# Use of medical gloves during wound care: blessing or curse?

KEY WORDS
- Antimicrobial practices
- Bacterial contamination
- Cross-contamination
- Medical glove
- PHMB

**Introduction:** Medical gloves are routinely used to prevent the spread of microorganisms between patients, health care workers and their environment. However, when used incorrectly, they can also increase the dissemination of pathogens. Antibacterial medical gloves coated in polyhexamethylene-biguanide hydrochloride (PHMB) show reduced bacterial contamination after clinical use, but whether they can also reduce cross-contamination of surrounding surfaces is not known. **Objective:** The primary objective of this study was to investigate the effect of antibacterial medical gloves on bacterial transmission to commonly touched surface areas. **Methods:** This study was performed in an outpatient wound care room in the Hospital Neunkirchen, Austria. A chicken breast was inoculated with a *Staphylococcus aureus* reference strain (ATCC 6538). After 30-minute incubation time, the skin was touched wearing a non-antibacterial glove, which then touched surrounding surface areas (another, non-contaminated, chicken breast; a computer keyboard and a window curtain). After 10 repetitions, the entire procedure was repeated using an antibacterial glove. Contact time was 40 seconds for each touch. **Results:** Antibacterial gloves significantly reduced the number of bacterial colonies forming units (cfu) on every surface area tested ($p$<0.05, two-sided Mann–Whitney U test) from a mean of 5.6 $\log_{10}$ bacteria to a mean of 4.2 $\log_{10}$ bacteria. **Conclusion:** Antimicrobial gloves reduce bacterial cross-contaminations of surface areas in a real hospital surroundings and could prove valuable in the reduction of microbial transmission in patient care. However, they do not prevent bacterial transfer completely and, thus, cannot replace proper glove technique and hand hygiene.

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Medical gloves are disposable gloves used during medical examinations and procedures that help prevent cross-contamination between healthcare workers and patients. During patient care, intact medical gloves act as a physical barrier against the transmission of microorganisms from the patient to the healthcare worker. However, incorrect use of medical gloves may support the transmission of microorganisms due to unintended contamination of surrounding surfaces.

During patient care, prevention or reduction of bacterial dissemination from gloved hands to other surfaces or other individuals will be achieved only if medical gloves are used correctly. A medical examination glove is used correctly if it is donned on hands before manipulation of innate or viable surfaces, which are anticipated to harbour pathogenic microorganisms in high numbers. Such situations typically occur when mucous membranes or wounds are touched, or during all patient-care activities involving exposure to blood or body fluids that may be contaminated with blood. Additionally, medical gloves shall be worn during outbreak situations for all direct patient care activities, e.g. during outbreaks at neonatal intensive care units. Immediately after the required manipulation, and before any other surface in the surrounding is touched, the contaminated medical glove must be taken off from hands, and hand antisepsis must be performed. The use of a medical glove, non-sterile or sterile, is not a substitute for hand hygiene.

However, strict adherence to the above procedure requires knowledge on bacterial transmission, training, great attention, and a high level of concentration during clinical work. It was highlighted by the World Health Organization (WHO, 2009) that the broad scope of these recommendations for medical glove use, together with the significant increase of usage frequency, potentially lead to inevitable, undesirable consequences, such as the misuse and the overuse of gloves, resulting in bacterial dissemination to the surrounding environment and contamination of surfaces in close contact to other patients.

Indeed, inappropriate use of medical gloves is common in all healthcare facilities worldwide, and medical staff often fail to remove medical gloves between patients or between contacts with various sites on a single patient or the adjacent environment, thus potentially facilitating the spread of microorganisms to the surrounding. Loveday et al (2014) investigated how various healthcare disciplines use gloves. The authors found that appropriate glove use was observed in only 42% of occasions. This deviation from recommended glove use practice increases transmission risks associated with ongoing poor hand hygiene compliance globally and inadequate and infrequent cleaning of high-touch objects as reported in several countries (Carling and Huang, 2006; Carling et al, 2006). These factors create favourable conditions for transmission of potentially pathogenic microorganisms via gloved healthcare workers' hands on contaminated surfaces.

