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ORIGINAL PAPER

Staphylococcus aureus colonization and chronic hand eczema: a multicenter clinical trial

Xin Wang[1] · Wei Xu[2] · Yue Chen[3] · Chengzhong Zhang[1] · Liuqing Chen[4] · Yan Lu[5] · Weimin Shi[1] · Linfeng Li[2]

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Abstract

Chronic hand eczema is a common chronic inflammatory skin disease that influences public health. *Staphylococcus aureus* colonization plays important roles in chronic hand eczema morbidity and progression, which also correlated to chronicity and severity of the disease. In this multicenter clinical trial, we aim to investigate the relationship between *S. aureus* colonization and chronic hand eczema. Eighty patient volunteers diagnosed with chronic hand eczema in 4 hospitals from 4 cities participated in this study. *Staphylococcus aureus* colonization was determined using Polymerase Chain Reaction and fluorescent labeling probe to rapidly detect the endemic thermostable nuclease gene nuc of *S. aureus* in clinical samples. All patients were treated with Halometasone Triclosan Cream for 2 weeks. The changes of clinical symptom scores were observed during the follow-up time. We found that the severity of chronic hand eczema was related to *S. aureus* colonization. Chronic hand eczema would remain severer than others if *S. aureus* colonization was not eliminated. Eliminating *S. aureus* colonization could provide good effectiveness in treatment of chronic hand eczema. Therefore, we make a proposal that detection and treatment of *S. aureus* should be considered in the clinical treatment of chronic hand eczema.

Keywords *Staphylococcus aureus* colonization · Chronic hand eczema · Clinical symptom scores · Multicenter · Clinical trial

Abbreviations

CHE	Chronic hand eczema
SA	*Staphylococcus aureus*
HECSI	Hand Eczema Severity Index
HEES	Hand Eczema Extent Score
IGA	Investigator's Global Assessment
DLQI	Dermatology Life Quality Index
VAS	Visual Analogue Scales
SSRI	Symptom Score Reducing Index

Xin Wang, Wei Xu and Yue Chen contributed equally to this work.

✉ Weimin Shi
weiminshisjtu@163.com

✉ Linfeng Li
zoonli@sina.com

1 Department of Dermatology, Shanghai General Hospital, Shanghai Jiaotong University School of Medicine, 100 Haining Road, Shanghai 200080, China

2 Department of Dermatology, Beijing Friendship Hospital, Capital Medical University, 95 Yongan Road, Beijing 100050, China

3 Department of Dermatology, Shanghai General Hospital of Nanjing Medical University, 100 Haining Road, Shanghai 200080, China

4 Department of Dermatology, Wuhan No. 1 Hospital, 215 Zhongshan Road, Wuhan 430022, China

5 Department of Dermatology, Jiangsu Province Hospital, The First Affiliated Hospital of Nanjing Medical University, 300 Guangzhou Road, Nanjing 210029, China

Introduction

Chronic hand eczema (CHE) is an eczematous disease course which lasts for more than 3 months or relapses more than twice in a year [1]. Since hand eczema is a highly visible skin disease, CHE is always associated with anxiety, socially awkward or inferiority because it is a visible disease [2]. Treatment of hand eczema is very difficult because of the different pathogeneses, courses, and prognoses [3]. Therefore, the study on chronic hand eczema has important clinical values.

Bacterial infections play vital roles in morbidity and progression of hand eczema, which also associated with severity and chronicity of the disease. Some studies have demonstrated that *Staphylococcus aureus* (SA)

colonization is one of the important pathogenic factor in atopic dermatitis [4, 5], and is also associated with the disease severity of atopic dermatitis [6]. The *S. aureus* may produce superantigens and permeate the skin barrier and lead to severe skin inflammation [7, 8].

In our previous study, we reported a new method of PCR to detect *S. aureus* in CHE and our study showed that the PCR method is superior to the traditional method of germiculture in detecting the *S. aureus* [9]. In this study, we collected clinicopathological data for all the patients and analyzed the correlation of *S. aureus* colonization with the severity and prognosis of the disease. Each patient with CHE were treated with Sicorten plus (Halometasone Triclosan Cream) for 2 weeks and followed up. Halometasone Triclosan Cream is a compound preparation and the main components are 0.05% Halometasone and 1% Triclosan, so it has the double effects of anti-inflammatory and antibacterial. We aim to reveal the influence of *S. aureus* colonization to the severity and prognosis of CHE.

