



ELSEVIER

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org



Major article

Improved hand hygiene compliance after eliminating mandatory glove use from contact precautions—Is less more?

Alexia Cusini MD^{a,*}, Doris Nydegger RN^a, Tanja Kaspar RN, MPH^a, Alexander Schweiger MD^a, Rolf Kuhn PhD^{a,b}, Jonas Marschall MD^a^a Department of Infectious Diseases and Hospital Epidemiology, University Hospital of Bern, Bern, Switzerland^b Clinic of Infectious Diseases and Hospital Epidemiology, Cantonal Hospital St. Gallen, St. Gallen, Switzerland

Key Words:

Hand hygiene

Glove use

Contact precautions

Background: Guidelines recommend that health care personnel (HCP) wear gloves for all interactions with patients on contact precautions. We aimed to assess hand hygiene (HH) compliance during contact precautions before and after eliminating mandatory glove use.

Methods: We assessed HH compliance of HCP in the care of patients on contact precautions in 50 series before (2009) and 6 months after (2012) eliminating mandatory glove use and compared these results with the hospital-wide HH compliance.

Results: We assessed 426 HH indications before and 492 indications after the policy change. Compared with 2009, we observed a significantly higher HH compliance in patients on contact precautions in 2012 (52%; 95% confidence interval [95% CI], 47–57) vs 85%; 95% CI, 82–88; $P < .001$). During the same period, hospital-wide HH compliance also increased from 63% (95% CI, 61–65) to 81% (95% CI 80–83) ($P < .001$). However, the relative improvement (RI) of HH compliance during contact precautions was significantly higher than the hospital-wide relative improvement (RI, 1.6; 95% CI, 1.49–1.81 vs 1.29; 95% CI, 1.25–1.34), with a relative improvement ratio of 1.27 (95% CI, 1.15–1.41).

Conclusion: Eliminating mandatory glove use in the care of patients on contact precautions increased HH compliance in our institution, particularly before invasive procedures and before patient contacts. Further studies on the effect on pathogen transmission are needed before revisiting the current official guidelines on the topic.

Copyright © 2015 by the Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.

Adequate hand hygiene (HH) is a key measure to prevent transmission of health care–associated infections.¹ Over the last few decades, campaigns promoting HH have been launched all over the world.² Nevertheless, the importance of this simple procedure is not sufficiently recognized by all health care personnel (HCP), and compliance with recommended HH practices is often low.

* Address correspondence to Alexia Cusini, MD, Department of Infectious Diseases and Hospital Epidemiology, University Hospital Bern, CH-3010 Bern, Switzerland.

E-mail address: alexia.cusini@inse.ch (A. Cusini).

Funding/Support: Cusini has received a travel grants and meeting expenses from Abbott, MSD, BMS, Gilead, and Astellas. Marschall was paid for consultancy by Astelles Switzerland and for development of educational presentations by Cape Girardeau Medical Society. He received grants from the CDC Prevention Epicenters Program (ongoing), an NIH KL2 Career Development Award, and an NIH BIRCWH Award that ended in 2012 and 2013, respectively. He also received travel grant and meeting expenses from Gilead. The other authors report no conflicts of interest and have not received any financial support.

Conflicts of interest: None to report.

Wearing gloves cannot be considered as an alternative to HH. Doebbeling et al showed that washing artificially contaminated gloves often failed to remove microorganisms and that bacteria could penetrate unapparent holes in gloves and eventually contaminate the individual's hands. Therefore, hand disinfection or washing is required after glove removal.³

In 1996, the Centers for Disease Control and Prevention (CDC) introduced a revised version of a preventive concept against nosocomial infections that had originated in the 1960s.⁴ In these guidelines, basic standard precautions are recommended for all health care activities. Additionally, contact precautions are intended to prevent transmission of pathogens that are spread by direct or indirect contact with the patient or the patient's environment. According to the CDC recommendations and the HH guidelines issued by the World Health Organization (WHO), HCP caring for patients on contact precautions should wear gloves for all interactions with patients or contact with potentially contaminated areas in their environment.^{5,6} This recommendation was based on general consensus and not on high-level evidence. To our

knowledge, no studies have directly compared the efficacy of standard precautions alone versus standard plus contact precautions for the control of multidrug-resistant (MDR) microorganisms.⁷

