Hand eczema is frequently colonized with *Staphylococcus aureus*. Some patients with hand eczema wear occlusive gloves regularly; however, the effect of this on the density of *S. aureus* is unexplored. The aim of this study is to examine the effect of occlusive gloves on the density of *S. aureus* sampled from the hands of patients with hand eczema. In an experimental set-up, patients with moderate-to-severe hand eczema wore an occlusive glove on one hand for 4 h with a 30-min break. Bacterial swabs were collected from the most severe eczema lesion on the hand before and immediately after glove exposure. *S. aureus* colony-forming units were counted and log-transformations used for comparison of before- and after-values. Among 30 patients, 19 (63%) were colonized with *S. aureus*. After glove occlusion *S. aureus* colony-forming units increased by a factor of 1.72 (\(p < 0.01\)). In conclusion, the density of *S. aureus* on eczematous skin after prolonged wearing of occlusive gloves is greatly increased.

**Key words:** hand eczema; *Staphylococcus aureus*; occlusive gloves; bacteria; alcohol-based hand rub; infection prevention.

Accepted Jul 1, 2021; Epub ahead of print Jul 5, 2021
Acta Derm Venereol 2021; 101: adv00515.

**Corr:** Line Brok Nørreslet, Department of Dermatology, University of Copenhagen, Bispebjerg Hospital, Bispebjerg Bakke 23, DK-2400 Copenhagen NV, Denmark. E-mail: line.brok.nørreslet.01@regionh.dk

**SIGNIFICANCE**

Hand eczema is a common skin disease, particularly in professions such as healthcare, cleaning and catering, in which wearing occlusive gloves is often required. Recent findings show that more than 50% of all patients with hand eczema are colonized with the potentially harmful bacteria *Staphylococcus aureus*. This study explored how wearing occlusive gloves influenced *Staphylococcus aureus* colonization in patients with hand eczema. There was a major increase in the density of *Staphylococcus aureus* following occlusive glove wear, which probably negatively influences the prognosis of hand eczema, and is important regarding transmission of bacteria to the local environment.

**MATERIALS AND METHODS**

**Patient population**

Patients with chronic HE, as defined by the European Society of Contact Dermatitis (16), were recruited from the outpatient clinic of the Department of Dermatology, Bispebjerg University Hospital, Copenhagen, Denmark, from September 2019 to October 2020. Inclusion criteria were age \(\geq 18\) years and a HE Severity Index (HECSI) (17) score of \(> 17\), corresponding to moderate-to-severe hand eczema.

**Society for Publication of Acta Dermato-Venereologica**

This is an open access article under the CC BY-NC license. www.medicaljournals.se/acta

Acta Derm Venereol 2021; 101: adv00515

doi: 10.2340/00015555-3866
very-severe HE (18). Exclusion criteria were pregnancy, breastfeeding, and use of systemic or topical antibiotics within 4 weeks prior to study participation. Patients were included regardless of other types of treatment, which were nevertheless registered. The dermatologist-diagnosed sub-type of HE (19) (either irritant contact dermatitis, allergic contact dermatitis, hyperkeratotic, acute recurrent vesicular, or atopic HE), as well as current or past medical history of atopic dermatitis (AD) (“Have you had childhood eczema” (20), or “Have you had atopic dermatitis diagnosed by a dermatologist”) were noted. The study was approved by the local ethics committee (project number H-18049625) and the Danish Data Protection Agency (project number VD-2019-15). Written informed consent was obtained from each patient.

**Study design and sampling of S. aureus**

The study was designed as a clinical trial with *S. aureus* sampling before and after standardized exposures to occlusive glove wear and ABHR, respectively. Patients were instructed not to use ABHR on the day of study participation, whereas usual hand washing was allowed. In addition, the intervention was performed in the morning, i.e. before job exposures. With a generation time, i.e. the doubling time or cell division rate, of approximately 30 min under laboratory conditions for *S. aureus* (21), it was hypothesized that exposure to occlusive glove wear for 2 h twice in one day would significantly increase the number of *S. aureus* in patients with HE. To mimic the everyday life of patients with HE working in different occupations where occlusive gloves are used repeatedly, the occlusive glove intervention was replicated after a break of 30 min. Therefore, the intervention with gloves was designed as follows: Non-bactericidal, powder-free, occlusive gloves were used on the hand hosting the most severe eczema for 2 h, followed by 30 min without a glove and subsequently another 2 h with a second, identical occlusive glove. Vinyl gloves (VWR, Leuven, Belgium) were chosen to protect the patients from potential sensitization to natural rubber latex or rubber chemicals. During the 30 min in between glove wear, the patients were not allowed to touch anything with the hand involved, in order to reduce potential bias from contamination. Before and immediately after the 4.5-h intervention period, the most severe eczematous lesion of the hand and a non-eczematous area on the back of the hand, each corresponding to an area of approximately 2 cm², were sampled by rubbing the skin for 30 s using an ESwab (Copan, Brescia, Italy).