Materials and methods

Ethics and selection of patients

This research was approved by the Institutional Research Ethics Committee of Beijing Friendship Hospital Capital Medical University, Jiangsu Province Hospital, Shanghai General Hospital and Wuhan No. 1 Hospital and abided by the ethical guidelines of the Declaration of Helsinki. Informed consents were obtained from all the patients involved in this study. This study was registered at ClinicalTrials.gov, identifier: NCT03246776. From October 1 to November 31, 80 patient volunteers with chronic hand eczema from the former 4 hospitals in the 4 cities participated in this study. The diagnosis of chronic hand eczema was established based on the 2011 guidelines for eczema diagnosis and treatment designated by Immunology Group, Dermatovenereology Society, Chinese Medical Association.

PCR method of detecting *Staphylococcus aureus*

Staphylococcus aureus and methicillin-resistant *S. aureus* Nucleic Acid Detection Kit (Fluorescent PCR) (Triplex International Biosciences (China) CO., LTD.) was used to detect *S. aureus*. In brief, the kit uses Polymerase Chain Reaction (PCR) and fluorescent-labeling probe to rapidly detect the endemic thermostable nuclease gene nuc of *S. aureus* in clinical samples to make qualitative diagnosis.

Clinical symptom scores

The Hand Eczema Severity Index (HECSI) scoring system [10], the Hand Eczema Extent Score (HEES) [11], the Investigator's Global Assessment (IGA) [12], the Dermatology Life Quality Index (DLQI) [13], Visual Analogue Scales (VAS) itch score [14] and Symptom Score Reducing Index (SSRI) were used in this study.

Statistical analysis

Statistical analysis was performed using the SPSS program (version 18.0; SPSS, Chicago, IL, USA). The statistical significance of differences between two groups was calculated by Student's t test (two-sided) or χ^2 test. $p < 0.05$ was considered as statistically significant.

Results

Grouping and baseline data analyses

Eighty patient volunteers including 39 male and 41 female diagnosed with chronic hand eczema participated in this study, and the ages were from 21 to 72 years, average 54 years old. In our previous study, we established a new method of PCR to detect *S. aureus* in CHE and our study showed that the PCR method is superior to the traditional method of germiculture in detecting the *S. aureus* [2]. In this study, we further continued the multicenter study and collected clinicopathological data for all the 80 patients (30 patients from Beijing, 20 patients from Shanghai, 10 patients from Nanjing and 20 patients from Wuhan). First, the patients were divided into two groups according to the PCR detection results, SA-negative group and SA-positive group. Then, the baseline data of the two groups were compared with Student's t test or χ^2 test. The result showed that there was no statistical significance of differences of the baseline data between the two groups (Table 1). This indicated that there were no age and gender differences of *S. aureus* colonization in CHE patients and *S. aureus* colonization did not influence body temperature, heart rate, respiration and blood pressure.

The severity of CHE was related to *Staphylococcus aureus* colonization

Clinical symptoms of CHE were estimated using HECSI scoring system [9], HEES score [1], IGA score [14], DLQI score [6], and VAS itch score [15]. To verify the relation between *S. aureus* and the severity of CHE, the five clinical

Table 1 Comparison of baseline data between patients with SA negative and SA positive

Baseline data	SA negative ($n=50$)	SA positive ($n=30$)	p
Age (year)[a]	55.16 ± 10.81	52.20 ± 11.37	0.25
Gender (male/female) [b]	25/25	14/16	0.48
Body temperature (°C)[a]	36.62 ± 0.40	36.70 ± 0.44	0.42
Heart rate (per min)[a]	74.90 ± 6.29	78.57 ± 9.17	0.059
Respiratory rate (per min)[a]	18.08 ± 1.71	18.06 ± 2.16	0.74
Systolic blood pressure (mmHg)[a]	123.08 ± 8.94	125.83 ± 8.71	0.18
Diastolic blood pressure (mmHg)[a]	75.98 ± 7.42	75.73 ± 8.25	0.89

SA, *Staphylococcus aureus*

[a]Statistics was done by Student's t test, data are shown as mean ± SD

[b]Statistics was done by χ^2 test

symptom scores of the two groups were compared with Student's t test. The result was that the SA-positive group showed higher HECSI score, HEES score, IGA score, DLQI score and VAS itch score. This indicated that CHE would be severer with *S. aureus* colonization and patients would have poorer quality of life and suffer from intense itch with *S. aureus* colonization (Table 2).

