

Providing care to patients in contact isolation: is the systematic use of gloves still indicated?

Cristina Bellini^{a*}, Marcus Eder^{b*}, Laurence Senn^{bc}, Rami Sommerstein^{bd}, Danielle Vuichard-Gysin^{be}, Yvonne Schmiedel^{bf}, Matthias Schlegel^{bg}, Stephan Harbarth^{bh}, Nicolas Troillet^{ab}

^a Service of Infectious Diseases, Central Institute, Valais Hospital, Sion, Switzerland

^b National Centre for Infection Control, Swissnoso, Bern, Switzerland

^c Service of Hospital Preventive Medicine, Department of Medicine, Lausanne University Hospital and University of Lausanne, Switzerland

^d Infectious Diseases and Hospital Epidemiology, Hirslanden Central Switzerland, Lucerne, Switzerland

^e Infectious Diseases and Hospital Epidemiology, Spital Thurgau AG, Münsterlingen, Switzerland

^f Infectious Diseases and Hospital Epidemiology, Hôpital du Jura, Delémont

^g Department of Infectious Diseases and Hospital Epidemiology, Cantonal Hospital St Gallen, Switzerland

^h Infection Control Programme and WHO Collaborating Centre on Patient Safety, University of Geneva Hospitals and Faculty of Medicine, Geneva, Switzerland

* Shared first authorship

Summary

This article reviews the available evidence on the effectiveness of gloves in preventing infection during care provided to patients under contact precautions, and analyses the risks and benefits of their systematic use. Although hand hygiene with alcohol-based handrub was shown to be effective in preventing nosocomial infections, many publications put the effectiveness and usefulness of gloves into perspective. Instead, literature and various unpublished experiences point towards reduced hand hygiene compliance and increased risk of spreading pathogens with routine glove use. Therefore, hospitals should emphasise hand hygiene in their healthcare staff and, instead of the routine use of gloves when caring for patients under contact precautions, limit their use to the indications of standard precautions, i.e., mainly for contact with body fluids. Wide and easy access to alcohol-based handrub and continual teaching are essential. If such conditions are met and adherence to hand hygiene is excellent and regularly assessed, the routine use of gloves for patients under contact precautions seems no longer indicated.

Introduction

Gloves are used by healthcare workers to reduce risks from blood-related accidents and during any activity involving a risk of hand contamination to prevent the spread of microorganisms in the environment and their transmission to patients. [1, 2]. Although it is often pointed out that gloves are no substitute for hand hygiene, they can create a false sense of security that encourages their inappropriate use and, paradoxically, a decrease in hand hygiene compliance and an increase in the risks they are supposed to prevent [3–7]. This article reviews the existing literature and analyses the rationale for routine glove use during con-

tact precautions now that hand hygiene in healthcare institutions is facilitated by widespread access to alcohol-based handrubs.

Research articles presenting data on controlling the spread of multidrug-resistant organisms (MDROs), such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), multi-resistant *Pseudomonas aeruginosa*, and *Acinetobacter* spp.) were identified through an electronic literature search using MedLine (National Library of Medicine Bethesda, MD), Google Scholar, and the Cochrane database, and by reviewing the references of retrieved articles. Index search terms included: gloves, personal protective equipment, protective clothing, hand hygiene, alcohol-based handrub, standard precautions, contact precautions, patient isolation, guidelines, outbreak, cluster, infection control, infection prevention, MRSA, VRE, *Pseudomonas*, *Acinetobacter*, MDRO, drug-resistant, cross-infection, cross-transmission, disinfection, reuse.