Five minutes after the end of the glove intervention, a sub-group of the patients was asked to rub their hands with 4 mL ABHR (cleansed water, 1.3% glycerol, 5% isopropyl alcohol and 85% ethanol by Amgros I/S), and another 5 min later new samples of *S. aureus* were collected from the 2 exact same locations as before ABHR (Copen, Brescia, Italy). Colony-forming units (CFU) of *S. aureus*, identified by the pink colony colours on the selective plates, were counted on each plate by ocular inspection by experienced laboratory technicians. If more than 200 colonies were counted the sample was diluted 10-fold and plated again. The mean CFU was calculated based on the duplicates of each sample, and results from diluted samples were multiplied to assess the absolute CFU undiluted in the sample.

**Statistical analysis**

All values of CFU were log-transformed in order to obtain normality before comparisons and calculations. Comparison of CFU before and after occlusive glove wear and ABHR, respectively, was assessed using paired *t*-test of “before” and “after” log10-transformed values. A linear model was used to test for association between CFU (log10-transformed “before” sample) and HECSI. *p*-values <0.05 were considered statistically significant. R version 3.5.2 and RStudio were used (R Foundation for Statistical Computing, Vienna, Austria).

**RESULTS**

A total of 30 patients with chronic HE were included in the study and completed the glove intervention, and a sub-sample of patients (*n*= 17; 57%) also participated in the subsequent ABHR intervention (Fig. 1). Baseline demographics are shown in Table 1. The mean ± standard deviation (SD) age of the study population was 37 ± 12 years, 73% were female, and 90% had atopic HE. The most common sub-type of HE was irritant contact dermatitis (77%), followed by atopic contact dermatitis (10%) and subjective (personal) contact dermatitis (13%) (Table 1). A total of 25 patients were atopic, and 24 patients had contact dermatitis. The most common sites of lesions were hands (90%) and feet (40%). A total of 28 patients had at least one site of skin lesion and 13 patients had lesions on the face. The occurrence of lesions was greatest during the cold season (November–March) (not shown).

![Flow chart of the number (n) of patients with hand eczema with and without *Staphylococcus aureus* colonization on lesional skin included for occlusive glove wear and, subsequently, alcohol-based hand-rub (ABHR). Three patients were culture-negative before glove wear, but culture-positive after glove wear; thus they were also considered culture-positive before glove wear, although below the lower limit of detection. The last 17 patients included for glove wear also participated in the use of ABHR, of which 11 patients were colonized with *S. aureus* on lesional skin of hands and 6 patients were not colonized.](image-url)

**Table 1**

| **Included for glove wear** | **No S. aureus** | **S. aureus before glove wear** |
|-----------------------------|------------------|-----------------------------|
| *n*= 30                     | *n*= 11          | *n*= 19                     |
| **(not detectable: n= 3)**  |                  |                            |
| **S. aureus after glove wear** | **Not included** | **S. aureus before ABHR** |
| *n*= 11                     | *n*= 8           | *n*= 11                     |
| **S. aureus after ABHR**    | **S. aureus not detectable after ABHR** | *n*= 4 |
| *n*= 7                      |                  |                            |