CHE will remain severer if *Staphylococcus aureus* colonization was not eliminated

To investigate the effectiveness of eliminating *S. aureus* in treatment of CHE, Halometasone Triclosan Cream was used for the 80 patients for 2 weeks. Halometasone Triclosan Cream is a compound preparation and the main components are 0.05% Halometasone and 1% Triclosan, so it has the double effects of anti-inflammatory and antibacterial. There were also 14 patients who remained *S. aureus* positive after the 2 weeks. Then, the 80 patients were divided into 2 groups again, SA negative after treatment group and SA positive after treatment group. First, the clinical symptoms of CHE were estimated using the former five clinical symptom scores. Then, the five clinical symptom scores of the two groups were compared with Student's t test. The result was that the SA positive after treatment group showed higher HECSI score, HEES score, IGA score, DLQI score and VAS itch score. This indicates that CHE would remain severer and patients will have poorer quality of life and suffer from intense itch if *S. aureus* colonization was not eliminated (Table 3).

Table 2 Comparison of clinical symptom scores of patients with SA negative and SA positive

Clinical symptom scores	SA negative ($n=50$)	SA positive ($n=30$)	p
HECSI			
Fingertips	6.02 ± 5.06	17.10 ± 16.90	**0.001**
Fingers (except tips)	8.80 ± 6.61	17.93 ± 11.48	**< 0.001**
Palm of hands	11.86 ± 9.05	18.83 ± 13.13	**0.014**
Back of hands	3.62 ± 6.03	7.33 ± 13.49	0.16
Wrists	1.26 ± 4.30	3.33 ± 9.42	0.35
Total	31.92 ± 17.87	64.53 ± 39.29	**< 0.001**
HEES			
Left hand	13.36 ± 4.65	19.20 ± 5.96	**< 0.001**
Right hand	13.18 ± 4.77	18.87 ± 6.24	**< 0.001**
Total	26.54 ± 9.04	38.07 ± 12.00	**< 0.001**
IGA	3.12 ± 0.39	3.67 ± 0.76	**0.001**
DLQI	10.14 ± 5.82	15.37 ± 5.23	**< 0.001**
VAS itch	5.32 ± 2.87	7.77 ± 2.19	**< 0.001**

Bold values indicate $p < 0.05$

SA, *Staphylococcus aureus*; HECSI, Hand Eczema Severity Index; HEES, Hand Eczema Extent Score; IGA, Investigator's Global Assessment; DLQI, Dermatology Life Quality Index; VAS, Visual Analogue Scales. Statistics was done by Student's t test, data are shown as mean ± SD

Table 3 Comparison of clinical symptom scores of patients with SA negative after treatment and SA positive after treatment

Clinical symptom scores	SA negative ($n=66$)	SA positive ($n=14$)	p
HECSI			
Fingertips	3.23 ± 3.61	8.64 ± 10.57	0.080
Fingers (except tips)	5.05 ± 4.82	12.50 ± 6.89	**0.001**
Palm of hands	7.44 ± 6.12	14.29 ± 11.33	**0.045**
Back of hands	1.08 ± 2.32	7.43 ± 11.64	0.063
Wrists	0.67 ± 1.82	3.57 ± 9.61	0.28
Total	17.46 ± 11.32	46.43 ± 29.90	**0.003**
HEES			
Left hand	8.64 ± 4.23	16.14 ± 7.13	**0.002**
Right hand	9.03 ± 4.35	15.93 ± 7.42	**0.004**
Total	17.67 ± 7.60	32.07 ± 14.54	**0.003**
IGA	1.82 ± 0.70	2.79 ± 0.98	**0.003**
DLQI	5.23 ± 4.26	11.29 ± 4.92	**< 0.001**
VAS itch	2.89 ± 1.99	6.29 ± 1.98	**< 0.001**

Bold values indicate $p < 0.05$

SA, *Staphylococcus aureus*; HECSI, Hand Eczema Severity Index; HEES, Hand Eczema Extent Score; IGA, Investigator's Global Assessment; DLQI, Dermatology Life Quality Index; VAS, Visual Analogue Scales. Statistics was done by Student's *t* test, data are shown as mean ± SD

