ORIGINAL ARTICLE

Types and prevalence of adverse skin reactions associated with prolonged N95 and simple mask usage during the COVID-19 pandemic

A.R. Darnall,[1,2,*] D. Sall,[2,3] C. Bay[4]

[1]Department of Dermatology, Honorhealth, Scottsdale, AZ, USA
[2]HonorHealth Internal Medicine Residency, Honorhealth, Scottsdale, AZ, USA
[3]Department of Internal Medicine, University of Arizona College of Medicine – Phoenix, Phoenix, AZ, USA
[4]Biostatistics, A.T. Still University, Mesa, AZ, USA
*Correspondence: A. Darnall. E-mail: adarnall@honorhealth.com

Abstract

Background As the coronavirus 2019 (COVID-19) pandemic persists on a global level, the chronic daily use of face masks within the healthcare system remains an important component of disease prevention and transmission. Increased use of personal protective equipment (PPE) may result in increased rates of occupational dermatoses and adverse skin reactions.

Objectives The purpose of this study is to explore how chronic, prolonged use of N95 masks or simple surgical masks affects the prevalence of adverse skin reactions in Healthcare Workers (HCWs).

Methods An optional, quantitative, web-based survey was administered to patient-facing HCWs across six network hospitals in a large metropolitan city. Data were analysed to assess the types and sites of adverse skin reactions, and to evaluate correlations between single mask use duration and adverse skin reactions.

Results A total of 230 HCWs responded with 192 endorsing occupational dermatoses. Among the healthcare responders, (n = 192, 83.5%) experienced at least one adverse skin reaction. The most common occupational adverse skin reactions were acne (n = 133, 57.8%), dryness (n = 108, 47.0%) and redness (n = 105, 45.7%). Anatomical areas most commonly affected included the nasal bridge (n = 92, 40.0%), cheeks (n = 92, 40.0%) and chin (n = 91, 39.6%). Acne (P = 0.002), dryness/scaling (P = 0.002), increased pore size (0.003), itch (P = 0.003), nasal bridge scarring (P < 0.001), redness (P < 0.001), frictional erosions (P = 0.001) and ulcerations (P = 0.002) showed a positive correlation to duration of mask use.

Conclusions Prolonged, daily usage of PPE is associated with numerous adverse skin reactions among HCWs with acne being the most commonly seen adverse reaction. Many adverse reactions are associated with prolonged use of single mask.

Received: 1 March 2022; Accepted: 2 June 2022

Conflicts of interest

The authors declare they have no conflicts of interest that might be relevant to the contents of this manuscript.

Funding sources

No funding sources were utilized for this study.

Introduction

Adverse skin reactions to personal protective equipment (PPE) have long been an issue among healthcare workers (HCWs).[1,2] With the COVID-19 (SARS-CoV-2) pandemic running rampant on a global level, HCWs not only encounter the virus more frequently than the average populace but also require the prolonged duration of use of PPE to protect themselves. As the COVID-19 pandemic persists into its second year, the incidence of these skin reactions is likely to increase and may require increased medical attention. A few studies have recently been published highlighting that use of N95s increases the incidence of adverse skin reactions.[1,2] The most commonly described reactions with use of PPE appear to be acne, scarring, itching, redness and dryness, with the nasal bridge and cheeks being the most commonly affected anatomical locations.[2–5] More profound dermatological issues have also been identified including eczema, pressure-related injury, folliculitis, seborrheic dermatitis and allergic skin reactions.[2–4]

Currently, there is limited evidence suggesting these problems may be exacerbated by prolonged time of individual mask use.[3,4,6] However, as COVID-19 continues to be a major problem worldwide, longer duration of mask use can be expected. It has been reported that 74% to 97% of HCWs have experienced adverse skin reactions related to their use of enhanced infection protection methods.[3,6] Simple masks and N95s limit spread and are required for safe patient care, as well as to limit community spread. However, these cutaneous complications can decrease mask compliance and alter pressure points of the mask thereby reducing the effectiveness of PPE.[7]

Of the few studies performed evaluating adverse skin reactions, there are very few studies looking at adverse skin reactions specifically among healthcare workers. Smaller sample sizes, minimal data related to duration of mask use and examination of pre-existing conditions, differences among climates and lack of multi-hospital locations are just some of the limitations among current data related to adverse skin reactions to PPE.[2–6]

The goal of this study was to enhance our understanding of adverse skin reactions seen with PPE use during the COVID-19 pandemic. Specifically, we aimed to add to the current small body of literature by further characterizing adverse skin reactions among HCWs in a large metropolitan health system. We also aimed to evaluate how the duration of the mask affects adverse skin reactions. It is possible that such adverse skin reactions could lead to increased healthcare utilization for diagnosis and treatment of such reactions or limit the use of masks in those experiencing adverse reactions. Therefore, anticipatory guidance on such issues is important as mask use continues to be a mainstay of COVID-19 prevention. This study aims to arm providers with expected adverse reactions with prolonged mask use to be able to provide such anticipatory guidance.

