

Donning gloves before patient contact, with or without prior hand hygiene

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Abstract

Objective: Hand hygiene (HH) is a fundamental infection prevention measure in healthcare settings, playing a crucial role in reducing healthcare-associated infections (HAIs). Despite its importance, HH compliance remains suboptimal worldwide. A common error is omitting HH before donning gloves, specifically during WHO Moment 1 ("Before touching a patient"). This study investigates bacterial contamination associated with direct gloving and its potential implications for infection control.

Methods: A randomized controlled trial included nurses and doctors preparing to touch patients in the pediatric cardiovascular surgery intensive care unit. Participants were divided into two groups: (1) "HH prior to gloving" (HH performed before donning gloves) and (2) "direct gloving" (no HH before gloves). For each group, 129 samples were collected. Bacterial counts on gloved hands were compared between groups and against bare hands.

Results: The total bacterial colony counts on gloved hands were similar between the HH prior to gloving group and the direct gloving group ($p = 0.559$). However, bacterial colony counts on gloved hands in both groups were significantly lower compared to bare hands ($p = 0.0001$, $p = 0.0001$).

Conclusions: Direct gloving did not increase bacterial contamination on gloves relative to HH before gloving. However, given the established benefits of HH in broader infection control practices, further research is needed to assess the impact of both or separate HH and gloving techniques across different clinical settings.

Key words: CFU; alcohol-based hand sanitizer; gloving; hand hygiene.

J Infect Dev Ctries 2026; 20(5):750-754. doi:10.3855/jidc.22190

(Received 06 August 2025 – Accepted 28 October 2025)

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Background

Healthcare-associated infections (HAIs) represent a significant global concern, contributing to prolonged hospital stays, increased morbidity and mortality rates, and rising healthcare costs. Hand hygiene (HH) is the cornerstone of infection prevention in healthcare settings and is recognized as one of the most critical measures to reduce HAIs [1]. However, despite its importance, global HH compliance remains suboptimal. Studies have reported an average HH compliance rate of 59.6%, with significant variations based on geographic region (64.5% in high-income countries vs. 9.1% in low-income countries), type of intensive care unit (ICU) (67.0% in neonatal ICUs, 41.2% in pediatric ICUs, and 58.2% in adult ICUs), and healthcare worker role (HCW) (43.4% among nursing staff, 32.6% among physicians, and 53.8% among other staff) [2].

In 2009, the World Health Organization (WHO) introduced the "5 Moments for Hand Hygiene" model to enhance infection control in healthcare settings. The WHO's 2009 guidelines state that "glove use does not modify hand hygiene indications or replace hand

hygiene", emphasizing that the use of gloves does not eliminate the need for hand hygiene, whether through hand rubbing or handwashing [3,4]. However, in daily practice, one of the most frequently observed errors in hand hygiene compliance is the failure to perform hand hygiene before donning gloves and subsequently contacting patients [1,2,5,6]. Healthcare workers (HCWs) often equate glove use with hand hygiene, leading to the misconception that wearing gloves alone is sufficient to prevent infection transmission [1,2]. On the other hand, neither the Centers for Disease Control and Prevention (CDC) nor the WHO explicitly states that donning nonsterile gloves constitutes an indication for HH. Nevertheless, glove use is frequently associated with Moment 1 of the WHO's "5 Moments for Hand Hygiene" and the CDC's recommendation for hand hygiene prior to patient contact [1]. The SHEA/IDSA/APIC Practice Recommendations also highlight this issue, suggesting that infection preventionists and hospital epidemiologists should evaluate the potential impact of direct gloving (donning gloves without prior hand hygiene) on patient and HCW safety to determine its compliance with facility policies

[1]. The evidence regarding whether performing hand hygiene before donning gloves offers significant advantages over direct gloving remains limited and insufficiently explored in the existing literature. A small number of studies have demonstrated that the microbial counts on gloves are similar regardless of whether hand hygiene is performed prior to gloving or gloves are donned directly without prior hand hygiene [7-9]. This suggests that the practice of direct gloving may not significantly increase the risk of microbial contamination compared to gloving after hand hygiene, highlighting the need for further research to clarify the clinical implications of these findings and to establish evidence-based guidelines for glove use in healthcare settings.