From Semmelweis to 2022: introduction of gloves as an additional layer of protection

A link between hand hygiene and disease transmission was identified in the 19th century by Ignaz Semmelweis, a pioneer in infection prevention, who recommended hand washing with calcium hypochlorite [2]. At that time, water-proof gloves were not available. The first written recommendations on the management of contagious patients date back to 1877 when they were mentioned in a "Hospital Manual", which recommended the cohorting of such patients in separate buildings [8]. However, because patients with various infectious diseases were not separated from each other, nosocomial transmission was not prevented. In 1910, American hospitals reorganised their isolation practices and introduced measures called "barrier nursing". They recommended wearing a gown and hand

Correspondence:

Marcus Eder, MD
Swissnoso, National Centre
for Infection Control
Sulgeneckstrasse 35
CH-3007 Bern
marcus.eder[at]swiss-
noso.ch

washing with antiseptic solution after contact with a contagious patient [9]. Isolation practices evolved over subsequent decades by specifying the type of measures to be taken, according to infectious pathology and clinical presentation, emphasising decision-making by users [8].

In 1985, as part of the response to the human immunodeficiency virus (HIV) epidemic, the US Centers for Disease Control and Prevention (CDC) introduced the concept of "universal precautions" for potential blood and body fluid contacts. These precautions essentially included the wearing of gloves and hand hygiene for the contact with any patient, regardless of infection status [8], focussing on the prevention of infection in caregivers, at the expense of any specific risk (e.g., the transmission of viruses or multidrug-resistant organisms) for the patient.

In 1996, the CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) published a revision of these guidelines, now known as "standard precautions". Hand hygiene by washing with antimicrobial soap was recommended. The use of a hand disinfectant was reserved for specific situations, such as for the control of epidemics, hyper-endemic infections, or infections caused by multidrug-resistant organisms [8].

At the end of the 20th century, Manfred Rotter already described the superiority of hand disinfection products [10], but it was only in 2002, following the publications of Didier Pittet and colleagues [11], who demonstrated hand hygiene by friction with an alcohol-based solution to effectively reduce healthcare-associated infections, that HICPAC defined friction with alcohol-based handrub as the "standard of care", reserving hand washing for specific situations [12]. In 2007, in light of growing scientific evidence, the "Geneva model" for hand hygiene was adopted by the World Health Organization (WHO) [13].

The American CDC's recommendations for the use of gloves when providing care have not changed since the publication of the 1996 guidelines. They are based on consensus rather than high-level evidence, since no studies directly compared the efficacy of standard precautions alone versus standard precautions plus contact precautions for the control of multidrug-resistant pathogens [2, 7, 14]. The use of gloves is recommended: (i) during procedures involving a risk of contact with blood or other body fluids to prevent risks for the healthcare worker; (ii) during invasive procedures and contact with mucous membranes or non-intact skin to prevent the risk of disease transmission to the patient and healthcare worker; and (iii) during any interaction with patients in contact isolation to prevent potential contamination of the healthcare worker's hands and thus pathogen transmission to other patients. The latter in-

dication implies the need for changing gloves between patients and to perform hand hygiene after glove removal [2, 15].

The recommendations of the European Centre for Disease Prevention and Control (ECDC) are in line with those of the CDC [16]. However, some countries, such as Germany [17] and France [18], no longer recommend the systematic use of gloves during contact precautions, but only as indicated under standard precautions and in cases of *Clostridioides difficile* infection or scabies (i.e., for all pathogens less, or not, respectively, sensitive to alcohol-based antiseptics, see also table 1). In recent years, several Swiss hospitals have adapted their practices accordingly.

A non-exhaustive list of situations requiring the use of (non-sterile) gloves according to standard precautions and examples of care situations for which gloves are not necessary are presented in table 2. Table 3 shows the indications for removing gloves, as recommended by the WHO [2].

Gloves to prevent hand contamination: a good barrier?

Several studies have shown gloves to reduce hand contamination by up to 70% when providing care to patients with multidrug-resistant organisms (MDROs), such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*. [19–24]. The same studies also revealed that gloves were contaminated between 50% and 70% of the time after touching the environment and/or the patient and that contamination was proportional to the duration of care [19, 20, 23]. In addition, between 5% and 29% of hands showed residual contamination after the removal of gloves [19, 20, 22, 23]. Olsen and colleagues [25] report a hand contamination rate of 13% (95% confidence interval [CI] 6–20%) after glove removal, more often with vinyl (24%) than with latex (2%) gloves ($p < 0.01$). They also noted leaking of gloves after use, more frequently with vinyl gloves (42.6%) than with latex gloves (8.6%) ($p < 0.001$). Nevertheless, gloves prevented hand contamination in 77% of the cases in their study, despite the presence of leaks.