Eliminating *Staphylococcus aureus* colonization could bring good effectiveness in treatment of chronic hand eczema

How is the effect of the treatment for those patients *S. aureus* changed to negative from positive? To investigate it, the 80 patients were divided into 3 groups—group 1, *S. aureus* negative before treatment; group 2, *S. aureus* changed to negative from positive; and group 3, *S. aureus* remained positive after treatment. The five clinical symptom scores of the three groups were compared with each other by Student's *t* test. The result was that the SA positive after treatment group showed higher HECSI score, HEES score, IGA score, DLQI score and VAS itch score than other two groups. However, there are no statistical differences between group 1 and group 2 on HECSI score, HEES score, IGA score, DLQI score and group 2 showed lower VAS itch score than group 1 (Table 4). This indicated that when *S. aureus* colonization was eliminated, CHE would be no longer severer and quality of life would be no longer poorer than that of patients with *S. aureus* negative before treatment, and these patients even suffer from less itch.

Then, we established Symptom Score Reducing Index (SSRI) for evaluation of curative effect. The result was that group 2 showed higher SSRI score than other two groups (Table 4). This also demonstrated that CHE patients would benefit more if *S. aureus* colonization was eliminated. Meanwhile, group 3 showed lowest SSRI score on HEES and VAS itch score which suggested that CHE patients would benefit less on some aspects if *S. aureus* colonization was not eliminated (Table 5).

Discussion

There are some studies that found a higher *S. aureus* colonization rate on the hands of eczema patients as compared to healthy individuals. They also found the relationship between the presence of *S. aureus* and severity of HE and they resumed that high frequency of *S. aureus* found in patients with HE could be an important cofactor for persistence of the disease [15, 16]. In this study, we explored the relationship between *S. aureus* colonization and CHE; furthermore, we also investigated the importance of eliminating *S. aureus* colonization in treatment of CHE.

Staphylococcus aureus is an important pathogenic factor for HE, and is associated with the severity of the disease. The mode of action may be through super antigens from exotoxin-producing *S. aureus* strains, which penetrate the skin barrier and contribute to the persistence and exacerbation of skin inflammation [7, 8, 15]. This explains why *S. aureus* colonization can lead to CHE severer and make patients feel itchier in this study. Halometasone Triclosan Cream was used in this study and it is a compound preparation and the main components are 0.05% Halometasone and 1% Triclosan. Triclosan is a highly effective broad-spectrum antibacterial agent, which can kill and inhibit Gram-positive bacteria, negative bacteria, some epidermis fungi and virus. For the 30 *S. aureus*-positive patients, *S. aureus* of 16 patients changed to negative and 14 patients remained positive. Our study found that the patients with *S. aureus* changed to negative from positive got the best curative effect after the treatment. Since *S. aureus* colonization is an important etiology for CHE, eliminating *S. aureus* means

Table 4 Comparison of clinical symptom scores of patients from three groups

Clinical symptom scores	Group 1 ($n=50$)	Group 2 ($n=16$)	Group 3 ($n=14$)
HECSI			
Fingertips	2.58 ± 2.86	5.25 ± 4.89	8.64 ± 10.57
Fingers (except tips)[b,c]	4.80 ± 4.82	5.81 ± 4.92	12.50 ± 6.89
Palm of hands[c]	8.06 ± 6.47	5.50 ± 4.50	14.29 ± 11.33
Back of hands[c]	1.22 ± 2.52	0.63 ± 1.54	7.43 ± 11.64
Wrists	0.82 ± 2.05	0.19 ± 0.54	3.57 ± 9.61
Total[b,c]	17.48 ± 12.01	17.38 ± 9.17	46.43 ± 29.90
HEES			
Left hand[b,c]	8.40 ± 3.84	9.38 ± 5.35	16.14 ± 7.13
Right hand[b,c]	8.66 ± 4.37	10.19 ± 4.23	15.93 ± 7.42
Total[b,c]	17.06 ± 7.72	19.56 ± 7.13	32.07 ± 14.54
IGA[b,c]	1.90 ± 0.74	1.56 ± 0.51	2.79 ± 0.98
DLQI[b,c]	5.66 ± 4.49	3.88 ± 3.16	11.29 ± 4.92
VAS itch[a,b,c]	3.16 ± 2.09	2.06 ± 1.34	6.29 ± 1.98