Materials and methods

This survey-based study was approved by the HonorHealth institutional review board (IRB). The 17-question survey was developed and edited by local content experts. This optional, anonymous, self-administered survey was then disseminated through multiple web-based newsletters throughout the healthcare system. Our health system consists of six hospitals that serve the greater Phoenix, Arizona area. Inclusion criteria consisted of healthcare workers (HCWs) within the hospital system with direct patient contact, such as physicians, nurses, respiratory therapists, physician assistants, nurse practitioners, physical therapists, occupational therapists and dieticians. Exclusion criteria included employees that did not require patient contact or those working from home.

Surveys were administered from August to October 2021. Responses were collected and subsequently stored in a secure database. The survey asked questions relating to the estimated exposure to COVID-19 patients on a daily basis, the duration of daily use of N95s and simple masks, use of additional PPE in conjunction with their N95/surgical mask, presence of adverse skin reactions and their anatomical locations, pre-existing dermatologic conditions (including acne, allergic contact dermatitis, irritant contact dermatitis, eczema and rosacea) and types of treatments tried. Conditions with a high prevalence and a related outcome analysed.

Counts and percentages were obtained for variable categories. Rank-biserial correlations (r_{rb}) were calculated to estimate the strength of the relationship between average duration of mask wearing per day and the appearance of adverse reactions. An alpha of 0.05 (two-tailed) was used as the criterion for statistical significance. Point-biserial correlations were used to evaluate the relationship between reporting of adverse events and average number of hours per day masks were worn. SPSS ver. 27 (IBM Corp., Armonk, NY, USA) was used for statistical analysis.

Results

A total of 230 healthcare workers responded to the survey. A variety of HCWs completed the survey, including 79 nurses (34.6%), 30 (13.2%) administrators and 16 (7.0%) attending physicians. See Table 1 for a listing of respondents. Age categories of respondents ranged from 15 to 84, with the highest proportion of participants aged 25–34 (n = 62, 27.0%) and 35–44 (n = 56, 24.3%).

Among these respondents, 192 (83.5%) reported at least one adverse skin reaction (mean count = 3.1, SD = 2.5). The most commonly reported reactions were acne (n = 133, 57.8%), dryness (n = 108, 47.0%) and redness (n = 105, 45.7%). All adverse skin reactions are provided in Table 2. Anatomical areas most affected included the nasal bridge (n = 92, 40.0%), cheeks (n = 92, 40.0%) and chin (n = 91, 39.6%). Counts and percentages of affected sites are provided in Table 3.

The most commonly reported daily duration of mask use was 10+ (n = 74, 32.2%), see Table 4. Surgical masks (n = 185,

Table 1 Count and percentage of respondents by position

Position	Count	Percentage
Nurse (RN/LPN)	79	34.6
Administration	30	13.2
Physician	16	7.0
MA	12	5.3
Resident/ Fellow	9	3.9
Respiratory Therapist	6	2.6
Outpatient/ Ambulatory	5	2.2
Dietitian	4	1.8
PA/NP	1	0.4
PT/OT	1	0.4
Pharmacist	1	0.4
Other	62	27.2
Not Provided	2	0.9

PA/NP, Physician's Assistant/ Nurse Practitioner; PT/OT, Physical Therapy/ Occupational Therapy.

Table 2 Count and percentage of adverse skin reactions reported

Site	Count*	Percentage
Acne	133	57.8
Dryness/ scaling	108	47.0
Redness	105	45.7
Itching	94	40.9
Increased pore size	61	26.5
Skin breakdown/frictional erosions	49	21.3
Rash	46	20.0
Nasal bridge damage/scarring	40	17.4
Pigmentation changes	24	10.4
Burning	17	7.4
Other	17	7.4
Ulceration	8	3.5

*Sums to more than the number of respondents because some respondents reported more than one adverse skin reaction. Percentages are based on total count.