Of note, when gloving is required, it may become more challenging to perform optimal HH. Indeed, several authors have identified the use of gloves as an important risk factor for poor HH.^{1,8-14}

In 2009, an observational study of HH compliance at our institution showed that the requirement to wear gloves during contact precautions caused HCP to neglect HH, thereby potentially increasing the risk of pathogen transmission.¹⁵ In light of this finding our infection prevention unit implemented a policy change in 2011, eliminating mandatory gloving from the care of patients on contact precautions knowing that this new strategy followed neither CDC nor WHO guidelines.

The objective of this study was to assess the compliance with HH before and after this policy change took place.

MATERIAL AND METHODS

Hospital setting

Our institution is a 950-bed tertiary care teaching hospital covering all medical specialties, including a 30-bed mixed intensive care unit (ICU). There are on average 38,000 admissions annually, resulting in 290,000 patient days. Institutional guidelines for infection prevention are based on the CDC's Guidelines for Isolation Precautions⁵ and are regularly updated by the infection prevention unit. Patients colonized or infected with MDR bacteria (eg, methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, MDR gram-negative bacteria) are placed on contact precautions.

The promotion of HH has a high priority among the infection prevention measures in our hospital. The hospital provides an alcohol-based solution for handrubs in wall-mounted and bed-mounted dispensers that has also been distributed as coat-pocket bottles for many years. There was no change in the availability of the alcohol-based solution during the study period. Since 2005, when a national campaign by Swissnoso (the Swiss national expert group for the prevention of hospital-acquired infections) launched the 5 HH indications (before patient contact, after patient contact, before an aseptic procedure, after body fluid exposure, and after touching the patient's environment), we have promoted these recommendations.¹⁶ These 5 HH indications were later adopted by the WHO concept My 5 Moments for Hand Hygiene in 2009.¹⁷

As a quality indicator, the hospital-wide compliance of HCP with HH has been assessed annually since 2005 (with direct feedback to the wards).

Study design

We performed a nonrandomized observational before-after study comparing HH compliance in contact precautions caused by colonization or infection with MDR microorganisms before and 6 months after eliminating mandatory glove use (September-December 2009 and April-June 2012, respectively). The hospital-wide HH compliance in nonisolated patients in both periods served as the control. Patients on contact precautions because of an infection with *Clostridium difficile* were excluded from the study.

Policy change and implementation

Prior to September 2011, all HCP were expected to perform HH and wear gloves before entering the room of a patient on contact

precautions and to change gloves if an indication for HH occurred during the encounter with the isolated patient. Afterward, glove use in this setting was only required according to standard precautions (contact with body fluids, nonintact skin, or mucosa and before invasive procedures). We communicated this policy change in written form to all hospital floors and highlighted it in the hospital's infection prevention guidelines. For 1 month, HCP providing care for patients on contact precautions were personally informed about the change in policy. On special request, we scheduled HH training sessions for individual floors. All HH indications were being taught to HCP since the 2005 national campaign. There was no special promotion of the HH indications during the study period (eg, after the publication of the 2009 WHO guidelines), and there was no other specific HH intervention.

Data collection

HH observations in patients on contact precautions and for the entire hospital were performed during routine patient care in the patients' rooms or in the ICU in series of 20 minutes each. For the observations we used a standardized questionnaire offered by Swissnoso¹⁶ evaluating HH in the following situations: (1) before patient contact, (2) after patient contact, (3) before an aseptic procedure, (4) after body fluid exposure, and (5) after touching the patient's environment.¹⁷ Additionally, we monitored the compliance with gloving in contact precautions. Before the policy change we assessed if (1) gloves were worn before entering a room with a patient on contact precautions, (2) HH was performed before and after glove use, and (3) gloves were changed to perform HH. After the policy change, we evaluated if gloves were worn when indicated by standard precautions.