This study aims to investigate the bacterial contamination of gloves associated with direct gloving, with a specific focus on its impact in the context of WHO's Moment 1 (before touching a patient).

Methods

This prospective study was conducted in the Pediatric Cardiovascular Surgery Intensive Care Unit at Ankara City Hospital over a four-week period between May 6, 2025, and June 6, 2025. This intensive care unit has six beds and is dedicated to the postoperative follow-up of patients who have undergone cardiovascular surgery.

In this study, the focus was on the first moment of the WHO's "5 Moments of Hand Hygiene," specifically "before touching a patient" [3]. Healthcare workers (nurses or doctors) preparing to touch a patient were included in the study. Participants were randomized into two groups: the "hand hygiene (HH) prior to gloving" group and the "direct gloving" group. In the HH prior to gloving group, participants first performed hand antisepsis using the hospital's alcohol-based hand sanitizer containing 65% ethyl alcohol, allowed their hands to dry, and then donned non-sterile gloves. In the direct gloving group, participants donned non-sterile gloves without performing hand hygiene beforehand.

In the direct gloving group, a culture was taken from the bare dominant hand before starting the gloving process, while in the HH prior to gloving group, a culture was taken before beginning hand antisepsis. In both groups, a culture was taken from the dominant hand after the gloving process was completed. For the culture collection process, a 50 mL Tryptic Soy Broth (ConDALab, Spain) in a sterile container was used. Participants immersed all fingers of their dominant hand into 50 mL of Tryptic Soy Broth solution, rubbing them inside the solution. Then they took their fingers

out of the broth, rubbed them against their palms, put their fingers back into the broth, and rubbed them one last time to complete the process. This procedure lasted 20 seconds.

The time taken to complete the donning of gloves was recorded. In the HH prior to the gloving group, the time was measured starting from the beginning of hand rubbing. Healthcare workers who performed hand hygiene immediately before randomization were not included in the study. Ethical approval was obtained from Ankara City Hospital local ethics committee (Approval number and date: TABED 1-25-962/7 May 2025).

Microbiology

After the 50 mL Tryptic Soy Broth samples were delivered to the laboratory, 0.01 mL was taken from each sample and inoculated onto 5% sheep blood agar and Eosin Methylene Blue (EMB) agar plates. All plates were incubated at 37°C for 18-24 hours. After incubation, colony counts were performed, taking into account all growth regardless of bacterial type. The total bacterial colony count was determined by quantifying all growth in colony-forming units per milliliter (CFU/mL). The microorganisms that grew were identified using conventional methods such as Gram staining, catalase, and coagulase tests. The total bacterial count on gloved hands was compared between both groups and also against bare hands.

Statistics

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The normality of data distribution was assessed using the Shapiro-Wilk test. Data that did not follow a normal distribution were presented as median (interquartile range, IQR). For statistical analyses, the Mann-Whitney U test was used for comparisons between two groups. A $p < 0.05$ was considered statistically significant.

Results

A total of 129 samples were collected for both the HH prior to gloving group and the direct gloving group. In the HH prior to gloving group, the total bacterial colony count of bare hands was a median of 1000 CFUs (IQR 400–3000), and the total bacterial colony count in gloved hands was 0 CFUs (IQR 0–0). The total bacterial colony count of the gloved hand was significantly lower compared to bare hand samples ($p = 0.0001$).

In the direct gloving group, the total bacterial colony count of bare hands was a median of 1100 CFUs

(IQR 400-3000), while the total bacterial colony count for gloved hands was 0 CFUs (IQR 0-0). The colony count for the direct gloving group was significantly lower compared to bare hand samples ($p = 0.0001$). The total bacterial colony counts on the gloved hands were similar between the HH prior to gloving group and the direct gloving group ($p = 0.559$) (Figure 1).