Gloves to prevent cross-transmission: myth or reality?

A 2015 Cochrane review analysed the existing literature on the role of protective equipment (gloves, gowns, and masks) in reducing cross-transmission of MRSA in hospitals. The authors found no studies comparing the effective-

Table 1:
Use of gloves and contact precautions: comparison of guidelines.

CDC (2019) [14]	Recommended throughout the interaction with patients under contact precautions to prevent contamination of the healthcare worker's hands and thus transmission of pathogens to other patients.
ECDC (2014) [16]	Recommended as part of contact precautions to reduce the risk of dissemination of pathogens in the patient's environment, to other patients, and for the protection of healthcare professionals.
RKI (2016) [17]	Particularly indicated if the expected pathogens are insensitive to alcohol-based hand sanitisers, e.g. <i>C. difficile</i> , or are particularly dangerous, e.g. viral haemorrhagic fever pathogens.
SF2H (2009) [18]	Not recommended for the patient to whom additional contact precautions apply. Recommended under standard precautions (and some specific microorganisms such as <i>C. difficile</i>).

CDC: US Centers for Disease Control and Prevention; EDC: European Centre for Disease Prevention and Control; RKI: Robert Koch-Institut; SF2H: Société Française d'Hygiène Hospitalière

ness of standard precautions alone versus the effectiveness of gloves, gowns, or masks when dealing with hospitalised patients or their environment [26]. However, this lack of evidence should not be interpreted as evidence of lack of effectiveness.

A randomised cluster-controlled study conducted in nursing homes in the canton of Vaud in Switzerland, published in 2015, compared the efficacy of standard precautions alone versus the application of the same standard precautions complemented by a policy of universal screening and active decolonisation known as “search and destroy” for MRSA control [27]. After 12 months, the MRSA carriage rate had decreased significantly in both groups in a similar manner. After a 5-year follow-up, the MRSA carriage rate did not change significantly in either group [28]. Although these two studies do not analyse the effectiveness of wearing protective equipment, they suggest that the application of standard precautions, and in particular hand hygiene, is probably sufficient to control MRSA cross-transmission.

On the other hand, inappropriate use of gloves is associated with more risks than benefits and several publications have shown that gloves are often overused, especially without indication, or used inappropriately, without being changed when indicated [3, 4, 29–33]. This creates an increased risk

of cross-transmission through contaminated gloves [12, 29, 34, 35]. Girou and colleagues [29] found that in 35% of cases, gloves were used with no indication, whereas in 8% of situations gloves were not worn even though they would have been indicated (exposure to body fluids). In this study, overall compliance with hand hygiene after glove removal was 51.5% (95% CI 50.6–52.4%) and gloves were worn continuously without change in 64.4% (95% CI 64.1–65.1%) of cases, implying potential microbial transmission in 18.3% (95% CI 17.8–18.8%) of all contacts. Loveday and colleagues [4] observed 163 situations and found inappropriate use in 69 (42%) and a risk of cross-transmission in 60 (37%), most often associated with failure to change gloves or to perform hand hygiene after removal. Yap and colleagues [36] described an MRSA outbreak in Hong Kong due to cross-transmission facilitated by the continued, universal use of gloves and gowns during the SARS-CoV-1 epidemic, linked to poor hand hygiene compliance.

Recent work on MDRO transmission during the SARS-CoV-2 pandemic found that glove use as part of an infection control bundle strategy was associated with a decrease of VRE transmission [37], whereas several other studies suggested that the use of gloves may have contributed to

Table 2:

Clinical indications for the use of gloves according to standard precautions (independently of isolation precautions) adapted from WHO [2]. Of note: this table does not cover indications for the use of sterile gloves.