Fig. 1. Flow chart of the number (n) of patients with hand eczema with and without *Staphylococcus aureus* colonization on lesional skin included for occlusive glove wear and, subsequently, alcohol-based hand-rub (ABHR). Three patients were culture-negative before glove wear, but culture-positive after glove wear; thus they were also considered culture-positive before glove wear, although below the lower limit of detection. The last 17 patients included for glove wear also participated in the use of ABHR, of which 11 patients were colonized with *S. aureus* on lesional skin of hands and 6 patients were not colonized.
49.5 ± 13.0 years, and 20 (66%) were females. A medical history of AD was reported in 11 patients (37%). The most prevalent HE sub-type was irritant contact dermatitis (n = 11; 37%) and atopic HE (n = 9; 30%), followed by allergic contact dermatitis (n = 5; 17%), hyperkeratotic (n = 3; 10%) and acute recurrent vesicular (n = 2; 7%) HE. Treatment comprised topical corticosteroids (n = 13; 43%), topical tacrolimus 0.1% (n = 11; 37%), systemic therapy with methotrexate (n = 2; 7%) and alitretinoin (n = 1; 3%).

The mean ± SD HECSI score for all patients was 66.1 ± 29.8 (Table I); and was higher in patients with S. aureus colonization on lesional skin (77.6 ± 34.0) compared with patients without S. aureus colonization (53.0 ± 17.3) (p = 0.02).

### Oclusive glove wear

Prior to the glove intervention, 16 patients (53%) were colonized with S. aureus on lesional skin on the hands, and 11 patients (37%) were colonized on non-lesional skin. All patients colonized with S. aureus on non-lesional skin on the hands were also colonized on lesional skin. After oclusive glove wear, the relative S. aureus CFU count was increased, with a log10 (after/before)-ratio of 1.720 on lesional skin (p < 0.01), whereas no increase was observed for non-lesional skin (p = 0.63) (Table II). For 3 patients, S. aureus was identified after the intervention only, and since it is likely that S. aureus was present before the intervention, though below the detection limit in these patients, they are included in the calculation with “before” values of 1 CFU as stand-in for zero and below the lower limit of detection (Table II).

Lesional skin sample sites and the relative changes (log10-ratio) in S. aureus density following the glove intervention are shown in Fig. 2. Lesional skin samples were collected from the ventral side of the hand (n = 18) and the dorsal side of the hand (n = 12). The relative increase in S. aureus density after the glove intervention was similar on both sides of the hand.

The relative increase (log10-ratio) in S. aureus density following oclusive glove wear was not related to HECSI score (p = 0.66).

The absolute S. aureus CFU/sample before wearing gloves for patients with S. aureus colonisation was not significantly correlated with increased HECSI (p = 0.17).

### Alcohol-based hand-rub

Among the 17 patients participating in the use of ABHR after oclusive glove wear, 11 patients (65%) were colonized with S. aureus on lesional skin and of these, 4 patients (24%) were also colonized on non-lesional skin (Table II). A medical history of AD was reported in 8 (47%) of these patients. After the use of ABHR, S. aureus was detectable in 7 patients (mean HECSI=88), i.e. ABHR eradicated S. aureus in 4 patients (mean HECSI=63). The relative S. aureus CFU count on lesional skin decreased, with a log10 (after/before)-ratio of 2.516 (p < 0.01).

### DISCUSSION

Knowing that 50–70% of patients with HE with moderate-to-severe disease are colonized by S. aureus on the hands, it is important to understand how commonly recommended procedures, such as the use of oclusive gloves and ABHR, affect S. aureus colonization. We found that the relative density of S. aureus increased dramatically on eczematous skin after the glove intervention. A single application of ABHR immediately after

---

**Table I. Baseline demographics and clinical data**

| Age, years, mean ± SD (range) | Patients with HE (n=30) | S. aureus positive patients (before glove intervention) (n=16) |
|------------------------------|-------------------------|---------------------------------------------------------------|
| Sex, female, n (%)           | 20 (66)                 | 11 (69)                                                       |
| Atopic dermatitis, yes, n (%)| 11 (37)                 | 8 (50)                                                        |
| Dominant sub-type of HE, n (%)|                        |                                                               |
| Irritant contact dermatitis   | 11 (37)                 | 3 (19)                                                        |
| Allergic contact dermatitis   | 5 (17)                  | 4 (25)                                                        |
| Atopic                       | 9 (30)                  | 7 (44)                                                        |
| Hyperkeratotic               | 3 (10)                  | 1 (6)                                                         |
| Acute recurrent vesicular     | 2 (7)                   | 1 (6)                                                         |