SA, *Staphylococcus aureus*; Group 1, SA negative before treatment; Group 2, SA changed to negative from positive; Group 3, SA remained positive after treatment; HECSI, Hand Eczema Severity Index; HEES, Hand Eczema Extent Score; IGA, Investigator's Global Assessment; DLQI, Dermatology Life Quality Index; VAS, Visual Analogue Scales

[a] $p<0.05$ for group 1 vs group 2

[b] $p<0.05$ for group 1 vs group 3

[c] $p<0.05$ for group 2 vs group 3; statistics was done by Student's *t* test, data are shown as mean ± SD

Table 5 Comparison of SSRI for the clinical symptom scores of patients from three groups

SSRI of clinical symptom scores	Group 1 ($n=50$)	Group 2 ($n=16$)	Group 3 ($n=14$)
HECSI			
Fingertips[a,c]	0.56 ± 0.32	0.74 ± 0.18	0.45 ± 0.33
Fingers (except tips)[a,b,c]	0.47 ± 0.28	0.66 ± 0.19	0.23 ± 0.21
Palm of hands[a,c]	0.33 ± 0.27	0.68 ± 0.18	0.30 ± 0.27
Back of hands	0.66 ± 0.34	0.69 ± 0.41	0.37 ± 0.45
Wrists	0.40 ± 0.51	0.79 ± 0.26	0.53 ± 0.49
Total[a,c]	0.44 ± 0.24	0.67 ± 0.15	0.35 ± 0.24
HEES			
Left hand[a,b,c]	0.36 ± 0.21	0.53 ± 0.24	0.13 ± 0.13
Right hand[b,c]	0.33 ± 0.25	0.44 ± 0.21	0.17 ± 0.18
Total[a,b,c]	0.33 ± 0.23	0.49 ± 0.16	0.15 ± 0.15
IGA[a,c]	0.34 ± 0.24	0.53 ± 0.18	0.27 ± 0.21
DLQI[a,c]	0.43 ± 0.29	0.73 ± 0.18	0.28 ± 0.26
VAS itch[a,b,c]	0.42 ± 0.29	0.61 ± 0.28	0.24 ± 0.20

SSRI, Symptom Score Reducing Index; SA, *Staphylococcus aureus*; Group 1, SA negative before treatment; Group 2, SA changed to negative from positive; Group 3, SA remained positive after treatment; HECSI, Hand Eczema Severity Index; HEES, Hand Eczema Extent Score; IGA, Investigator's Global Assessment; DLQI, Dermatology Life Quality Index; VAS, Visual Analogue Scales

[a] $p<0.05$ for group 1 vs group 2

[b] $p<0.05$ for group 1 vs group 3

[c] $p<0.05$ for group 2 vs group 3; statistics was done by Student's *t* test, data are shown as mean ± SD

eliminating one of the causes of the disease. Therefore, these patients may benefit more than other patients. In the meanwhile, CHE of these patients will be no longer severer and quality of life will be no longer poorer than that of patients with *S. aureus* negative before treatment, and these patient even suffer from less itch. Thus, we hold the opinion that treatment of *S. aureus* colonization in CHE is necessary.

However, not all the *S. aureus* colonization could be easily eliminated. For those patients remained *S. aureus* positive after treatment, the disease remained severer than others.

What is more, these patients benefited less from the treatment. The questions come to us that whether or not some of the refractory CHE is due to the intractable *S. aureus* colonization? This might urge us to reassess the role of *S. aureus* played in CHE and discuss the importance of detection and treatment for *S. aureus*. We think regular follow-up and detection of *S. aureus* is essential. We reported a new method of PCR which is superior to the traditional method of germiculture in detecting the *S. aureus* [2]. This method is quicker and more accurate which might be widely used in the future.

Nevertheless, we admitted that treatment of *S. aureus* using Triclosan was only an experimental therapy and we only aimed to find the relation between *S. aureus* colonization and CHE in this study. Therefore, we raise an issue that treatment for *S. aureus* in CHE needs further investigation and should formulate guidelines, especially for the intractable *S. aureus* colonization.

In conclusion, our study revealed that the severity of CHE was related to the colonization of *S. aureus* and eliminating *S. aureus* colonization could bring good effectiveness in CHE. We make a proposal that detection and treatment of *S. aureus* should be considered in the clinical treatment of CHE.