Use of clean gloves indicated	
<i>Risk of exposure to blood, body fluids, secretions, excretions, and equipment visibly soiled with body fluids.</i>	
<i>Examples:</i>	
Direct exposure to patients	Contact with blood, mucous membranes, or non-intact skin
	Blood collection
	Insertion and removal of vascular access
	Opening a vascular line (in the presence of blood)
	Endotracheal suctioning on an open system
	Pelvic and vaginal examination
	Emergencies
	Potential presence of highly infectious and dangerous organisms
Indirect exposure to patients	Handling of excretions
	Handling/cleaning/disinfecting of instruments
	Handling of waste
	Cleaning/disinfection of surfaces and objects soiled with biological fluids
Use of gloves NOT indicated	
<i>No risk of exposure to blood, body fluids, or a contaminated environment.</i>	
<i>Examples (list not exhaustive):</i>	
Direct exposure to patients	Administering subcutaneous and intramuscular injections
	Any manipulation of vascular access lines in the absence of blood flow
	Taking blood pressure, temperature, and pulse
	Grooming and dressing the patient
	Accompanying and transporting the patient
Indirect exposure to patients	Distribution of oral medication
	Making up the bed and changing the patient's bedding
	Setting up non-invasive ventilation equipment and oxygen cannula
	Distribution or collection of food trays for patients
	Using the telephone, writing in the patient's file
Moving the patient's furniture	

Table 3:

Indication to remove gloves - adapted from WHO [2].

As soon as gloves are damaged or defective (or suspected to be defective)
Immediately after contact with blood, other body fluids, injured skin, or mucous membranes
Immediately after contact with a contaminated patient or body site and the immediate environment
When there is an indication for hand hygiene

enhanced transmission or outbreaks of MDROs [38–42], especially when facing a critical lack of medical staff, isolation space and protective equipment. We, therefore, recommend the use of gloves as part of standard precautions when caring for patients with COVID-19.

Blanco and colleagues [34] also evaluated the effect of wearing gloves and gowns to prevent the transmission of MDROs in nursing homes in Maryland, USA. Thirty-one percent of the residents were colonised with Gram-negative MDROs. Glove and gown contamination occurred in 7% and 2% of caregiver/resident interactions, respectively. This contamination rate is higher in high-risk settings such as intensive care units, as demonstrated in the prospective cohort study by O'Hara and colleagues [43]. In this study, gloves and gowns were contaminated with MRSA in 14.3% and 5.9%, respectively, and contamination of either gloves or gowns occurred in 16.2% of caregiver/patient interactions. Morgan and colleagues [22] found that 38.7% (95% CI 31.9–45.5%) of intensive care workers caring for patients colonised with multidrug-resistant *A. baumannii* or *P. aeruginosa* had their gloves and/or gowns contaminated with these bacteria, which were also found on the hands of 4.5% (95% CI 1.6–7.4%) of them after glove removal. The role of gloves in the transmission of *Acinetobacter* spp. in intensive care has also been demonstrated by Patterson and colleagues [35].

Three cluster-randomised studies in the intensive care setting and one systematic review showed a decrease in hand hygiene compliance but no statistically significant change in the transmission of MDROs (MRSA, VRE, and Gram-negatives) when gloves were routinely used for contact precautions [44–47]. Prasad and colleagues in their before-and-after quasi-experimental quality improvement study [48] did observe an increase in hand hygiene compliance and a decrease in *C. difficile* infection rates during a universal gloving programme, but no statistically significant effects on catheter-associated urinary infection or central line-associated bloodstream infection rates. Of further note is that the study measured hand hygiene compliance by using only two of the 'five moments of WHO hand hygiene indications' (before and after patient care).