**Table II. Staphylococcus aureus counts on lesional skin (LS) and non-lesional skin (NLS) of patients with hand eczema (n=30) before and after oclusive glove wear for 2 + 2 hours and alcohol-based hand-rub**

| Exposure, skin sampling site | S. aureus frequency (detectably present), n (%) | S. aureus CFU/sample log10, geometric mean (SD) |
|------------------------------|-----------------------------------------------|-----------------------------------------------|
|                              | Before, After | Before, After | Ratio (log10 (after/before)), (95% CI) | p-value** |
| Oclusive glove wear          |                |               |                                     |          |
| LS (eczema) (n=30)           | 16 (53)       | 19 (63)       | 2.731** (1.44)                      | 4.452 (1.64) | 1.720 (1.28; 2.16) | <0.001 |
| NLS (dorsal hand) (n=30)     | 11 (37)       | 6 (20)        | 1.696 (0.85)                        | 1.460 (1.52) | –0.186 (–1.00; 0.63) | 0.625 |
| Alcohol-based hand-rub       |                |               |                                     |          |
| LS (eczema) (n=17)           | 11 (65)       | 7 (41)        | 4.531 (1.58)                        | 2.015 (1.92) | –2.516 (–3.78; –1.25) | 0.001 |

*Paired t-test. **Undetectable S. aureus are counted as 1 colony forming unit (CFU)/sample present, 3 for LS, 5 for NLS. †Undetectable S. aureus are counted as 1 CFU/sample present, 4 for LS. Bold indicates statistically significant p-values.
wearing occlusive gloves reduced the density of *S. aureus* from the eczematous lesions on the hands, but eradicated colonization in only less than half of the patients, which may have severe implications, e.g. for healthcare workers regarding transmission of bacteria to patients. These effects of commonly used and recommended procedures have, to our knowledge, not previously been investigated in patients with HE.

The mechanisms driving the large increase in density of *S. aureus* after occlusive glove wear in our patients are not fully understood. However, wet hands, in contrast to dry hands, have been documented to increase the likelihood of microbial transmission (22). Thus, factors such as heating and hyper-hydration of the skin surface underneath the glove may lead to higher *S. aureus* growth rate or to *S. aureus* being released from the surface and thereby being more accessible to a swab. We believe that both factors may explain the current results. Accordingly, this might also partly explain why we only observed a significant increase on the eczematous lesional skin with impaired skin barrier and not on the intact, non-lesional skin. *S. aureus* is a facultative anaerobic bacterium with a strain-specific growth rate that increases with higher temperatures (23). Patients were enrolled consecutively throughout 1 year, and consequently, the temperature and humidity of the examination room changed slightly. Generation times of *S. aureus* have been reported to range from 1 to 3 h during human nasal colonization (24). Therefore, cell division of *S. aureus* cannot solely explain our observed many-fold increase after 4.5 h. Acidic skin surface pH has been suggested to inhibit bacterial growth, dispersal and adhesion compared with more alkaline pH (25). In a previous study (26) skin pH increased after 4 days of occlusion of the arm of healthy volunteers, with an additional considerable increase in coagulase-negative staphylococci count, indicating that occlusion may cause the skin pH to become more alkaline and thereby contribute to bacterial growth, as observed in the current study. Adhesion, or binding capacity, of *S. aureus* to the skin may also be determined by other factors, such as lectin or sugar (glycocalyx) binding interactions (27). Likewise, *S. aureus* expresses a variety of adhesive surface proteins, so-called “microbial surface components recognizing adhesive matrix molecules” (MSCRAMMs), which bind more easily to atopic eczematous lesions than to intact skin (28). Whether these binding interactions are altered following glove wear needs to be explored. Other, unidentified mechanisms might contribute to explain the current results.

Occlusive glove wear is an integral part of wet work occupations, where HE is reported with a prevalence of up to 20% or even higher (6, 29). Several patients experience a chronic course of HE despite circumvention of relevant allergens and irritants. The potential role of *S. aureus* in the chronic aspect of HE has been suggested (5), and might be supported by the current results on the increased density of *S. aureus* following glove occlusion. The severity of HE in the patients in the current study was strongly related to the presence of *S. aureus*, supporting previous studies (2–4, 30, 31). The severity was not significantly associated with the density of *S. aureus*, in contrast to 2 previous studies (3, 30).