All HH observers were members of the infection prevention team. All of them were instructed in HH observation with the same educational tools provided by Swissnoso and underwent annual refreshers in HH observation. One author (D.N.) performed all HH observations in contact precautions in 2009 and performed most in 2012 (D.N. performed 389 and T.K. performed 103 observations in 2012). The hospital-wide HH observations were conducted with the same methodology by the entire infection prevention team consisting of 10 staff members in 2009 and 7 in 2011. Two authors (D.N. and T.K.) and 1 additional staff member participated in the observations in both years.

Ethics

This study did not require approval by the local ethics committee because it was deemed a quality improvement project. The directors of the involved clinical departments were informed of the study and the research methodology before research activities started. The observed health care workers were aware of the fact that they participated in an HH study.

Statistical analyses

We used Stata/SE10.0 (StataCorp, College Station, TX) to perform statistical analyses. HH compliance was defined as the percentage of opportunities in which HCP adhered to HH guidelines (indications with adequate HH/all HH indications \times 100). We evaluated differences in HH compliance in the care of patients on contact precautions between 2009 and 2012 and differences in HH compliance in the care of patients on contact precautions versus the hospital-wide compliance during the respective year, using the χ^2 test, and calculated the corresponding 95% confidence intervals. Additionally, we calculated the absolute difference in HH compliance between 2009 (baseline) and 2012 for patients on

Table 1
Hand hygiene compliance before (2009) and after (2012) elimination of mandatory glove use in the care of patients on contact precautions and in the entire hospital

Indications for Hand Hygiene	2009		2012		P value
	No. of observations	Compliance (95% CI)	No. of observations	Compliance (95% CI)	
Contact precautions					
Before patient contact	127	32.3 (24.0-40.5)	116	76.7 (68.9-84.5)	<.001
After patient contact	105	94.3 (88.0-97.9)	131	93.9 (89.8-98.7)	.90
Before aseptic procedure	88	23.9 (14.8-32.9)	75	72.0 (61.6-82.4)	<.001
After body fluid exposure	106	56.6 (46.6-66.2)	110	90.9 (85.5-96.4)	<.001
After contact to patients surroundings	No observations		60	90.0 (82.2-97.8)	
All indications	426	51.9 (47.1-56.6)	492	85.4 (82.2-88.5)	<.001
Entire hospital					
Before patient contact	582	46.9 (42.8-51.0)	539	71.8 (68.0-75.6)	<.001
After patient contact	841	75.2 (72.3-78.2)	1,132	87.3 (85.3-89.2)	<.001
Before aseptic procedure	253	60.5 (54.4-66.5)	285	76.8 (71.9-81.8)	<.001
After body fluid exposure	305	66.6 (61.2-71.9)	391	83.9 (80.2-87.5)	<.001
After contact to patients surroundings	264	56.8 (50.8-62.8)	314	78.0 (73.4-82.6)	<.001
All indications	2,245	62.9 (60.9-64.9)	2,661	81.4 (80.0-82.9)	.001

CI, confidence interval.

contact precautions and for the entire hospital, respectively, and expressed these differences as relative improvement (RI) with 95% confidence intervals (ie, 2012 compliance/2009 compliance). In a second step we compared the RI of the patients on contact precaution with the RI of the entire hospital and expressed this relationship as the RI ratio with a corresponding 95% confidence interval.

RESULTS

In 2009 we observed a total of 426 HH indications in HCP providing care for 32 patients on contact precautions (19 patients were observed once, and 13 patients were observed repeatedly, after transfer to another floor or in case of a second hospitalization). In 2012 we observed a total of 492 indications in 44 patients on contact precautions (38 patients once, 6 patients twice). During the hospital-wide HH observations we assessed 2,245 HH indications in 2009 and 2,661 indications in 2012.