Table 3 Count and percentage of anatomical sites affected by survey respondents

Anatomical Site	Count*	Percentage
Nasal bridge	92	40.0
Cheek	92	40.0
Chin	91	39.6
Auricles/ behind ears	79	34.3
Zygomatic arch	47	20.4
No adverse skin reactions	9	3.9
Other	12	5.2

*Sums to more than the number of respondents because some respondents reported more than one anatomical site. Percentages are based on total count.

Table 4 Count and percentage of total duration of mask use by healthcare workers during a typical workday

Daily duration of mask use	Count	Percentage
<1 h	63	27.4
1–3 h	12	5.2
3–5 h	15	6.5
5–7 h	13	5.7
7–9 h	49	21.3
10+ h	74	32.2
Not Provided	4	1.7

79.7%) were used most frequently. A breakdown of all types of masks and additional PPE reported is provided in Table 5.

Among the 192 reporting at least one adverse skin reaction, 83 (36.1%) sought a therapeutic intervention. The two most common therapies were topical antibiotic ointment ($n = 37$, 16.1%) and a topical steroid ($n = 34$, 14.8%). Only eight respondents (3.5%) actively sought medical care.

Table 5 Count and percentage of type of PPE used on a daily basis

PPE	Count*	Percentage
Surgical Mask	185	79.7
Goggles	89	38.4
N95 mask	82	35.3
Gown	76	32.8
Face shield	55	23.7
Reusable respirator	40	17.2
Other	22	9.5

*Sums to more than the number of respondents because some respondents reported more than one type of PPE. Percentages are based on total count.

Rank-biserial correlations estimated the strength of the relationship between the average duration of mask wearing per day and the appearance of adverse reactions (see Table 6). Nine of the twelve correlations were statistically significant. Redness was most strongly associated with mask duration ($r_{rb} = 0.37$, $P < 0.001$) followed by nasal bridge damage/ scarring ($r_{rb} = 0.25$, $P < 0.001$), and skin breakdown/ frictional erosions (($r_{rb} = 0.22$, $P < 0.001$).

Eight of the eleven adverse events recorded exhibited significant, though modest positive dose–response relationships with the average number of hours a mask was worn per day (Fig. 1). For most of these events the largest change occurred between those who wore a mask <1 h per day and those who wore a mask 1–7 h per day but continued to increase thereafter. Point-biserial correlation coefficients for the relationship between endorsement of adverse events and average number of hours a mask was worn per day are provided in Table 7.

Table 6 Rank- biserial correlations (and associated *P*-values) between duration of daily mask use and adverse skin reaction

Skin reaction	Rank-biserial correlation coefficient	*P*-value*
Redness	0.369	<0.001
Nasal bridge damage/ scarring	0.250	<0.001
Skin breakdown/ frictional erosions	0.217	0.001
Ulceration	0.211	0.002
Dryness/scaling	0.206	0.002
Acne	0.205	0.002
Itching	0.199	0.003
Increased pore size	0.195	0.003
Other	0.182	0.006
Rash	0.119	0.076
Burning	0.118	0.080
Pigmentation changes	0.113	0.091