The impact of occlusive glove wear on *S. aureus* colonization also needs to be considered with respect to the risk of contamination of the local environment, particularly in the healthcare sector and the food industry. According to the Danish infection control and prevention recommendations in hospital settings (32), healthcare workers with HE should avoid close contact with patients and instead perform other tasks. The World Health Organization (WHO) states that occlusive gloves should be worn to prevent transmission of pathogenic microorganisms (33), especially when eczema is present (34). Therefore, a potential paradox is present: occlusive gloves are considered to protect from transmission of pathogenic bacteria, although they may serve as an “incubator” or reservoir for *S. aureus*, thus causing an even higher density of *S. aureus* once the gloves are removed or in case of puncture (11, 35), and eradication with ABHR may even be difficult.

Although ABHR is generally the first choice for hand hygiene in healthcare sectors (36) and is advised prior
to glove wear in some procedures (33), its effectiveness varies and depends on compliance (37), the type of alcohol used (38), the application technique (39), the amount of ABHR used, and density of bacterial loads (38). We hypothesize, that the effectiveness of ABHR in patients with HE might be decreased due to high loads of Staphylococcus aureus, increased adherence of Staphylococcus aureus to the eczematous lesions, or due to insufficient rub of the painful ABHR application. Although the current results show that ABHR significantly reduced the density of Staphylococcus aureus in patients with HE, complete eradication was observed in only a few patients.

Reduced time of exposure to occlusive gloves, or wearing cotton gloves underneath the occlusive gloves, could have influenced the current results of the glove intervention, making them less pronounced. Furthermore, the increase in density of the sampled Staphylococcus aureus might have been reduced if bactericidal and/or powdered gloves had been used. Vinyl occlusive gloves were used in order to avoid the possible danger of sensitization, although the fit and permeability are different compared with those of nitrile or latex gloves, and the results are not directly transferable. However, there is no evidence to show that the use of latex or nitrile gloves would have changed the results of the current study.

The accuracy of the swab sampling technique, in contrast to the previously described “glove juice” method, where PBS liquid from inside a glove is used to assess Staphylococcus aureus CFU released from the entire hand surface (3, 40) is a matter of debate. However, swabs are suitable for the investigation of specified sites, i.e. lesional and non-lesional skin, respectively, and for subsequent sampling and thereby the current study design, in which the “glove juice” method is not suitable. In order to minimize variation biases, the same investigator performed all samplings in a standardized manner and one of the same two laboratory technicians evaluated both cultures from each patient. Regarding the ABHR-intervention, it was a drawback that only a sub-group participated, and these results should be considered as preliminary findings to be further investigated in larger studies.

The current results are surprisingly clear; however, the current findings are required to be repeated and assessed using additional different study designs. Research into the dose–response relationship between length of time of occlusive glove wear and Staphylococcus aureus growth is needed.

Little attention has been paid to Staphylococcus aureus colonization in patients with HE, although it has been proposed to influence disease severity and prognosis, and furthermore, may result in contamination of the local environment. This study found that prolonged wear of occlusive gloves results in a sizeable increase in the density of Staphylococcus aureus sampled from patients with HE. The use of ABHR reduced the density of Staphylococcus aureus, although Staphylococcus aureus was not completely eradicated in several of the patients with HE.

ACKNOWLEDGEMENTS

The authors thank Nrs Jette Holt, PhD, and Dr Anne Kjerulf, PhD, from the Department of Infectious Disease Epidemiology and Prevention at Statens Serum Institute, Copenhagen, Denmark, for valuable discussions about the study.

This work was supported by The Danish Working Environment Fund (grant number 20185100823); Augustinusfonden; and Aage Bangs Fond. The funding sources were not involved in this study, including the study design; the collection, analysis and interpretation of data; the writing of the paper; or the submission process.

Conflicts of interest: TA: Personal fees from advisory boards (Leo Pharma, Sanofi, Pfizer and Eli-Lilly); involved in Clinical trial (Abbvie); personal fees from consultancy, lectures (Leo Pharma, Sanofi); outside this paper. The other authors have no conflicts of interest to declare.