The HH compliance in the care of patients on contact precautions and in the entire hospital in the years 2009 and 2012, respectively, is summarized in Table 1 and depicted in Figure 1. We found a significant increase of HH compliance in contact precautions between 2009 and 2012 (51.9%; 95% confidence interval [CI], 47.1-56.6 vs 85.4; 95% CI, 82.2-88.5; $P < .001$). During the same period the hospital-wide HH compliance also improved (62.9%; 95% CI, 60.9-64.9 vs 81.4; 95% CI, 80.0-82.9; $P < .001$). The RI of HH compliance in contact precaution situations was significantly higher than the hospital-wide RI (1.6; 95% CI, 1.49-1.81 in contact precaution situations vs 1.29; 95% CI, 1.25-1.34 in hospital-wide observations), with a RI ratio of 1.27 (95% CI, 1.15-1.41).

In contact precaution settings, HH compliance improved particularly before patient contact (32.3%; 95% CI, 24.0-40.5 in 2009 vs 76.7; 95% CI, 68.9-84.5 in 2012; $P < .001$) and before performing aseptic procedures (23.9%; 95% CI, 14.8-32.9 vs 72.0; 95% CI, 61.6-82.4; $P < .001$). HH compliance after patient contact remained high (94.3%; 95% CI, 88.0-97.9 vs 93.9%; 95% CI, 89.8-98.7; $P = .90$) (Fig 2).

In 2009, when gloving still was a mandatory component of contact precautions, the overall HH compliance in the care of patients on contact isolation was significantly lower than the hospital-wide HH compliance (51.9%; 95% CI, 47.1-56.6 vs 62.9; 95% CI, 60.9-64.9; $P < .001$). The difference in HH compliance was particularly remarkable for the indications before patient contact (32.3%; 95% CI, 24.0-40.5 vs 46.9; 95% CI, 42.8-51.0; $P < .001$) and before performing aseptic procedures (23.9%; 95% CI, 14.8-32.9 vs

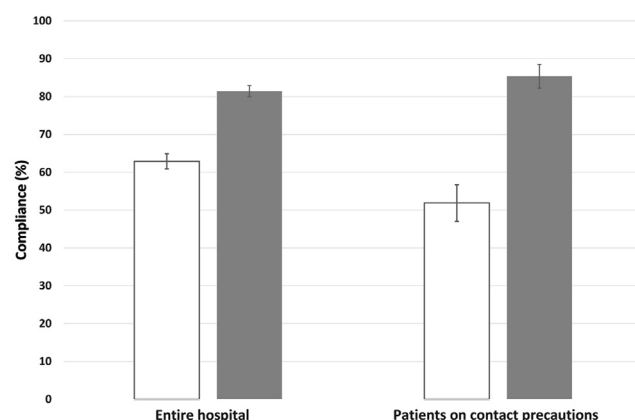


Fig 1. Hand hygiene compliance before (2009, white bar) and after (2012, grey bar) eliminating mandatory glove from contact precautions compared with all hospitalized patients. Error bars indicate 95% confidence interval.

60.5; 95% CI, 54.4-66.5; $P < .001$). In 43.2% of 88 observed indications before performing aseptic procedures, there was no hand disinfection and no change of gloves was performed, and in 33% of observations gloves were either disinfected or changed without in-between hand disinfection. Compliance with the indication after patient contact was significantly higher in the care of isolated patients than the hospital-wide compliance for this indication (94.3%; 95% CI, 88.0-97.9 vs 75.2; 95% CI, 72.3-78.2; $P < .001$).