**P*-value <0.05 was considered statistically significant.

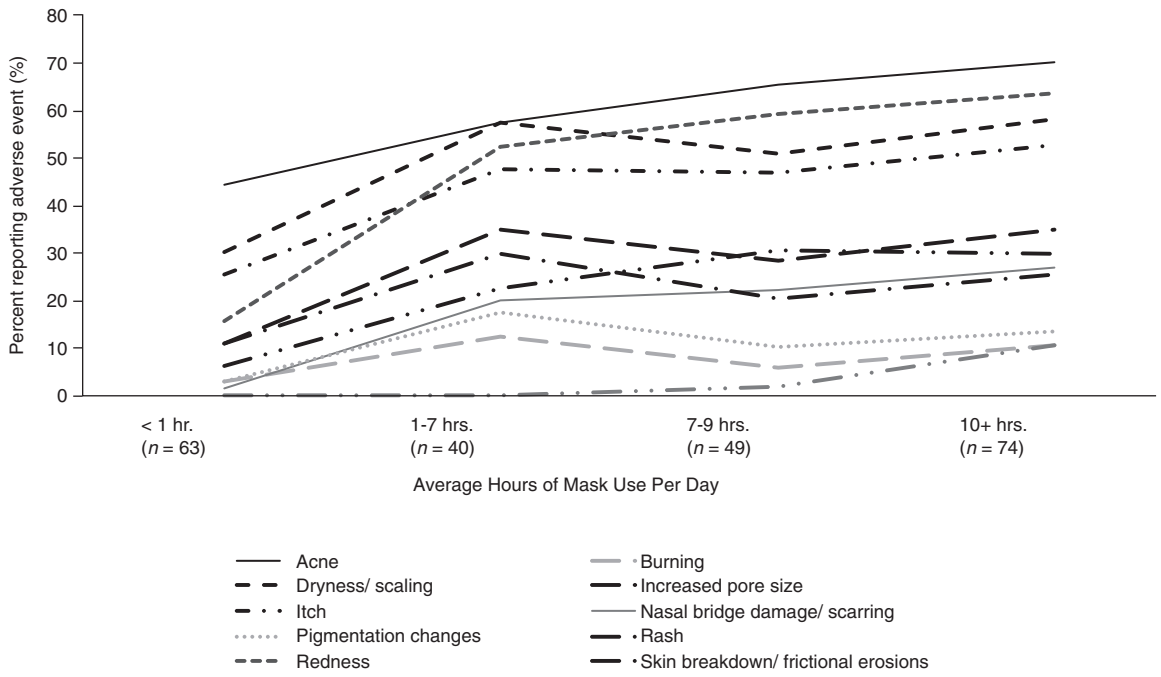

Figure 1 Dose–response relationships with the average number of hours a mask was worn per day.

Table 7 Point-biserial correlations (and associated *P*-values) to evaluate the relationship between reporting of adverse events and average number of hours per day masks were worn

Adverse skin reaction	Point biserial correlation coefficient	*P*-value
Acne	0.209	0.002*
Burning	0.086	0.199
Dryness/ scaling	0.197	0.003*
Increased pore size	0.189	0.004*
Itch	0.204	0.002*
Nasal bridge damage/ scarring	0.253	<0.001*
Pigmentation changes	0.104	0.117
Rash	0.113	0.092
Redness	0.364	<0.001*
Skin breakdown/frictional erosions	0.224	0.001*
Ulceration	0.219	0.001*

*$P < 0.01$ was considered statistically significant.

Information on selected pre-existing skin conditions (acne, allergic contact dermatitis, irritant contact dermatitis, eczema and rosacea) was collected, but endorsements of all (except acne, at 20%) were well below 10%. The pre-existing conditions asked about (apart from acne) were not a part of the current PPE-related dermatological conditions experienced so correlations were not made.

Discussion

COVID-19 (SARS-CoV-2) is a highly infectious viral illness transmitted *via* respiratory particles. Studies have shown that people who wore masks had at least 70%–80% lower risk of testing positive for COVID-19.[8–10] This makes proper mask compliance an important aspect of reducing respiratory transmission in both the healthcare setting and in the community. However, obtaining full mask compliance can become difficult when healthcare workers experience mask-related adverse skin reactions. Understanding the types of reactions and risk factors for development, including duration of mask use can help provide guidance on prevention or treatment.

This study revealed that the most common adverse reaction seen among healthcare workers was acne, which is consistent with some existing literature.[11,12] Acne is a common skin issue caused by a triad of follicular microbial colonization with Propionibacterium acnes, overactive pilosebaceous units and follicular hyperkeratinization that can be exacerbated when exposed to a moist, occluded environment.[11–16] It is hypothesized that the humid, occlusive nature of masks, particularly the tight fitting N95 mask, create the exact warm and moist environment necessary to increase sebum production and foster development of acne.[11–14] These changes can possibly be due to pressure associated microcirculatory dysfunction and fluid loss in addition to skin microbiome changes that is more supportive of bacterial

growth.[11–14]The age of respondents could also be why there was such a higher prevalence of acne in our cohort, as younger populations tend to have acne more frequently than the older population.

In our study, dryness was a common adverse reaction, with the nasal bridge and cheeks being the most commonly affected anatomical sites. This was consistent with similar studies and can be postulated to be attributed to constant frictional forces and subsequent skin barrier breakdown facilitating moisture loss.[3,4,17,18] It is possible that our local climate is related to increased dryness, as this study was conducted in the Southwest United States where the climate is arid.