REFERENCES

1. Quaade AS, Simonsen AB, Halling AS, Thyssen JP, Johansen JD. Prevalence, incidence and severity of hand eczema in the general population – a systematic review and meta-analysis. Contact Dermatitis 2021; 84: 361–374.
2. Haslund P, Bangsgaard N, Jarlov JO, Skov L, Skov R, Agner T. Staphylococcus aureus and hand eczema severity. Br J Dermatol 2009; 161: 772–777.
3. Merneilu S, Carlsson E, Henricson J, Lofgren S, Lindgren PE, Ehrich R, et al. Staphylococcus aureus colonization related to severity of hand eczema. Eur J Clin Microbiol Infect Dis 2016; 35: 1355–1361.
4. Narreslet LB, Edslev SM, Andersen PS, Plum F, Holt J, Kjerulf A, et al. Colonisation with Staphylococcus aureus in patients with hand eczema: prevalence and association with severity, atopic dermatitis, subtype and nasal colonisation. Contact Dermatitis 2020; 83: 442–449.
5. Agner T, Elnser P. Hand eczema: epidemiology, prognosis and prevention. J Eur Acad Dermatol Venereol 2020; 34: 4–12.
6. Hammernius N, Svedman C, Bergendoff O, Bjork J, Bruze M, Ponten A. Wet work exposure and hand eczema among healthcare workers: a cross-sectional study. Br J Dermatol 2018; 178: 452–461.
7. Lund T, Petersen SB, Flachs EM, Ebbehej NE, Bonde JP, Agner T. Risk of work-related hand eczema in relation to wet work exposure. Scand J Work Environ Health 2020; 46: 437–445.
8. Lund T, Flachs EM, Sørensen JA, Ebbehej NE, Bonde JP, Agner T. A job-exposure matrix addressing hand exposure to wet work. Int Arch Occup Environ Health 2019; 92: 959–966.
9. Ramsing DW, Agner T. Effect of glove occlusion on human skin (I). Long-term experimental exposure. Contact Dermatitis 1996; 34: 258–262.
10. Tiedemann D, Clausen ML, John SM, Angelova-Fischer I, Kezic S, Agner T. Effect of glove occlusion on the skin barrier. Contact Dermatitis 2016; 74: 2–10.
11. Eklund AM, Ojajärvi J, Laitinen K, Valtonen M, Werkkala KA. Glove punctures and postoperative skin flora of hands in cardiac surgery. Ann Thorac Surg 2002; 74: 149–153.
12. Wistrand C, Söderquist B, Falk-Brynildsen K, Nilsson U. Exploring bacterial growth and recolonization after preoperative hand disinfection and surgery between operating room nurses and non-health care workers: a pilot study. BMC Infect Dis 2018; 18: 466–473.
13. Rotter ML, Kampf G, Suchomel M, Kundt M. Population kinetics of the skin flora on gloved hands following surgical hand disinfection with 3 propanol-based hand rubs: a prospective, randomized, double-blind trial. Infect Control Hosp Epidemiol 2007; 28: 346–350.
14. Kampf G, Meyer B, Goronyc-Bermes P. Comparison of two test methods for the determination of sufficient antimicrobial activity of three commonly used alcohol-based hand rubs for hygienic hand disinfection. J Hosp Infect 2003; 55: 220–225.
15. Kampf G, Ostermeyer C, Heeg P, Paulson D. Evaluation of
two methods of determining the efficacies of two alcohol-based hand rubs for surgical hand antisepsis. Appl Environ Microbiol 2006; 72: 3856–3861.

16. Diepgen TL, Andersen KE, Chosidow O, Coenraads PJ, Elsner P, English J, et al. Guidelines for diagnosis, prevention and treatment of hand eczema. J Dtsch Dermatol Ges 2015; 13: e1–22.

17. Held E, Skoet R, Johansen JD, Agner T. The hand eczema severity index (HECSI): a scoring system for clinical assessment of hand eczema. A study of inter- and intraobserver reliability. Br J Dermatol 2005; 152: 302–307.

18. Oosterhaven JAF, Schutteelaar MLA. Responsiveness and interpretability of the Hand Eczema Severity Index. Br J Dermatol 2020; 182: 932–939.

19. Agner T, Aalto-Korte K, Andersen KE, Foti C, Gimenez-Arnau A, Goncalo M, et al. Classification of hand eczema. J Eur Acad Dermatol Venereol 2015; 29: 2417–2422.

