Infection Control & Hospital Epidemiology (2022), **43**, 390–392
doi:10.1017/ice.2021.53

SHEA

Concise Communication

Recovery efficiency of two glove-sampling methods

Amanda K. Lyons MS, Laura J. Rose MS and Judith Noble-Wang PhD
Division of Healthcare Quality and Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia

Abstract

Two methods to sample pathogens from gloved hands were compared: direct imprint onto agar and a sponge-wipe method. The sponge method was significantly better at recovering *Clostridiodes difficile* spores, and no difference was observed between the methods at 10^1 inoculum for carbapenemase-producing KPC+ *Klebsiella pneumoniae*, methicillin-resistant *Staphylococcus aureus,* and *Acinetobacter baumannii.*

(Received 4 November 2020; accepted 25 January 2021; electronically published 2 March 2021)

Microbes can be transferred from patients to healthcare personnel (HCP) gloves and then from gloves to surfaces.[1,2] The World Health Organization has recommended intervention strategies aimed at reducing transmission by disinfecting gloves with alcohol-based hand rubs (ABHRs) at health hygiene moments such as after touching a patient, bodily fluid, or patient surroundings.[3] To date, no standardized method has been established for sampling healthcare gloves to evaluate the efficacy of ABHR or other interventions to reduce transmission of pathogens.[4] Cellulose sponges are a widely used sampling tool for healthcare surfaces, though no studies have the reported routine use of the sponge method in recovering bacteria from healthcare gloves. Directly imprinting gloved hands onto agar has been used in studies, though data in controlled settings are limited.[4] In this study, we compared the efficiency of 2 sampling methods to recover 4 pathogens from gloved hands: direct imprinting onto agar (imprint) and sponge sampling and processing (sponge).

Materials and methods

Carbapenemase-producing KPC+ *Klebsiella pneumoniae* BAA-1705 (KPC), *Acinetobacter baumannii* multilocus strain type 12, and methicillin-resistant *Staphylococcus aureus* ATCC 43300 (MRSA) were grown on trypticase soy agar with 5% sheep blood (TSA II, Becton Dickson, Franklin Lakes, NJ) overnight at 35°C. Spores of *Clostridioides difficile* ATCC 43598 were produced as described by Hasan et al.[5] Cells and spores were diluted in series to a titer of 10^2 or 10^1 CFU/mL in 20% artificial test soil (ATS, Healthmark Industries, Frasier MI).

Each experiment consisted of 3 volunteers inoculated at either the higher or lower inoculum, and each experiment was conducted a minimum of 4 times ($n \geq 12$). Volunteers were double gloved, with inner gloves having an extended cuff. Outer gloves were textured nitrile gloves (SafePoint, Naples FL and Microflex, Iselin NJ). Gloved hands were inoculated inside a biosafety cabinet; 3 µL of bacterial suspension per fingertip and thumb, and 5 µL across the top and bottom of each palm (25 µL total/glove). Gloved hands were then gently pressed together to aid in drying. Gloves were sampled upon being visibly dry (~5 minutes).

One glove from each volunteer was sampled ($n \geq 12$) by directly imprinting onto an agar plate (150 mm diameter); the remaining glove was sampled using a cellulose sponge (Sponge-Stick, 3M, St Paul MN).

Direct imprint sampling consisted of pressing the gloved thumb and each fingertip onto the agar for 5 seconds at ~1 kg pressure, followed by pressing the palmar surface with the same pressure on the bottom half of the plate. Trypticase soy agar with 5% sheep blood (TSAII) was used for KPC, *A. baumanii*, and MRSA, and brain heart infusion agar with horse blood and taurocholate (BHI-HT) incubated anaerobically was used for *C. difficile*. The volunteer's second gloved hand was sampled using the sponge method. Finger pads were wiped with the larger face of the sponge, and top and bottom palmar areas sampled sequentially with the smaller edge of the sponge, followed by the sponge tip. Sponges were held for 1 hour at room temperature, then the cells were eluted into 45 mL phosphate-buffered saline with 0.02% Tween 80 (PBST) using a Stomacher 400 Circulator (Seward Laboratory Systems, UK) operated for 1 minute. Eluents were centrifuge concentrated and decanted, leaving 3–5 mL. Pellets were resuspended and cultured (in triplicate) on TSA II for vegetative cells or anaerobically on BHI-HT for *C. difficile* spores. Colony-forming units (CFU) were counted, and percent recovery (% R) was calculated relative to the inoculum. The Student *t* test was used to determine significant differences, with significance set at $\leq .05$.