Tahir and colleagues [49] experimentally investigated the potential role of gloves in the transmission of *S. aureus*. They cultured nitrile, latex, and surgical gloves after contact with artificially contaminated objects that were dried to mimic surface biofilms and repeated the experiment after immersing the contaminated objects in a neutral detergent to simulate cleaning. *S. aureus* was present on all three types of gloves after the first contact with the contaminated object (nitrile and surgical gloves six times more frequently than latex gloves, $p < 0.01$) and still present, to 10 times the extent, after immersion of the contaminated object in the detergent. The experiment thus confirmed that bacteria embedded in surface biofilms can easily be transferred to new surfaces via gloved hands and that such transfer increases after exposure of the biofilm to detergent.

Glove use and hand hygiene: between beliefs and practices

The use of gloves has been shown to reduce hand hygiene compliance and alter its perception [3–6]. Similar obser-

vations have been made in Switzerland by Cusini and colleagues at the Inselspital in Bern [7]. They found that the requirement to wear gloves when caring for patients under additional contact precautions was associated with reduced hand hygiene compliance. As in Bern and other hospitals, this was also found in 2018 in the intensive care unit of the Centre Hospitalier du Valais Romand. Compliance with hand hygiene fell from almost 90% (of 55 hand hygiene opportunities) to less than 20% (of 30 opportunities) when gloves were worn during care provided to patients in contact isolation. (personal communication, N. Troillet, ICH). At the CHUV in Lausanne, observations of hand hygiene during contact precautions were carried out in 2013: the overall compliance rate was 69% during contact precautions versus 71% during standard precautions (personal communication, L. Senn, CHUV). However, the difference was greater for indications according to the "WHO five moments of hand hygiene" before clean/aseptic procedures (37% during contact precautions versus 65% during standard precautions) and after touching patient surroundings (48% versus 58%), with gloves being kept for the sequence of different care activities without hand hygiene.

These observations led some authors to investigate the reasons behind healthcare workers wearing non-sterile gloves and to identify their specific perceptions and beliefs around this subject by using a mixed-methods approach [4, 50, 51]. Baloh and colleagues [50] found a significant difference between self-reported adherence to hand hygiene (close to 100%) and actual observations (42%) in the context of mandatory glove use under contact precautions. The main reasons for glove use cited by participants in their study were "their own safety", "feelings of disgust" and "fear of contamination". Loveday and colleagues [4] observed similar findings, focusing on glove use in general. They concluded that the decision to wear gloves was influenced by emotions and misjudgment of risk to oneself, rather than to protect patients. More recently, Acquarulo and colleagues [51] found that, in addition to the reasons above, s were wearing gloves because it was easier than going to the nearest sink to wash their hands and because they had learned this during their training, an approach entirely contradicting the long-standing indication for hand washing only in the case of visibly soiled hands.

Are gloves a single-use medical device?

Manufacturers do not recommend washing or disinfecting gloves for subsequent reuse, nor to reprocessing used gloves. Neither the removal of microorganisms nor the integrity of gloves can be guaranteed [8, 12]. Some experiments evaluated options regarding this but without success and such practices have been associated with increased risk of cross-transmission.

With regard to external decontamination of gloved hands, Doebbeling and colleagues [52] evaluated the efficacy of three cleaning agents on gloved hands previously contaminated with *S. aureus*, *P. aeruginosa*, *Serratia marcescens*, and *Candida albicans*: standard soap, 60% isopropyl alcohol solution, and 4% chlorhexidine gluconate. The median reduction in the number of CFU (colony forming units) on the glove surface was 2.1 to 3.9 \log_{10} . After removal of the gloves, the proportion of hands contaminated with the test organisms ranged from 5% to 50%, depending on

the agent used. These results suggest that reusing gloves between different patients is not prudent and reinforce the message about the need to disinfect hands after glove removal.

