



Original Research

Donning Gloves Before Surgical Gown Cross-contaminates the Assistant

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ABSTRACT

Background: Maintaining a sterile surgical environment is of the utmost importance in total joint arthroplasty. The surgical gown-glove interface is a frequent and known cause of bacterial contamination. A variation of the traditional staff-assisted open-gloving technique has been developed in an attempt to address this. In this method, the surgeon dons their undergloves before their gown. Although this has demonstrated improved sterility for the surgeon, no studies have considered the effects of this technique on the person assisting the surgeon. The present study was designed to investigate this. We hypothesize that the process of donning undergloves before the surgical gown leads to higher rates of contamination for the assistant.

Methods: We performed a comparative study between the traditional and a gloves-first scrubbing technique. We assessed the differences in gown and glove contamination of the surgical assistant following each scrubbing event. Two surgeons applied ultraviolet light-disclosing lotion to their upper extremities and then performed each method in a randomized order with 40 surgical technologists/nurses. Blinded evaluators then quantified the amount of contamination on the surgical assistant's gown and gloves.

Results: The gloves-first technique resulted in increased contamination of the surgical assistant's gloves ($P = .002$). There was no difference in contamination of the surgical gown ($P = .982$).

Conclusions: Although the staff-assisted open-gloving technique may improve the sterility of the surgeon, it does so at the expense of the surgical assistant. Surgeons adopting this technique should consider donning their own undergloves or having the assistant rescrub before any further contact with the sterile environment.

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Introduction

Prosthetic joint infections are a devastating complication of total joint arthroplasty and are associated with significant patient morbidity. For that reason, an entire industry of products and methods have been developed with the hope of minimizing them. One such area of focus has been the surgical gowning process, particularly the gown-glove interface [1–6].

Surgeons most commonly don their gown and gloves with the assistance of a staff member. After the gown has been placed on the

surgeon, they can enter the gloves via a closed or open technique. In the closed method, the surgeon's hand remains entirely within the cuff while the assistant places the glove over the enclosed hand. Subsequent adjustments are often necessary to maneuver the cuff into a comfortable position and to ensure the fingers are in the right location. In the open method, the fingers protrude through the end of the sleeve and are exposed. The assistant then stretches the glove open while the hand slides into the glove. Of these 2 methods, the closed technique results in less contamination than the open one [3], but the uncomfortable nature of the closed technique and need for adjustments have limited its adoption.

Recently, Byrd et al. reported that donning surgical undergloves before the surgical gown resulted in essentially zero contamination at the gown-glove interface [1]. In the conclusion of that paper, the authors strongly recommended the use of their gloves-first technique. We began to explore the implementation of this method at

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our institution, and we were met with significant resistance from our surgical assistants. The technique involves staff-assisted gloving of the surgeon's disinfected hands with the initial under-gloves, prior to donning the surgical gown. To achieve this, the scrubbing assistant must stretch the glove open for the surgeon's hand. Once the hand is fully seated in the glove, the assistant must let go of the glove. Releasing of the glove results in a variable amount of elastic recoil, and thus snapping of the glove against the surgeon's forearms. This prompted concern for the sterility of the scrubbing assistant's gloves, as their hands are in the same region of space of any liberated debris from the surgeon's forearms. This is of significant importance, as the scrubbing assistant aids subsequent members of the team in the donning procedure, and they are also in frequent contact with the surgical instruments. Thus, the purpose of this study was to evaluate the risk of contamination of the scrubbing assistant's gloves and gown with the gloves-first vs the standard gown-first open-gloving technique.

Material and methods

Institutional review board approval was obtained prior to the start of the study. Forty certified surgical assistants and 2 board-certified orthopedic surgeons were recruited to participate. The surgical assistants were a combination of surgical technologists and surgical scrub nurses. The assistants were from a broad range of surgical specialties, and their familiarity with the methods was variable. We did not specifically ask whether they were or were not experienced at both techniques. Each surgeon performed both the gloves-first and gown-first scrubbing procedures with every surgical assistant in a randomized order, for a total of 80 scrubbing events. In the gown-first method, the gloves were donned via an open-gloving technique. For the gloves-first method, the surgical assistant helped the surgeon, who was not yet gowned, don gloves. The right hand was always gloved first regardless of method. We used ultraviolet (UV) lotion (GlitterBug UV disclosing lotion, Brevis Corporation, Salt Lake City, UT) on the surgeon's upper extremities and a black light (Phillips, Amsterdam, Netherlands) to evaluate the assistant's gown and gloves for contamination.