In 2012, the overall HH compliance in the care of patients on contact precautions was slightly higher than the hospital-wide compliance (85.4%; 95% CI, 82.2-88.5 vs 81.4; 95% CI, 80.0-82.9; $P = .04$). No difference was found for the indications before patient contact (76.7%; 95% CI, 68.9-84.5 vs 71.8; 95% CI, 68.0-75.6; $P = .30$) and before performing aseptic procedures (72.0%; 95% CI, 61.6-82.4 vs 76.8; 95% CI, 71.9-81.8; $P = .40$). We observed 197 indications in which wearing gloves was required as part of standard precautions in the care of patients on contact precautions in 2012. In 193 (98%) occasions gloves were worn when it was indicated.

A quality assessment showed the 2 authors (D.N. and T.K.) who performed all observations in the setting of contact precautions and also participated in the hospital-wide observations in 2009 and 2012 achieved a similar global compliance in the hospital-wide observations when compared with the rest of the infection control team (data not shown).

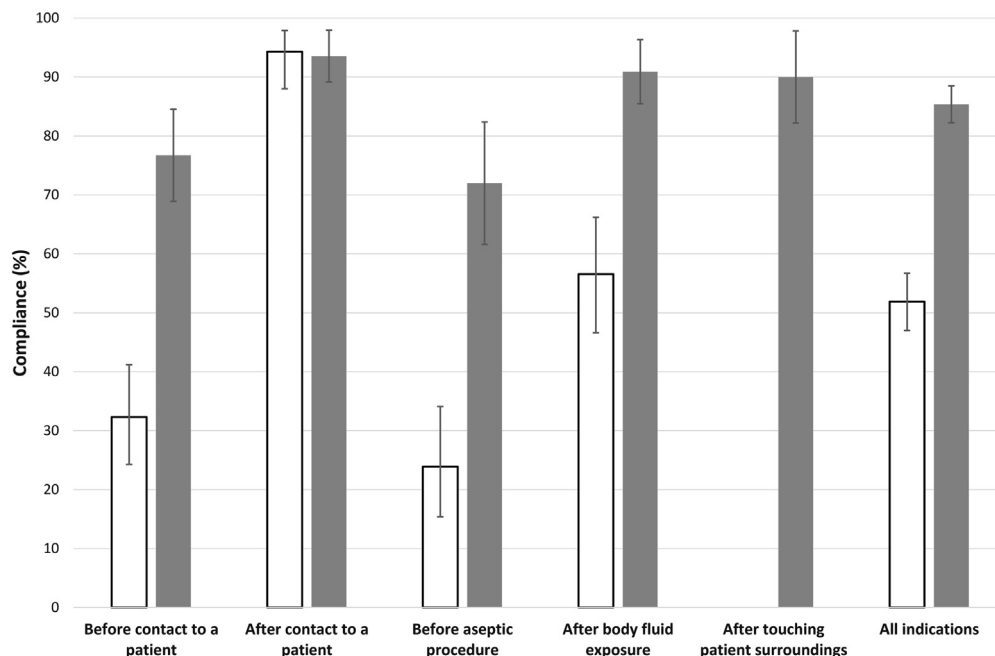


Fig 2. Hand hygiene compliance for all observed indications in the care of patients on contact precautions before (2009, white bar) and after (2012, grey bar) eliminating mandatory glove use. Error bars indicate 95% confidence interval.

DISCUSSION

In 2009 we observed that HH compliance in the care of patients on contact precautions was significantly worse than the hospital-wide compliance despite the fact HH following the 5 indications had been promoted since 2005 and substantial improvement of HH compliance had been achieved across the hospital since then (global HH compliance had improved from 46.9%-62.9% in those years). We observed that HCP donned gloves before entering the room of an isolated patient and tended to remove them only after leaving the room, without changing them and without performing adequate HH when indicated.