Pressure-related injuries such as redness or nasal bridge scarring were also frequently experienced. The chin, cheeks and nasal bridge were by far the most common areas affected. This is consistent with prior studies.[3,4] Foo *et al*[1] of the Singapore study that looked at adverse skin reactions to PPE during the severe acute respiratory syndrome (SARS) outbreak in 2003 also found that the most common adverse reaction was acne while Hu *et al*[2] found that the most common adverse reaction was nasal bridge scarring. Both studies only examined the use of N95 masks, while this study included both the use of N95 and simple surgical masks. This could be why nasal bridge scarring was less frequently seen as simple surgical masks do not have the malleable nasal bridge metal piece that some N95 masks use, yet still suggests simple mask use is a risk factor for nasal bridge redness or scarring.

We found that HCWs are frequently using over-the-counter modalities such as topical antibiotic ointment and topical steroids to treat adverse skin reactions. While topical antibiotic preparations like clindamycin are appropriate for treatment of acne, pressure-related ulcerations or infectious skin conditions like folliculitis[19]; over-the-counter antibiotic ointments like neomycin/polymyxin B/bacitracin are often inappropriate topical preparations for other commonly experienced reactions. In addition, chronic use of topical antibiotic ointments has been shown to paradoxically cause allergic contact dermatitis or other hypersensitivity reactions.[20,21] This suggests that educational materials aimed at proper dose, duration and indication may be helpful to support sustained mask use.

A multitude of adverse skin reactions were found to be correlated with prolonged duration of mask use. Prolonged duration of mask use leading to adverse skin reactions is likely multifactorial related to factors such as prolonged pressure, ideal environments for bacterial growth, persistent friction and skin breakdown, inconsistent or infrequent equipment cleaning and predisposing skin conditions.[3,12,14,17,18] Our results further help support the use of preventative measures with mask use and the development of healthcare system educational materials HCWs may access to help support sustained mask use. This may include barrier protection to redistribute pressure and prevent friction and rubbing in addition to proper skin care and hygiene practices.[19,22]

As noted by Figure 1, the largest change occurred between those who wore a mask <1 h per day and those who wore a mask 1–7 h per day which suggests that breaks from PPE use every 60 min may provide a decrease in adverse skin reactions and provide guidance on mask-wearing breaks or perhaps that changes into new masks may prove efficacious in mitigating these adverse reactions. Focus on intermittent breaks from mask use in a safe, secluded location and avoidance of persistent same mask use are important to adverse skin reaction prevention.

Very few patients sought out medical care for their mask-related skin reactions compared to the frequency of those reporting adverse reactions. It is possible that this reflects the fact that many experienced reactions were not severe. Alternatively, this could be explained by the fact that the respondents are healthcare workers who would not only have access to both medical knowledge of treatment modalities and the supplies necessary for management but also access to colleagues who could offer treatment recommendations. Further study is warranted to understand the severity of reactions and the need for access to additional medical care for treatment.

This study has several limitations. First, this was administered at one health system (albeit comprised six facilities) in one city, in one climate. A similar study performed with more diverse geographical locations with differing climates during different seasons may yield different results. Second, there is potential for selection bias in that those who responded may have experienced skin reactions more frequently than those that did not respond. While this may overestimate the prevalence of skin reactions, it should not affect the types of reactions reported. Another limitation is that there was limited data collected regarding information on pre-existing conditions and therefore further study on those with pre-existing skin conditions is warranted. Lastly, we had a smaller number of respondents, though more than in some other previously reported studies.[2–4]

The objective of this study was to add to the limited existing literature to offer further insight on the most common adverse skin reactions seen with daily chronic, prolonged mask use among healthcare workers. Given the continued worldwide presence of COVID and new emerging variants, masking in healthcare settings and in the community will be a crucial prevention strategy. We hope that our work helps HCWs and providers anticipate some of the expected adverse skin reactions, and offer guidance on how to approach mitigation efforts related to duration of single mask use. Further study is needed to examine treatment and prevention efforts.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

