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The adverse skin reactions of health care workers using personal protective equipment for COVID-19

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Abstract

In December 2019, a new coronavirus was found in Wuhan, Hubei Province, China, and spread rapidly throughout the country, attracting global attention. On February 11, the World Health Organization (WHO) officially named the disease caused by 2019-nCoV coronavirus disease 2019 (COVID-19). With the increasing number of cases, health care workers (HCWs) from all over China volunteered to work in Hubei Province. Because of the strong infectivity of COVID-19, HCWs need to wear personal protective equipment (PPE), such as N95 masks, latex gloves, and protective clothing. Due to the long-term use of PPE, many adverse skin reactions may occur. Therefore, the purpose of this study is to explore the adverse skin reactions among HCWs using PPE.

Questionnaires were used for the research; a quantitative study was carried out to determine the incidence of adverse skin reactions among HCWs using PPE.

A total of 61 valid questionnaires were collected. The most common adverse skin reactions among HCWs wearing N95 masks were nasal bridge scarring (68.9%) and facial itching (27.9%). The most common adverse skin reactions among HCWs wearing latex gloves were dry skin (55.7%), itching (31.2%), and rash (23.0%). The most common adverse skin reactions among HCWs wearing protective clothing were dry skin (36.1%) and itching (34.4%).

When most HCWs wear PPE for a long period of time, they will experience adverse skin reactions. The incidence of adverse skin reactions to the N95 mask was 95.1%, that to latex gloves was 88.5%, and that to protective clothing was 60.7%.

Abbreviations: COVID-19 = 2019-nCoV coronavirus disease 2019, HCWs = health care workers, MERS = Middle East respiratory syndrome coronavirus, PPE = personal protective equipment, SARS = severe acute respiratory syndrome coronavirus, WHO = The World Health Organization.

Keywords: 2019-nCoV coronavirus disease 2019, adverse skin reactions, health care workers, personal protective equipment

1. Introduction

Since the beginning of the 21st century, the outbreak of coronavirus has brought serious losses to society, the most serious of which are severe acute respiratory syndrome coronavirus (SARS) and Middle East respiratory syndrome coronavirus (MERS). In December 2019, a new coronavirus was found in Wuhan, Hubei Province, China, and spread rapidly across the country, attracting global attention.[1,2]

From the existing epidemiological data, the transmission speed of COVID-19 is significantly faster than that of SARS, but its pathogenicity is remarkably weaker than that of MERS and SARS. To control the epidemic, the Chinese government has formulated a series of social alienation strategies.[3] Because of the strict blockade and quarantine measures, the spread outside Hubei Province seems to be slowing down.[4] A large number of health care workers (HCWs) from all over China rushed to Hubei Province to jointly fight against COVID-19.

Because of the strong transmission of COVID-19 and the uncertainty of the infection status of patients, HCWs must provide personal protective equipment (PPE).[5] PPE, such as N95 masks, latex gloves, and protective clothing, will often be worn for hours at a time. There are not a few cases of adverse skin reactions related to the use of PPE by HCWs.[6] However, existing research on poor skin reactions to the use of PPE by HCWs is limited. The study collected the results of a survey of adverse skin reactions caused by the use of PPE by HCWs in Hubei Province during the COVID-19 outbreak. Combined with these results, we can determine the prevalence and characteristics of adverse skin reactions caused by PPE among HCWs in Hubei Province. The findings of this study will help to determine whether long-term use of PPE poses significant occupational health risks and suggest possible solutions.

2. Methods

2.1. Design

The purpose of this study is to explore the problem of adverse skin reactions among HCWs who have been using PPE for a long

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Table 1

The population statistics of the participants.

Age	Numbers	Percentage
20–29	16	26.3%
30–39	41	67.2%
40–49	3	4.9%
50–59	1	1.6%

period of time in Hubei Province. This study uses the method of quantitative descriptive research. As a descriptive research method, quantitative descriptive research can not only analyze the samples qualitatively but can also combine qualitative and quantitative data obtained by statistics. Therefore, quantitative descriptive research is considered appropriate. In light of the fact that the purpose of this study is to explore the incidence of adverse reactions of HCWs who have been wearing PPE for a long period of time, a comprehensive summary is generated through quantitative descriptive design, which clearly reflects adverse skin reactions.

2.2. Setting and participants

This study uses a purposeful sampling method to select qualified research objects. Purposeful sampling methods can collect useful information needed for this study by identifying different participants. Based on this method, we selected participants according to the following criteria: registered doctors or nurses; HCWs fighting COVID-19 in Hubei Province hospitals; those often wearing PPE, such as N95 masks, latex gloves, and protective clothing; staff who are contacted with patients directly; and those willing to participate in the questionnaire survey. According to this standard, we selected a total of 65 HCWs who met the criteria. Table 1 summarizes the population statistics of the participants.