It is not surprising that gloving can have a negative impact on HH because it can be time-consuming under these circumstances. Other reasons for neglecting HH could be a false sense of safety with gloving or the erroneous belief that glove use obviates HH.¹⁸

In consequence of our own observations we decided to eliminate the practice of default gloving during contact precautions in 2011, which was a departure from both CDC and WHO recommendations on isolation precautions. The second HH observation in contact precautions (6 months after the policy change) showed that these modified contact precautions were associated with a considerably better HH compliance in our institution. Given that there was no other intervention and that the hospital-wide improvement of HH compliance over the same period was significantly smaller, we assume that eliminating mandatory glove use in the care of patients on contact precautions had a positive attributable effect on compliance, beyond the hospital-wide trend toward better HH practices.

The scientific literature on the impact of glove use on health care workers' HH compliance is limited and contradictory. A number of studies identified the use of gloves as an important risk factor for poor HH.^{1,8-14} In agreement with these reports, we identified the failure to change potentially contaminated gloves as the major barrier for proper HH.⁸⁻¹⁰ These studies were limited by different methods, different indications for glove use, and a small number of observations. To overcome these limitations, Fuller et al performed a study on gloving and HH in 15 hospitals in the United Kingdom.

They found that gloves are often worn when not indicated and vice versa and described a significant association between glove use and lower rates of HH compliance.¹² In contrast, only a few studies showed increasing HH compliance when gloves were used.¹⁹⁻²² In these studies, the authors argued that wearing gloves may remind health care workers of the personal risk of pathogen transmission and therefore prompt them to disinfect hands after a clinical encounter. This perception is supported by our results in 2009 when HH compliance for the indication after patient contact was significantly higher in the contact precaution setting than in non-isolated patients. However, gloving in itself should not be seen as a marker for good compliance.

To our knowledge, our study is the first to analyze the impact of modified contact precautions eliminating mandatory glove use on compliance with HH. One important strength of our study is the use of a standardized HH observation tool that considered all indications as proposed by the WHO in a systematic way,¹⁷ by infection prevention personnel specifically trained in HH observation. A systematic review including 96 studies on HH compliance reported an overall median compliance rate of 40%, with a wide range from 4%-100%. Only 25% of studies reported compliance rates >50% across all professions.² Compared with these rates, the hospital-wide HH compliance at our institution was moderate in 2009 (62.9%) and good in 2012 (81.4%). Similar to the results of the aforementioned review, HH compliance in our study was better after than before patient contact and better for nurses than for physicians (data not shown). The use of alcohol-based handrub (as opposed to handwashing), its good accessibility in the hospital, and the periodically performed observations of HH with feedback to the observed health care workers could be reasons for the continuous improvement in our institution. Nevertheless, because HCP were aware of being observed, they may have displayed different behavior (Hawthorne effect).²³ Therefore, the HH compliance in our study may overestimate clinical reality, particularly in the setting of contact precautions where the 2 sole observers were physically close to the observed HCP (because patients on contact precautions are mostly located in single rooms).

Our study has other limitations. Although its quasi-experimental design using the hospital-wide HH compliance as a control can be considered high quality, important confounding variables may have been missed because of the lack of randomization.²⁴ The main limitation is certainly that in light of the overall trend of improving HH compliance throughout our hospital since 2005 (overall compliance was 46.9% in 2005, 56.3% in 2006, 62.2% in 2007, 61.9% in 2008, 62.9% in 2009, 68.4% in 2010, 73.0% in 2011, and 81.4% in 2012, with a notable improvement for all 5 indications), the RI that is directly caused by the policy change in contact precautions may have been overestimated.

Moreover, the higher improvement ratio in HH compliance in contact precautions may in part be because it is easier to improve HH when starting from a low level of compliance.²⁵ We also are aware that the interval between initial (2009) and subsequent (2012) assessment in the setting of contact precautions was rather long. However, for acquiring more data, which would have permitted a time series analysis, we had neither funding nor personnel.