Recently, Pineles et al (2017) demonstrated that transmission of methicillin-resistant *Staphylococcus aureus* (MRSA) from colonised residents to gloves occurred in 20% of care activities, including changing dressings. The authors concluded, "Optimising [...] glove use by targeting high-risk care activities could improve resident-centred care for MRSA-colonised residents by promoting a home-like environment." However, the authors did not elaborate on how to optimise glove use during dressing change in elderly patients.

Previously, it was demonstrated that use of antibacterial medical gloves coated with polyhexamethylene-biguanide hydrochloride (PHMB) on the external surface significantly reduced bacterial contamination of worn gloves after typical patient care activities in a clinical setting (Kahar Bador et al, 2015). While these findings suggested that the use of antibacterial medical gloves might also support reduction of cross-contamination during wound care, this previous study did not provide data on the reduction of contamination in the environment of patients with chronic wounds.

Therefore, the objective of this study was to investigate if a significant reduction in the numbers of bacteria on commonly touched surfaces in a wound care outpatient setting are measurable when using antimicrobial medical gloves compared to identical non-antibacterial control gloves during wound care.

## METHOD

We conducted an experimental study in a real outpatient wound care room at the Hospital Neunkirchen, Austria. The Hospital Neunkirchen is a 400-bed secondary healthcare care facility located 75 km south of Vienna, the capital of Austria. The room contained a patient stretcher with disposable paper underlay, monitors for vital parameters, a movable table for instruments, and a table for PC and documentation. The room also contains a hand-washing sink with soap and alcohol-based hand rub. The windows are equipped with fabric curtains.

### Experimental setting

A *S. aureus* reference strain (ATCC 6538) was used for all experiments and processes as described previously (Assadian et al, 2018). One 140 g fresh and unfrozen chicken breast with skin but without feathers was inoculated with 5.0 mL of the bacterial stock solution suspension. The contaminated chicken breast was then held for 30 minutes at room temperature to facilitate attachment of the test strain. The colonised chicken breast was touched with all five fingers of a hand wearing the non-antibacterial control glove (Micro-Touch Denta-Glove White Nitrile, Ansell Ltd, Australia) for an average of 40 seconds. Thereafter, test surfaces were touched for another 40 seconds. The whole procedure was repeated 10 times. Finally, the identical procedure was repeated with the antibacterial intervention glove (Gammex Nitrile Antibacterial*, Ansell Ltd, Australia; glove not yet available on the market).

**Table 1. Comparison of control (non-antimicrobial) and intervention (antimicrobial) gloves. $Log_{10}$ difference from initial inoculum to test surface**

| Transfer from skin to test surface | Initial inoculum | Control glove $log_{10}$ difference ± SD | Intervention glove $log_{10}$ difference ± SD | *p*-value |
|---|---|---|---|---|
| Skin to skin | 7.13 | 1.07 ± 0.15 | 2.74 ± 0.39 | 0.023 |
| Skin to plastic | 7.36 | 1.64 ± 0.48 | 3.20 ± 0.68 | 0.046 |
| Skin to fabric | 7.38 | 1.42 ± 0.34 | 3.36 ± 0.65 | 0.027 |

Target surfaces were sampled using swabs (FLOQSwab, COPAN; Brescia, Italy). Swabs were rotated (10 turns) in eSwab liquid Amies preservation medium (COPAN, Brescia, Italy, ref. 490CE.A). Colony-forming unit (cfu) were then counted by 10-fold serial dilution steps and plating of 200 µl aliquots onto Columbia agar supplemented with 5% sheep blood (Becton Dickinson, Heidelberg, Germany).

### Environmental sample sites

In order to address different conditions and surface texture materials, three environmental sampling sites with potentially high touch frequencies were selected:

- Skin: Non-contaminated fresh and unfrozen chicken breasts with skin and no feathers to simulate contamination of skin
- Plastic: One computer keypad key to simulate contamination of plastic material
- Fabric: Window curtain to simulate contamination of fabric.