Evaluation of the surgical assistant's gloves was performed by 2 blinded inspectors who remained in a closed, dark room. Using clean gowns and gloves for each scrubbing event, the surgical assistants used their normal method of self-gowning and gloving. They then entered the dark room where the inspectors analyzed the gown and glove to ensure that the surgical assistant did not introduce any contamination as part of their own donning process.

Each surgeon, after lathering their hands and arms in 4 cc of UV lotion, then performed either the gloves-first or the gown-first open-gloving method. The order in which the 2 scrubbing methods were done was randomized. The surgical assistant was then led into the adjacent dark room where the 2 blinded inspectors were waiting. Using UV lights, the inspectors then examined the surgical assistant's gloves and gown for signs of UV lotion contamination. The number of fluorescing specks were counted and recorded (Fig. 1). The surgical assistant then left the room, removed the gown and gloves, and repeated the method with the alternative technique.

Statistical methods

The counts of specks on gowns or gloves were treated as continuous, non-normally distributed data. Summary data are presented as mean \pm 95% confidence interval (CI). Comparisons between study groups were by Wilcoxon signed rank test, with $P < .05$ set as detecting a statistically significant difference. Given that the right hand was always gloved first, the data were also analyzed for possible side-to-side differences. Initial analysis of the



Figure 1. A surgical technologist's contaminated glove after assisting a surgeon. The fluorescing contamination reveals itself as small specks in the ultraviolet light.

data demonstrated that there were no left-right differences in the number of specks on either the gloves (left = 3.51 [95% CI 1.30-5.73] vs right = 2.30 [95% CI 1.03-3.57], $P = .14$) or gowns (left = 0.11 [95% CI 0.004-0.18] vs right = 0.10 [95% CI 0.04-0.16], $P = 1.0$), so all subsequent analyses were performed using the pooled data from both sides. All statistics were calculated using SPSS (version 25, IBM Corp., Armonk, NY).

Results

Forty surgical assistants performed both the gloves-first and gown-first methods. Surgeon 1 completed the protocol with 18 of the assistants, and surgeon 2 completed it with the other 22. Thus, there were a total of 80 gowning and gloving events. Gown and glove contamination was independently recorded by the blinded inspectors for every gowning event.

Overall comparison of the 2 methods showed that the surgical assistant's gloves demonstrated significantly more contamination with the use of the gloves-first technique (gloves = 2.87 [1.63-4.11] vs 0.97 [0.6-1.35] for gown first, $P = .002$) (Table 1). There was no difference between the 2 methods when it came to contamination of the surgical assistant's gown (gloves first 0.09 [0.02-0.17] vs 0.09 [0.02-0.16] for gown first, $P = .982$).

To ensure that the difference in glove contamination was not entirely attributable to one surgeon, the distribution of glove contamination between the surgeons was compared directly. There was a difference in the amount of glove contamination (2.86 [95% CI 1.6-4.13] vs 1.0 [95% CI 0.65-1.35], $P = .001$) between the 2 surgeons. This difference between the 2 surgeons was further explored on a per-method basis. There was a significant difference in the surgical assistant's glove contamination between the gloves-first and gown-first methods for surgeon 1, which was less pronounced for surgeon 2 (Table 1).

Table 1
Contamination of the scrub assistant by the surgeon during gloving and gowning.

Method	Contamination of scrub assistant	
	Gloves ^a	Gown
Gloves first	2.87 (1.63–4.11)	0.09 (0.02 to 0.17)
Gown first	0.97 (0.6–1.35)	0.09 (0.02 to 0.16)
P value	.002	.982
Surgeon 1		
Gloves first	4.26 (1.93–6.59)	0.03 (–0.03 to 0.08)
Gown first	1.39 (.66–2.12)	0.11 (–0.02 to 0.25)
P value	.017	.276
Surgeon 2		
Gloves first	1.43 (0.78–2.09)	0.16 (0.01 to 0.31)
Gown first	0.63 (0.3–0.96)	0.07 (–0.01 to 0.15)
P value	.053	.383

^a Numbers are the mean (95% CI) of the number of fluorescent specks detected on either the gloves or gown sleeve of the scrub assistant.

