the technique recommended by the CDC. Overall, contamination of the hands and wrists with the fluorescent tracer occurred in 37% of the simulations. The frequency of contamination was significantly lower when the CDC-recommended versus the nonrecommended techniques were used (24% vs 44%). Our results suggest that education on glove removal technique is needed to reduce the risk for contamination of personnel.

The fact that contamination occurred frequently, even when the recommended technique was used, highlights the need for additional measures to reduce contamination of personnel during glove removal. One potentially useful adjunctive measure might be the disinfection of gloves prior to removal. For example, glove disinfection after care of patients with *C. difficile* infection has been associated with a reduction in acquisition of spores on the hands of personnel.^{8,9} A simple modification of current glove design has also been reported to reduce contamination in simulations; the modification provides a flap above the thumb that can be gripped to assist in doffing.⁶ Double

gloving has also been associated with reduced contamination.¹⁰ Finally, our results also suggest that a modified removal method can help reduce the risk of hand contamination.

CONCLUSIONS

Our findings demonstrate that health care personnel are at risk for contamination of their skin during removal of contaminated gloves. There is a need for education to improve glove removal technique and for further studies to determine if modified glove designs or removal techniques may reduce the risk for contamination. In addition, our findings reinforce the importance of performing hand hygiene after glove removal.

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