20. Stenberg B, Lindberg M, Meding B, Svensson A. Is the question ‘Have you had childhood eczema?’ useful for assessing childhood atopic eczema in adult population surveys? Contact Dermatitis 2006; 54: 334–337.

21. Domingue G, Costerton JW, Brown MR. Bacterial doubling time modulates the effects of opsonisation and available iron upon interactions between Staphylococcus aureus and human neutrophils. FEMS Immunol Med Microbiol 1996; 16: 223–228.

22. Gammon J, Hunt J. COVID-19 and hand hygiene: the vital importance of hand drying. Br J Nurs 2020; 29: 1003–1006.

23. Belay N, Rasooly A. Staphylococcus aureus growth and entero-toxin A production in an anaerobic environment. J Food Protection 2002; 65: 199–204.

24. Szafranska AK, Junker V, Steglich M, Nübel U. Rapid cell division of Staphylococcus aureus during colonization of the human nose. BMC Genomics 2019; 20: 229–241.

25. Lambers H, Piessens S, Bloem A, Pronk H, Finkel P. Natural skin surface pH is on average below 5, which is beneficial for its resident flora. Int J Cosmet Sci 2006; 28: 359–370.

26. Aly R, Shirley C, Cunico B, Maibach HI. Effect of prolonged occlusion on the microbial flora, pH, carbon dioxide and transdermal water loss on human skin. J Invest Dermatol 1978; 71: 378–381.

27. Costerton JW, Geesey GG, Cheng KJ. How bacteria stick. Sci Am 1978; 238: 86–95.

28. Hepburn L, Hjñen DJ, Sellman BR, Mustelin T, Sleeeman MA, May RD, et al. The complex biology and contribution of Staphylococcus aureus in atopic dermatitis, current and future therapies. Br J Dermatol 2017; 177: 63–71.

29. Ibler KS, Jemec GB, Flyvholm MA, Diepgen TL, Jensen A, Agner T. Hand eczema: prevalence and risk factors of hand eczema in a population of 2274 healthcare workers. Contact Dermatitis 2012; 67: 200–207.

30. Tauber M, Berard E, Lourari S, Questel E, Redoules D, Paul C, et al. Latent class analysis categorizes chronic hand eczema patients according to skin barrier impairment. J Eur Acad Dermatol Venereol 2020; 34: 1529–1535.

31. Wang X, Xu W, Chen Y, Zhang C, Chen L, Lu Y, et al. Staphylococcus aureus colonization and chronic hand eczema: a multicenter clinical trial. Arch Dermatol Res 2019; 311: 513–518.

32. Statens Serum Institut, Central Enhed for Infektionshygiejne 2.1 udgave 2021, Nationale Infektionshygiejniskes Retningslinjer [cited 2021 May]. Available from: https://hygiejne.ssi.dk/NIRhaandhygiejne.

33. World Health Organization (WHO). Glove use information leaflet 2009 [cited May 2020]. Available from: https://www.who.int/gpsc/5may/Glove_Use_Information_Leaflet.pdf.

34. World Health Organization. Best Practices for Injections and Related Procedures Toolkit. Annex A, Indications for glove use in health care. 2010. [cited 2021 May]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK138494/.

35. Harnoss JC, Partecke LI, Heidecke CD, Hübner NO, Kramer A, Assadian O. Concentration of bacteria passing through puncture holes in surgical gloves. Am J Infect Control 2010; 38: 154–158.

36. World Health Organization (WHO). Hand hygiene, why, how and when 2009 [cited May 2020] Available from: https://www.who.int/gpsc/5may/Hand_Hygiene_Why_How_and_When_Brochure.pdf.

37. 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: 283–294.

38. Gold NA, Mirza TM, Avva U. Alcohol sanitizer. StatPearls. Treasure Island, FL: StatPearls Publishing, ©2020, StatPearls Publishing LLC.; 2020.

39. Widmer AE, Dangel M. Alcohol-based handrub: evaluation of technique and microbiological efficacy with international infection control professionals. Infect Control Hosp Epidemiol 2004; 25: 207–209.

40. Fagernes M, Lingaas E. Factors interfering with the microflora on hands: a regression analysis of samples from 465 health-care workers. J Adv Nurs 2011; 67: 297–307.