Regarding a potential reprocessing of gloves for re-use, more recently, Scheithauer and colleagues [53] analysed various types of gloves, one made of latex and two made of nitrile, for the effectiveness of five alcohol-based disinfectant solutions. The decrease in the bacterial load of gloves contaminated with 10^8 CFU/ml of *Escherichia coli* K12 was $5 \log_{10}$ after five disinfections. The article does not mention the amount of disinfectant solution used or the application time. Some nitrile gloves, but especially latex gloves, showed breaches of varying size depending on the solution used. Propanol-based solutions were more deleterious than ethanol-based solutions. The authors of the study concluded that disinfection of gloves could be allowed, but with attention to the disinfectant/glove combinations used. In their literature review, Kampf and colleagues [54] did not find any study of sufficient quality for the wider promotion of this practice. However, they suggested that gloved hand disinfection could be considered in certain clinical situations, such as performing successive procedures on the same patient.

Importantly, protective gloves are single-use medical devices, and reprocessing is not recommended by the manufacturers and such a practice would therefore deviate from standard practice.

Towards abandoning the systematic use of gloves for additional contact precautions

In the conclusion of his 2009 literature review, Kirkland [55] suggested that the dogma of glove use for contact precautions should be reviewed. In April of the same year, the French Society of Hospital Hygiene [17] published a revision of the national recommendations for the prevention of cross-transmission. This revision took into account the evolution of basic measures, in particular, the substitution of hand washing by rubbing the hands with an alcohol-based solution. These new recommendations no longer included the routine use of gloves for patients in contact isolation. Reports from the French surveillance network "BMR-Raisin" (available at <http://invs.santepubliquefrance.fr>) show that the rate of colonisation by MRSA and VRE, which was already decreasing before the publication of these recommendations, has continued to decline.

Cusini and colleagues in Bern [7] evaluated the impact of limiting glove use to standard precautions (table 2) for patients under contact precautions. Their study showed better adherence to hand hygiene in the absence of systematic glove-wearing. This increased from 52% (95% CI 47–57%) to 85% (95% CI 82–88%; $p < 0.001$). A concomitant improvement in their hospital was also observed for patients without additional contact precautions, but to a lesser extent: from 63% (95% CI 61–65%) to 81% (95% CI 80–83%; $p < 0.001$). As a result of this study, routine glove use has no longer been required in hospitals of the canton of Bern since 2011.

In 2015, several other hospitals in Switzerland decided to eliminate the systematic use of gloves as part of contact precautions while increasing their efforts to improve hand

hygiene compliance. This change did not increase the incidence of MDRO carriage, which continues to decrease in the canton of Vaud, as elsewhere in Europe. Overall, the average rate of hand hygiene adherence in Vaud institutions increased slightly from $83 \pm 6.9\%$ to $86.3 \pm 2.5\%$ (data extracted from the "Rapport annuel surveillance HP-Ci, 2018, Unité Cantonale HPCI-VD").

Jain and colleagues [56] evaluated the impact of hand hygiene on contamination of ungloved hands when caring for patients colonised with MRSA and VRE in contact isolation. Their study included 40 healthcare workers and 240 cultures of their hands, 120 of them taken after disinfection with three pushes of alcohol-based handrub and 120 after washing with neutral soap. All were negative for MRSA and VRE after patient contact. Hand hygiene is therefore effective in eliminating MRSA and VRE during routine clinical care of colonised patients, even without gloves. With regard to specific pathogens less sensitive to alcohol such as *C. difficile*, an outbreak in a Swiss hospital was successfully controlled without applying default gowning, gloving, or hand washing with soap and water [57].

Conclusion

Excellent hand hygiene compliance should be a priority in all hospitals and healthcare facilities. This includes easy access to alcohol-based handrub solutions as well as continual teaching and audits on hand hygiene. If such conditions are met and adherence to hand hygiene is excellent and regularly assessed, the routine use of gloves when caring for patients under contact precautions seems no longer indicated. Instead, their use may be restricted according to the principles of standard precautions, i.e., when in contact with biological fluids. The scientific arguments reviewed in this article speak in favour of such an attitude and demonstrate that eliminating the systematic use of gloves during contact precautions could improve the quality of care and the safety of patients. Moreover, since only a few studies examined the association between glove use and hand hygiene compliance, further work is needed to address this research gap.

Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest was disclosed.

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