No pathogenic organisms other than *Staphylococcus aureus* were detected. *S. aureus* was identified in a total of 10 bare-hand samples. In gloved samples, irrespective of whether hand hygiene was performed, no *S. aureus* growth was observed. All identified organisms belonged to the transient flora, including alpha-hemolytic *Streptococcus*, diphtheroid bacilli, and coagulase-negative *Staphylococcus*.

The time elapsed until gloving differed significantly between the two groups ($p = 0.0001$). In the direct gloving group, the median time was 25 seconds (IQR 17–35 seconds), while in the HH prior to gloving group, it was 70 seconds (IQR 60–83 seconds).

Discussion

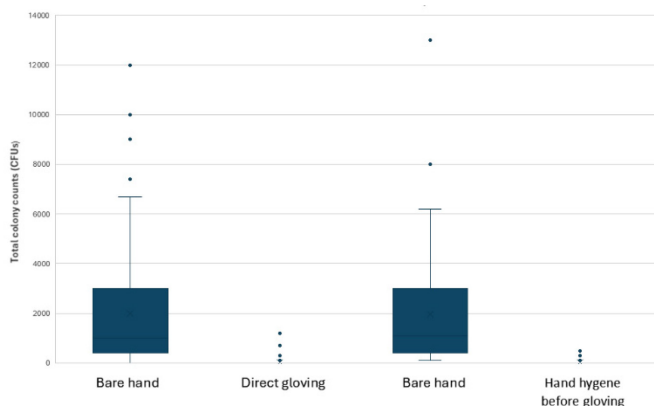
In this study, gloved hands demonstrated significantly lower median CFU (colony-forming unit) counts compared to bare hands before patient contact, regardless of whether hand antisepsis was performed prior to donning gloves. In the direct gloving group, the time taken to complete the donning of gloves was significantly shorter.

A study comparing bacterial density on gloves between direct gloving and hand hygiene prior to gloving demonstrated that there was no significant difference in the mean CFU counts on gloved hands between the two groups. The majority of bacteria detected on the gloves, regardless of whether hand hygiene was performed prior to gloving, were identified

as transient flora rather than pathogenic bacteria, such as coagulase-negative staphylococci [7]. In another study, pathogens were identified in 4% of the 1,194 samples taken from individuals who practiced direct gloving, whereas pathogens were detected in 2% of the 1,189 samples taken from those who performed hand hygiene before donning gloves [9]. The results of the current study align with these findings, indicating no notable difference in CFU count on gloves between the direct gloving group and HH prior to gloving group. This consistency across studies suggests that the practice of hand hygiene prior to gloving may not provide a substantial benefit in reducing bacterial contamination on gloves. This raises questions about the necessity of HH as a mandatory step before glove use in certain contexts. Evidence in this area is limited, and to provide recommendations on circumstances where gloves may be donned without prior hand hygiene, there is a need for qualitative studies exploring the daily practices of HCWs and other healthcare professionals. Understanding the perceptions and beliefs of those working in this field regarding glove use and associated hand hygiene may yield valuable insights and ultimately contribute to improved practice.

In a study conducted in a trauma resuscitation setting, HCWs demonstrated compliance with the WHO hand hygiene standards in only 7% of hand hygiene opportunities. HCWs donned and removed gloves without performing any hand hygiene in 51% of cases according to WHO guidance for HH opportunities. The authors observed that HCWs frequently donned and removed gloves instead of performing hand hygiene as per WHO guidance, effectively substituting glove use for hand hygiene. When the authors expanded the definition of hand hygiene compliance to include either hand hygiene or glove use, compliance rates increased from 7% to 57% [2]. In a randomized controlled trial involving 13 hospital units and 3,790 observed HCWs, 47% of HCWs were observed donning gloves directly without performing hand hygiene. The emergency department had the lowest rate of hand hygiene before gloving, with compliance as low as 8%. In intervention settings where direct gloving was accepted as a hand hygiene method, adherence to expected practice was significantly higher in direct-gloving units (87%) compared to units requiring hand hygiene before gloving (41%) [9]. Both studies concluded that direct gloving—donning gloves without prior hand hygiene—is a common practice among HCWs, who often substitute direct gloving for hand hygiene. The results of this study demonstrate that this common behavior among healthcare workers does