Results

The sponge method resulted in a significantly higher % R of *C. difficile* than the imprint method at both inoculum levels (Figs. 1 and 2). No statistically significant differences were seen between the 2 methods for *A. baumanii*, regardless of inoculum level (means, 14%–15%). At 10^1 inoculum no significant differences were observed between sampling methods for MRSA and KP, but at 10^2 inoculum KP was recovered significantly better by imprint than with the sponge method (10.8% [SD, 3.4%] and 4.4% [SD, 2%], respectively). In contrast, at the higher inoculum,

Author for correspondence: Amanda Lyons, E-mail: gvd4@cdc.gov
Cite this article: Lyons AK, Rose LJ, and Noble-Wang J. (2022). Recovery efficiency of two glove-sampling methods. *Infection Control & Hospital Epidemiology*, 43: 390–392, https://doi.org/10.1017/ice.2021.53

© The Author(s), 2021. Published by Cambridge University Press on behalf of The Society for Healthcare Epidemiology of America.

https://doi.org/10.1017/ice.2021.53 Published online by Cambridge University Press

CrossMark

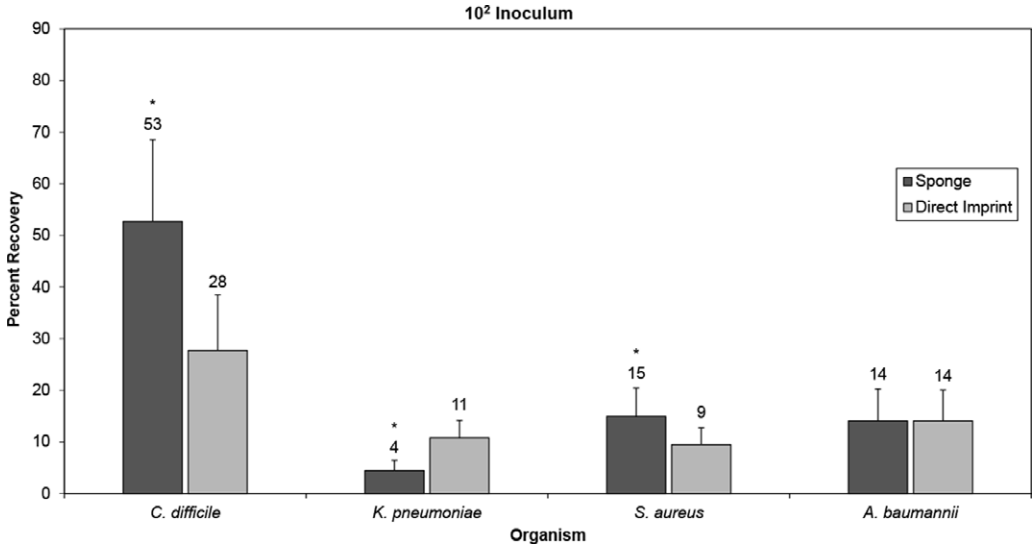


Fig. 1. Percent recovery (% R) of 4 healthcare pathogens using 2 glove-sampling methods; 10^2 CFU/mL inoculum ($n \geq 12$). *denotes $P \leq .05$.

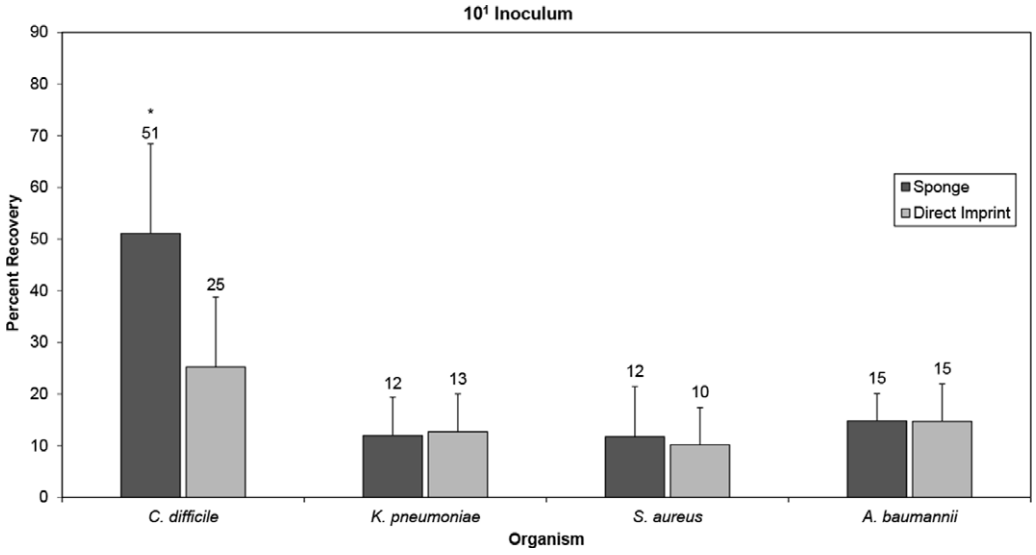


Fig. 2. Percent recovery (% R) of 4 healthcare pathogens using 2 glove-sampling methods; 10^1 CFU/mL inoculum ($n \geq 12$). *denotes $P \leq .05$.

MRSA was recovered significantly better using the sponge (14.9%; SD, 5.5%) as compared to the imprint method (9.4%; SD, 3.3%).