Discussion

The results of our study demonstrate that when the surgeon's undergloves are donned first, the assisting staff member's own gloves are more contaminated than if the surgeon had performed the more commonly used open-gloving technique ($P = .002$). The scrubbing assistant is in frequent contact with the surgical tools and the personal protective equipment of all surgical team members. In that way, any contamination of their gloves can logically transfer to the entire team and ultimately the patient. This is an important consideration given recent support for the gloves-first method and a calling for "wide-spread implementation" [1].

The gown-glove interface is a significant problem and a continued source of intraoperative contamination. Variations on the traditional gowning process have proven incapable of eliminating the issue [4]. The newly reported gloves-first technique is a novel approach to the problem that has demonstrated superior levels of sterility for the surgeon in one study. With new solutions come new problems, and our study has identified a significant limitation of the gloves-first technique.

An interesting aspect of our results was that there was a difference for surgeon 1 between the methods but not for surgeon 2. We cannot say for certain the cause for this, but potential explanations could include arm length, width, glove-hand size mismatch, or perhaps purely just differences in technique. To address this, future studies would benefit from additional surgeon data.

Our study sought to match the methodology used by Byrd et al., and in doing so, we inherited the limitations of the study design [1]. Notably, our study uses the transfer of UV lotion from the surgeon's arms to the assistant's personal protective equipment as a surrogate for the transfer of infectious organisms. Surgeons use a wide variety of products to sterilize their hands, and each one has

variable bactericidal properties, residue, and ability to be aerosolized. The fact that UV lotion was transferred from the surgeon's forearms to the assistant's gloves does not formally mean that this transfer would also occur with modern sterilizing lotions or traditional soap and water. Furthermore, although the transfer of UV lotion identifies instances where contamination did occur, it does not say anything about the actual infectious risk that the transfer may carry. Similarly, the extent to which fluorescing material enhances our ability to detect contamination is ultimately limited, and there could be additional contamination at a level beyond our ability to detect. Ultimately, it would take a large, randomized controlled clinical trial of the methods to formally capture the entire risk profile associated with each technique.

Conclusions

Although the gloves-first technique may result in a more sterile setup for the surgeon, it does so at the expense of increasing contamination of the scrubbing assistant. The sterility of all members on the surgical team is paramount in avoiding surgical infections, particularly in arthroplasty. Until this technique is revised to properly address the contamination introduced to other members on the surgical team, we cannot advocate for its widespread adoption and would strongly recommend that institutions in favor of it require the assistant to rescrub or change gloves after assisting someone with this technique.

Conflicts of interest

J. D. Michelson is in the editorial or governing board of the *Journal of Orthopaedic Trauma*. N. J. Nelms is an editorial board member of *Arthroplasty Today* and is an AAOS Knee Program Evaluation Committee member. A. Sundet has no potential conflicts of interest to disclose.

For full disclosure statements refer to [doi:10.1016/j.artd.2022.08.009](https://doi.org/10.1016/j.artd.2022.08.009).

References

- [1] Byrd WA, Kavolus JJ, Penrose CT, Wellman SS. Donning gloves before surgical gown eliminates sleeve contamination. *J Arthroplasty* 2019;34:1184.
- [2] Fraser JF, Young SW, Valentine KA, Probst NE, Spangehl MJ. The gown-glove interface is a source of contamination: a comparative study. *Clin Orthop Relat Res* 2015;473:2291.
- [3] Jones C, Brooker B, Genon M. Comparison of open and closed staff-assisted glove donning on the nature of surgical glove cuff contamination. *ANZ J Surg* 2010;80:174.
- [4] Newman JB, Bullock M, Goyal R. Comparison of glove donning techniques for the likelihood of gown contamination. An infection control study. *Acta Orthop Belg* 2007;73:765.
- [5] Roth RA, Whitbourne J. The potential for contamination: a pilot study of open and closed surgical gloving. *AORN J* 1982;36:571.
- [6] Ward WG, Cooper JM, Lippert D, Kablawi RO, Neiberg RH, Sherertz RJ. Glove and gown effects on intraoperative bacterial contamination. *Ann Surg* 2014;259:591.