Some HCP perform better at HH than others: as a result, an individual who was observed repeatedly may have acted as cluster, therefore influencing our findings.²⁶ However, because each floor was evaluated only once in the care of the same patient, it is likely that the cluster effect was minimal. We evaluated only the volume of performed HH actions and not the quality, with respect to technique and duration of hand disinfection. Moreover, no microbiologic tests to assess colonization with MDR bacteria of health care workers' hands were undertaken. We did not systematically analyze the nosocomial transmission of MDR organisms during the study period; however, no notable clusters of nosocomial infections occurred since the policy change. Finally, it was not a study objective to demonstrate whether or not the positive effect on HH compliance persisted. Despite all the mentioned limitations, we postulate that eliminating the mandatory use of gloves had a positive effect on HH compliance in contact precautions in our institution because this was the only specific HH intervention between 2009 and 2012.

A recent study by Dhar et al showed that an increasing number of patients on contact precautions in a given unit was associated with reduced compliance with these contact isolation precautions. The authors presume that a burden of contact isolation >40% may lead to compliance fatigue, leading to breaks in the contact isolation precautions process. The component of such precautions most frequently not complied with was HH prior to donning gloves and gown.²⁷ Although the study setting differed considerably from ours, both studies reinforce the need to rethink contact precautions, be it in terms of accommodating an increased number of patients on precautions or modifying isolation measures like we did.

CONCLUSIONS

In our experience mandatory use of gloves in contact precautions may impede improvement in HH. Therefore, in our institution we modified contact precautions eliminating mandatory gloving and found that the policy change brought about a significant improvement of HH compliance. In our institution we now recommend the use of gloves only according to standard precautions, irrespective of whether patients are on contact precautions or not. Further studies analyzing the impact of eliminating mandatory glove use in contact precautions in other settings and its effect on pathogen transmission are needed before revisiting the current official guidelines.

Acknowledgments

We thank all of the health care workers of the University Hospital of Bern for their enormous effort in improving hand hygiene during daily patient care and all patients that allowed us to perform the observations of hand hygiene during their hospitalization. We also thank the members of the infection prevention team for participating in data collection and especially Kathrin Mühlemann, MD, PhD, who initiated and provided supervision of the first part of study but, unfortunately, passed away prematurely in 2012.