Discussion

Failure of HCP to change gloves and perform hand hygiene prior to patient contact and after contact with contaminated surfaces can increase the risk of HAI transmission.[6] In response to poor hand hygiene compliance, intervention strategies have been investigated such as the use of alcohol based hand rub on gloved hands, and antibacterial gloves.[4,7] To best evaluate the efficacy of intervention studies and the role of glove contamination in pathogen transmission, a standard glove sampling method is needed. Currently, the most commonly used hand-sampling method is the glove juice method,[8] but this method is difficult, time consuming, and has not been proven effective for gloved hands. Sponge processing is also time consuming (30–40 minutes per sample), whereas the imprint method requires no processing. Although the recovery was surprisingly low, these sampling recovery results coincide with the 1–2 $\log_{10}$ loss relative to the inocula reported by Kpadeh et al.[9] Recovery of the same pathogens from steel and plastic surfaces were observed to range from 6.9% for KPC to 54.7% for *C. difficile*.[10] This lower recovery may indicate that cells are adhering more to the nitrile gloves, though additional investigations are needed to understand the adherence dynamics between nitrile and these healthcare organisms.

The imprint method is a convenient glove-sampling method for active healthcare settings due to time and resources saved in processing, allowing the collection of a larger number of samples during epidemiological investigations or transmission intervention studies. Although typical background environmental organisms that might overgrow or mask the target pathogens were not included in this work, use of selective media could be used to inhibit their growth. The most efficient sampling method will provide the best evaluation of a transmission intervention strategy. These data show higher or equivalent recovery using the direct imprint method for

https://doi.org/10.1017/ice.2021.53 Published online by Cambridge University Press

the vegetative organisms evaluated when compared to the sponge sampling method. If targeting *C. difficile* spores, the sponge method should be considered because it provides a better estimate of spores present. For the vegetative organisms evaluated, this method can be considered a reliable, time-saving glove-sampling method for hand hygiene and transmission studies.

Acknowledgments. We would like to thank Monica Chan, Lauren Franco, Hollis Houston, Lori Spicer, and Carrie Whitworth for their laboratory support. The conclusions, findings, and opinions expressed by authors contributing to this journal do not necessarily reflect the official position of the US Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention, or the authors' affiliated institutions. The use of trade names is for identification only and does not imply endorsement by the Public Health Service or by the US Department of Health and Human Services.

Financial support. No financial support was provided relevant to this article.

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

References

1. Guerrero DM, Nerandzic MM, Jury LA, Jinno S, Chang S, Donskey CJ. Acquisition of spores on gloved hands after contact with the skin of patients with *Clostridium difficile* infection and with environmental surfaces in their rooms. *Am J Infect Control* 2012;40:556–558.
2. Takoi H, Fujita K, Hyodo H, *et al. Acinetobacter baumannii* can be transferred from contaminated nitrile examination gloves to polypropylene plastic surfaces. *Am J Infect Control* 2019;47:1171–1175.
3. WHO guidelines on hand hygiene in health care: a summary. World Health Organization website. https://www.who.int/gpsc/information_centre/hand-hygiene-summary/en/. Published 2009. Accessed February 10, 2021.
4. Robinson GL, Otieno L, Johnson JK, *et al.* Comparison of two glove-sampling methods to discriminate between study arms of a hand hygiene and glove-use study. *Infect Control Hosp Epidemiol* 2018;39:884–885.
5. Hasan JA, Japal KM, Christensen ER, Samalot-Freire LC. In vitro production of *Clostridium difficile* spores for use in the efficacy evaluation of disinfectants: a precollaborative investigation. *J AOAC Int* 2011;94:259–272.
6. Girou E, Chai SH, Oppein F, *et al.* Misuse of gloves: the foundation for poor compliance with hand hygiene and potential for microbial transmission? *J Hosp Infect* 2004;57:162–169.
7. Kahar Bador M, Rai V, Yusof MY, Kwong WK, Assadian O. Evaluation of the efficacy of antibacterial medical gloves in the ICU setting. *J Hosp Infect* 2015;90:248–252.
8. Standard test method for evaluation of the effectiveness of health care personnel or consumer handwash formulation. E1174-13. 2013, ASTM International website. http://materialstandard.com/wp-content/uploads/2019/10/E1174-13.pdf. Accessed February 10, 2021.
9. Kpadeh-Rogers Z, Robinson GL, Alserehi H, *et al.*, Effect of glove decontamination on bacterial contamination of healthcare personnel hands. *Clin Infect Dis* 2019;69 suppl 3:S224–S227.
10. Harris J. Artificial test soil helped improve recovery rate of health care pathogens. Infectious Disease Advisor. 2016. https://www.infectiousdiseaseadvisor.com/home/meetings/asm-2016/artificial-test-soil-helped-improve-recovery-rate-of-health-care-pathogens/. Published June 18, 2016. Accessed February 16, 2021.

https://doi.org/10.1017/ice.2021.53 Published online by Cambridge University Press