These sample sites were selected because of their high frequency of contact with healthcare workers' hands (approximately five contacts per hour) and the assumed high rate of bacterial re-colonisation as a consequence of routine clinical care.

### Primary objective and outcome measures

a) Number of bacterial cfu per sampled surface after simulated patient care in the intervention arm (after wearing an antimicrobial medical glove)
b) Number of bacterial cfu per sampled surface after simulated patient care procedures in the control arm (after wearing a non-antimicrobial medical glove)
c) Statistical significant difference in the number of bacterial cfu between the two study arms.

### Statistical analysis

Mean $log_{10}$ cfu counts were tested for a statistically significant difference using the two-sided Mann–Whitney U test. The confidence level was set at 95%, and a *p*-value of <0.05 indicated a statistically significant difference in the post-values of the yielded numbers of test organisms between the control and the intervention glove.

### Ethics committee approval

Since no specimens or personal identifiable biometric information was collected from the participants, this experimental study did not require ethical committee approval.

## RESULTS

*Table 1* summarises the results for the mean $log_{10}$ cfu recovery of *S. aureus* (ATCC 6538) after 40 seconds contact time of the antibacterial intervention and the non-antibacterial control gloves. The contaminated standard non-antibacterial glove transferred a mean of 5.9 $log_{10}$ bacteria from skin to various surfaces, while the antibacterial glove transferred a mean of 4.2 $log_{10}$ bacteria. In other words, if contaminated skin with 10 million bacteria is touched by a glove, a conventional non-antibacterial glove will transfer 1 million bacteria to consecutively touched surfaces, while an antibacterial glove will transfer 20000 bacteria to further surfaces.

There was a difference between bacteria transmission and surface materials for the antibacterial glove, but not for the non-antibacterial glove. The lowest transmission was observed for fabrics followed by plastic surfaces, while transfer to a second skin showed lower antibacterial efficacy, although not to a significant level.

## DISCUSSION

This preliminary pilot study demonstrated that an antibacterial examination glove transferred fewer bacteria from highly contaminated skin to secondary surfaces than a non-antibacterial glove. The difference was in the magnitude of 1.7 $\log_{10}$ or 50 times fewer bacteria transferred to the surrounding.

It is important to note that neither of the control or intervention gloves prevented bacterial transfer completely. Therefore, it is imperative to highlight the importance of hand hygiene, use of no-touch techniques wherever possible, and intelligent control of hand movement and touch during patient care.

Maintaining good infection prevention and control practices in a clinic can be challenging often due to lack of time or correct equipment, and sometimes due to inadequate education or habitual behaviours.

There are some concerns that an antibacterial gloves coated with an antibacterial compound may distribute chemicals to the environment or patients' wounds. Certainly, antimicrobial use without a justifiable benefit must not be advocated. However, in situations where the benefit outweighs the risks, antimicrobial use can be considered, provided that an active antimicrobial compound with favourable environmental and toxic properties is used.

PHMB is a moderately fast-acting biguanide biocide, which has been found to be effective in vitro and in clinical studies against a broad spectrum of microorganisms. PHMB interacts with acidic, negatively charged phospholipids in bacterial membranes, leading to an increased fluidity, permeability, and loss of membrane integrity followed by the death of microorganisms (Ikeda et al, 1984; Yasuda et al, 2003; Gilbert and Moore, 2005; Gabriel et al, 2007). The maximum antimicrobial activity occurs between pH 5–6 (Broxton et al, 1984). Neutral phospholipids such as those in human cells are little or not affected by PHMB (Broxton et al, 1983). This explains the low toxicity of PHMB against human cells. Therefore, PHMB is one of the best-tolerated antiseptics when used topically on skin, mucous membranes or wounds.

## CONCLUSION

In conclusion, the use of antibacterial medical gloves may be a novel strategy to prevent or reduce cross-contamination and hence indirect transmission of microorganisms during wound care. However, such a tactic must not be used as a substitute for good hand hygiene and maintenance of good infection prevention and control rules. WUK

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