References

- Pittet D, Boyce JM. Hand hygiene and patient care: pursuing the Semmelweis legacy. *Lancet Infect Dis* 2001;1:9-20.
- Erasmus V, Daha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infect Control Hosp Epidemiol* 2010;31:283-94.
- Doebbeling BN, Pfäller MA, Houston AK, Wenzel RP. Removal of nosocomial pathogens from the contaminated glove. Implications for glove reuse and handwashing. *Ann Intern Med* 1988;109:394-8.
- Garner JS. Guideline for isolation precautions in hospitals. The hospital infection control practices advisory committee. *Infect Control Hosp Epidemiol* 1996;17:53-80.
- Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings. *Am J Infect Control* 2007;35(Suppl):S65-164.
- World Health Organization. WHO guidelines for hand hygiene in health care. 2009. Available from: <http://www.who.int/gpsc/5may/tools/9789241597906/en/>. Accessed March 18, 2014.
- Siegel JD, Rhinehart E, Jackson M, Chiarello L. Management of multidrug-resistant organisms in health care settings, 2006. *Am J Infect Control* 2007;35(Suppl):S165-93.
- Katherason SG, Naing L, Jaalam K, Nik Mohamad NA, Bhojwani K, Harussani ND, et al. Hand decontamination practices and the appropriate use of gloves in two adult intensive care units in Malaysia. *J Infect Dev Ctries* 2010;4:118-23.
- Girou E, Chai SH, Oppein F, Legrand P, Ducellier D, Cizeau F, et al. Misuse of gloves: the foundation for poor compliance with hand hygiene and potential for microbial transmission? *J Hosp Infect* 2004;57:162-9.
- Flores A, Pevalin D. Health care workers' compliance with glove use and the effect of glove use on hand hygiene compliance. *Br J Infect Control* 2006;7:15-8.
- Sánchez-Payá J, Galicia-García MD, Gracia-Rodríguez RM, García-González C, Fuster-Pérez M, López-Fresneña N, et al. Compliance with hand hygiene guidelines and determinants of compliance [Spanish]. *Enferm Infec Microbiol Clin* 2007;25:369-75.
- Fuller C, Savage J, Besser S, Hayward A, Cookson B, Cooper B, et al. "The dirty hand in the latex glove": a study of hand hygiene compliance when gloves are worn. *Infect Control Hosp Epidemiol* 2011;32:1194-9.
- Thompson BL, Dwyer DM, Ussery XT, Denman S, Vacek P, Schwartz B. Handwashing and glove use in a long-term-care facility. *Infect Control Hosp Epidemiol* 1997;18:97-103.
- Eveillard M, Joly-Guillou ML, Brunel P. Correlation between glove use practices and compliance with hand hygiene in a multicenter study with elderly patients. *Am J Infect Control* 2012;40:387-8.
- Nydegger D, Kuhn R, Mühlemann K. Implementation of isolation guidelines for multi-drug-resistant microorganisms in daily practice. Poster presented at: Annual Meeting of the Swiss Society of Infectious Diseases; September 2-4, 2010; Lausanne, Switzerland.
- Pittet D, Allegranzi B, Chraïti MN, Sax H, Ruef C. "Clean care is safer care": die WHO widmet den ersten globalen "challenge" für die Patientensicherheit der Infektionsprävention. *Swiss - Noso Nosokomiale Infektionen und Spitalhygiene: Aktuelle Aspekte* 2010;16:2-7.
- Sax H, Allegranzi B, Chraïti MN, Boyce J, Larson E, Pittet D. The World Health Organization hand hygiene observation method. *Am J Infect Control* 2009;37:827-34.
- Jang JH, Wu S, Kirzner D, Moore C, Youssef G, Tong A, et al. Focus group study of hand hygiene practice among healthcare workers in a teaching hospital in Toronto, Canada. *Infect Control Hosp Epidemiol* 2010;31:144-50.
- Kim PW, Roghmann MC, Perencevich EN, Harris AD. Rates of hand disinfection associated with glove use, patient isolation, and changes between exposure to various body sites. *Am J Infect Control* 2003;31:97-103.
- Lund S, Jackson J, Leggett J, Hales L, Dworin R, Gilbert D. Reality of glove use and handwashing in a community hospital. *Am J Infect Control* 1994;22:352-7.
- Lankford MG, Zembower TR, Trick WE, Hacek DM, Noskin GA, Peterson LR. Influence of role models and hospital design on hand hygiene of healthcare workers. *Emerg Infect Dis* 2003;9:217-23.
- Eveillard M, Guilloteau V, Kempf M, Lefrancq B, Pradelle MT, Raymond F, et al. Impact of improving glove usage on the hand hygiene compliance. *Am J Infect Control* 2011;39:608-10.

23. Maury E, Moussa N, Lakermi C, Barbut F, Offenstadt G. Compliance of health care workers to hand hygiene: awareness of being observed is important. *Intensive Care Med* 2006;32:2088-9.
24. Harris AD, Bradham DD, Baumgarten M, Zuckerman IH, Fink JC, Perencevich EN. The use and interpretation of quasi-experimental studies in infectious diseases. *Clin Infect Dis* 2004;38:1586-91.
25. Allegranzi B, Gayet-Ageron A, Damani N, Bengaly L, McLaws ML, Moro ML, et al. Global implementation of WHO's multimodal strategy for improvement of hand hygiene: a quasi-experimental study. *Lancet Infect Dis* 2013;13:843-51.
26. Golan Y, Doron S, Griffith J, El Gamal H, Taniot M, Blunt K, et al. The impact of gown-use requirement on hand hygiene compliance. *Clin Infect Dis* 2006;42:370-6.
27. Dhar S, Marchaim D, Tansek R, Chopra T, Yousuf A, Bhargava A, et al. Contact precautions: more is not necessarily better. *Infect Control Hosp Epidemiol* 2014;35:213-21.