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Author contributions WS and LL designed the study; XW, WX, YC, CZ, LC and YL collected, analyzed, and interpreted the data; XW, WS and LL drafted the manuscript. All the authors critically read and approved the manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

References

1. Diepgen TL, Andersen KE, Chosidow O, Coenraads PJ, Elsner P, English J, Fartasch M, Gimenez-Arnau A, Nixon R, Sasseville D et al (2015) Guidelines for diagnosis, prevention and treatment of hand eczema. J Dtsch Dermatol Ges 13:e1–e22. https://doi.org/10.1111/ddg.12510
2. Diepgen TL, Agner T, Aberer W, Berth-Jones J, Cambazard F, Elsner P, McFadden J, Coenraads PJ (2007) Management of chronic hand eczema. Contact Dermat 57:203–210. https://doi.org/10.1111/j.1600-0536.2007.01179.x
3. de Leon FJ, Berbegal L, Silvestre JF (2015) Management of chronic hand eczema. Actas Dermosifiliogr. 106:533–544. https://doi.org/10.1016/j.ad.2015.04.005
4. Hanifin JM, Rogge JL (1977) Staphylococcal infections in patients with atopic dermatitis. Arch Dermatol 113:1383–1386. https://doi.org/10.1001/archderm.1977.01640100061009
5. Williams RE, Gibson AG, Aitchison TC, Lever R, Mackie RM (1990) Assessment of a contact-plate sampling technique and subsequent quantitative bacterial studies in atopic dermatitis. Br J Dermatol 123:493–501. https://doi.org/10.1111/j.1365-2133.1990.tb01455.x
6. Leyden JJ, Marples RR, Kligman AM (1974) *Staphylococcus aureus* in the lesions of atopic dermatitis. Br J Dermatol 90:525–530. https://doi.org/10.1111/j.1365-2133.1974.tb06447.x
7. Skov L, Baadsgaard O (2000) Bacterial superantigens and inflammatory skin diseases. Clin Exp Dermatol 25:57–61. https://doi.org/10.1046/j.1365-2230.2000.00575.x
8. McFadden JP, Noble WC, Camp RD (1993) Superantigenic exotoxin-secreting potential of staphylococci isolated from atopic eczematous skin. Br J Dermatol 128:631–632. https://doi.org/10.1111/j.1365-2133.1993.tb00257.x
9. Chen Y, Wang X, Zhang C, Shi W (2018) Detection and treatment of *Staphylococcus aureus* colonization in chronic hand eczema: a multicenter study. J Dermatol Treat. https://doi.org/10.1080/09546634.2018.1476650
10. Held E, Skoet R, Johansen JD et al (2005) 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 152:302–307. https://doi.org/10.1111/j.1365-2133.2004.06305.x
11. Carlsson A, Svensson Å, Anderson CD et al (2016) Scoring of hand eczema: good reliability of hand eczema extent score. Acta dermato-venereol 97:193. https://doi.org/10.2340/00015555-2521
12. Pg VDV, van Gils RF, Boot CR et al (2013) A simple tool with which to study the course of chronic hand eczema in clinical practice: a reduced-item score. Contact Dermat 69:112–117. https://doi.org/10.1111/cod.12041
13. Finlay AY, Khan GK (2010) Dermatology Life Quality Index (DLQI)—a simple practical measure for routine clinical use. Clin Exp Dermatol 19:210–216. https://doi.org/10.1111/j.1365-2230.1994.tb01167.x
14. Zhu B, Edson-Heredia E, Guo J et al (2014) Itching is a significant problem and a mediator between disease severity and quality of life for patients with psoriasis: results from a randomized controlled trial. Br J Dermatol 171:1215–1219. https://doi.org/10.1111/bjd.13065
15. Haslund P, Bangsgaard N, Jarlov JO, Skov L, Skov R, Agner T (2009) *Staphylococcus aureus* and hand eczema severity. Br J Dermatol 161:772–777. https://doi.org/10.1111/j.1365-2133.2009.09353.x
16. Mernelius S, Carlsson E, Henricson J, Lofgren S, Lindgren PE, Ehricht R, Monecke S, Matussek A, Anderson CD (2016) *Staphylococcus aureus* colonization related to severity of hand eczema. Eur J Clin Microbiol Infect Dis 35:1355–1361. https://doi.org/10.1007/s10096-016-2672-2