1 Foo CC, Goon AT, Leow YH, Goh CL. Adverse skin reactions to personal protective equipment against severe acute respiratory syndrome--a descriptive study in Singapore. *Contact Dermatitis* 2006; **55**: 291–294.
2 Hu K, Fan J, Li X, Gou X, Li X, Zhou X. The adverse skin reactions of health care workers using personal protective equipment for COVID-19. *Medicine* 2020; **99**: e20603.
3 Lan J, Song Z, Miao X *et al.* Skin damage among health care workers managing coronavirus disease-2019. *J Am Acad Dermatol* 2020; **82**: 1215–1216.
4 Tang J, Zhang S, Chen Q, Li W, Yang J. Risk factors for facial pressure sore of healthcare workers during the outbreak of COVID-19. *Int Wound J* 2020; **17**: 2028–2030.
5 Thatiparthi A, Liu J, Martin A, Wu J. Adverse effects of COVID-19 and face masks: a systematic review. *J Clin Aesthet Dermatol* 2021; **14**(9 Suppl 1): S39–S45.
6 Lin P, Zhu S, Huang Y *et al*. Adverse skin reactions among healthcare workers during the coronavirus disease 2019 outbreak: a survey in Wuhan and its surrounding regions. *Br J Dermatol* 2020; **183**: 190–192.
7 Elston DM. Occupational skin disease among health care workers during the coronavirus (COVID-19) epidemic. *J Am Acad Dermatol* 2020; **82**: 1085–1086.
8 Payne DC, Smith-Jeffcoat SE, Nowak G *et al.* SARS-CoV-2 infections and serologic responses from a sample of U.S. Navy Service Members: USS Theodore Roosevelt, April. *MMWR Morb Mortal Wkly Rep* 2020; **69**: 714–721.
9 Doung-Ngern P, Suphanchaimat R, Panjangampatthana A *et al*. Case-control study of use of personal protective measures and risk for SARS-CoV 2 infection, Thailand. *Emerg Infect Dis* 2020; **26**: 2607–2616.
10 Wang Y, Tian H, Zhang L *et al.* Reduction of secondary transmission of SARS-CoV-2 in households by face mask use, disinfection and social distancing: a cohort study in Beijing, China. *BMJ Glob Health May* 2020; **5**: e002794.
11 Chris CIF, Anthony TJG, Yung-Hian L, Chee-Leok G. Adverse skin reactions to personal protective equipment against severe acute respiratory syndrome a descriptive study in Singapore. *Contact Dermatitis* 2006; **5**: 291–294.
12 Zuo Y, Hua W, Luo Y, Li L. Skin reactions of N95 masks and medial masks among health-care personnel: A self-report questionnaire survey in China. *Contact Dermatitis* 2020; **83**: 145–147.
13 Tan KT, Greaves MW. N95 acne. *Int J Dermatol* 2004; **43**: 522–523.
14 Hua W, Zuo Y, Wan R *et al*. Short-term skin reactions following use of N95 respirators and medical masks. *Contact Dermatitis* 2020; **83**: 115–121.
15 Techasatian L, Lebsing S, Uppala R *et al*. The effects of the face mask on the skin underneath: a prospective survey during the COVID-19 pandemic. *J Prim Care Community Health* 2020; **11**: 2150132720966167.
16 Zaenglein AL, Pathy AL, Schlosser BJ *et al.* Guidelines of care for the management of acne vulgaris. *J Am Acad Dermatol* 2016; **74**: 945–73.e33.
17 Oranges T, Janowska A, Dini V. Reply to: "Skin damage among health care workers managing coronavirus disease-2019". *J Am Acad Dermatol* 2020; **82**: e233–e234.
18 Desai SR, Kovarik C, Brod B *et al*. COVID-19 and personal protective equipment: treatment and prevention of skin conditions related to the occupational use of personal protective equipment. *J Am Acad Dermatol* 2020; **83**: 675–677.
19 Zhou NY, Yang L, Dong LY *et al*. Prevention and treatment of skin damage caused by personal protective equipment: experience of the first-line clinicians treating 2019-nCoV infection. *Int J Dermatol Venereol* 2020;**3**:70–75.
20 Warshaw EM, Ahmed RL, Belsito DV *et al*. Contact dermatitis of the hands: cross-sectional analyses of North American Contact Dermatitis Group Data, 1994–2004. *J Am Acad Dermatol* 2007; **57**: 301–314.
21 Shahbazian JH, Hartzell TL, Pandey AK, Azari KK. Allergic dermatitis due to topical antibiotics. *West J Emerg Med* 2012; **13**: 380–382.
22 Maliyar K, Sachdeva M, Mufti A, Yeung J. Reply to: "Skin damage among health care workers managing coronavirus disease 2019". *J Am Acad Dermatol* 2020; **83**: e169–e170.