Figure 1. The total bacterial colony counts of bare hand and gloved samples, in the direct gloving and hand hygiene, before gloving groups.



not increase the bacterial CFU count on gloves, providing a reassuring finding for the infection control committee. This suggests that direct gloving does not elevate the risk of infection and that healthcare workers' practices may align with infection control standards. The study also revealed a substantial time reduction with the direct gloving technique (25 seconds vs. 75 seconds), significantly streamlining the workflow for healthcare workers. This considerable time efficiency likely explains the underlying reason for healthcare workers' common practice of omitting hand hygiene before gloving. As a limitation, the study did not evaluate cost implications, leaving this aspect for future research.

Healthcare workers often find performing hand hygiene before donning gloves cumbersome. The direct-gloving strategy is perceived by HCWs as beneficial in several ways, including improved time and cost efficiency, reduced skin irritation, better adherence to hand hygiene expectations, and enhanced staff satisfaction [7,9]. One study reported that HCWs who performed hand hygiene before donning nonsterile gloves took an additional 31.5 seconds per episode compared to those who put on gloves directly [7]. In the current study, a similar time difference was observed. After hand hygiene, hands must dry completely, as wearing gloves on damp hands can be challenging. These findings highlight the need for balanced strategies that maintain infection control standards while addressing the practical challenges HCWs face in their workflow.

According to standard precautions, personal protective equipment (PPE), including gloves, should be used during any procedure where there is an anticipated risk of direct contact with blood or body fluids. However, many studies have shown that gloves are often used even in situations where there is no exposure to body fluids, and it is frequently observed that hand hygiene is not performed after glove removal, gloves are not changed, and the use of gloves diminishes the trigger for hand hygiene, thereby weakening the principles of the 5 Moments for Hand Hygiene [6,7,10,11]. Therefore, HCWs do not contaminate gloves through direct gloving is not sufficient; it is equally important for HCWs to use gloves for correct indication, remove gloves at the appropriate time, and ensure proper hand hygiene.

Study limitations and generalizability of our findings: One limitation of this study is that it was conducted in a single unit. The pediatric cardiovascular intensive care unit (CVC ICU) is typically a unit with high compliance rates for hand hygiene. Results may

differ in units where hand hygiene compliance is lower. For instance, one study found that direct gloving had a protective effect on CFU counts in a pediatric unit, while in the emergency department, the direct gloving group showed a higher prevalence of pathogenic bacteria and significantly higher total CFU counts [9]. The difference between various units may be related to the level of care taken to avoid contamination while donning gloves. To consider direct gloving as a safe practice, the post-contact process is crucial. Healthcare workers who perform direct gloving must remove their gloves and perform hand hygiene after patient contact. The lack of observation regarding this step is another limitation of our study. The inappropriate behavioral shift observed among HCWs, involving the frequent use of gloves instead of hand hygiene, necessitates an analysis of the significant procurement costs associated with maintaining high-volume glove inventories. Additionally, glove use contributes significantly to plastic medical waste generation. Increased glove usage rates will undoubtedly have a negative impact on medical waste production. However, this study does not provide data pertaining to these costs and environmental concerns.

Conclusions

In conclusion, donning gloves without performing hand hygiene before patient contact may be considered an acceptable alternative to hand hygiene in certain situations. However, further quantitative and qualitative studies are needed across different settings, such as emergency departments, to better understand the impact of direct gloving on infection control.

Authors' contributions

G.İ.B: Conceptualization, Methodology, Writing – Original Draft, Supervision; C.A.A: Data Collection, Formal Analysis, Writing – Review & Editing; N.C.: Investigation, Resources, Visualization, Project Administration

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Conflict of interest

No conflict of interest is declared.

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