2.3. Ethics of human research

All participants signed an informed consent form before the study. The research scheme has been approved by the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University and is based on the ethical principles of medical research involving human objects in the Helsinki Declaration.

2.4. Data collection

This survey was conducted by the distribution of questionnaires to participants who met the criteria. The questionnaire covers the duration of the use of masks, gloves, and protective clothing, as well as adverse skin reactions caused by their use. Participants who agreed to participate in the study were asked to sign an informed consent form on the date of data collection. Finally, a total of 61 valid questionnaires were collected. To facilitate subsequent data analysis, all questionnaires were collected and backed up to ensure that no data were lost during transcription and statistical analysis.

2.5. Data analysis

SPSS21.0 software (SPSS Inc, Chicago, IL) was used for statistical analysis. Chi-square tests and two-sample t tests were used to compare the differences between groups. A P-value of $<.05$ was considered significant.

2.6. Trustworthiness

Trustworthiness is the criterion used to assess a study. The trustworthiness of this study is maintained by 4 main criteria: credibility, confirmability, transferability, and dependability. For credibility, the content of the study is discussed between researchers and authors to determine the conclusions. For confirmability, participants were asked to verify the survey contents to ensure that their ideas were accurately reflected in the study. For transferability, a vivid and detailed description of the results and the research process were recorded. The results and conclusions can be transferred to the study of similar fields. For the dependability, an in-depth and vivid description of the research methods was accurately recorded to show a comprehensive understanding of the research methods. Therefore, future researchers can repeat this study.

3. Results

A total of 65 HCWs were surveyed by questionnaire. Sixty-one (93.8%) of them responded to the questionnaire. Among them, there were 5 men (8.2%) and 56 women (91.8%), including 30 doctors and 31 nurses. These HCWs are illustrated in Table 1.

3.1. Masks

Among the 61 HCWs who regularly used the N95 mask, 58 (95.1%) reported adverse reactions, including nasal bridge scarring (68.9%), facial itching (27.9%), skin damage (26.2%), dry skin (24.6%), and rash (16.4%). Seven workers had indentation and ear pain, and 1 had acne. Six of them developed wheals on the bridge of the nose, jaw, and cheeks. All people with skin reactions developed these reactions after using the N95 mask for 12 hours a day over an average of 3.5 months. HCWs using surgical masks, cloth masks, and paper masks did not report any adverse skin reactions. Table 2 lists the adverse reactions reported by the HCWs surveyed who were using the N95 mask. Because of the strong transmission of COVID-19, all 58 HCWs continued to use the N95 mask despite their symptoms. Only 5 HCWs sought treatment from doctors. Fifteen HCWs took medicine on their own. The others did not take any measures. There was no significant difference in occupational adverse skin reactions. However, the proportion of women HCWs with skin rash was significantly higher than that of men HCWs. Most HCWs with skin rashes were between 20 and 29 years old. Among HCWs with skin damage, the proportion of women was significantly

Table 2

Adverse skin reactions of using N95 mask.

Nasal bridge scar	42	68.9%
Facial itching	17	27.9%
Skin damage	16	26.2%
Dry skin	15	24.6%
Rash	10	16.4%
Wheals	7	11.5%
Indentation and ear pain	7	11.5%
Skin desquamation	6	9.9%
Acne	1	1.6%

Table 3

Adverse skin reactions of using latex gloves.

Dry skin	34	55.8%
Itching	19	31.2%
Rash	14	23.0%
Chapped skin	13	21.3%
Wheals	5	8.2%
Skin soaked with sweat	3	4.9%
Edema	1	1.6%

higher than that of men. Most of the HCWs with itching were concentrated in the age group between 20 and 29 years old.

3.2. Latex gloves

Among 61 workers who regularly used latex gloves, 54 (88.5%) reported adverse skin reactions, including dry skin (55.7%), itching (31.2%), rash (23.0%), and chapped skin (21.3%). Three people had skin soaked with sweat, and 1 had symptoms of edema. Table 3 lists the adverse reactions of using latex gloves reported by HCWs who were surveyed. For an average of 3.5 months, latex gloves were used for an average of 10 hours. No one reported that the use of plastic gloves and cloth gloves can cause adverse skin reactions. Five people switched to plastic gloves because of wheals, while most of the participants continued to use latex gloves. Among the 5 people, 1 switched to plastic gloves, and 4 wore plastic gloves under their latex gloves. Of the 54 HCWs, 10 people sought treatment from doctors, 5 people took medicine on their own, and the others did not take any action. There were no significant sex or occupational differences in adverse skin reactions. However, most of the HCWs with dry skin were between 20 and 29 years old. Most of the HCWs with itching were 20 to 29 years old. HCWs with chapped skin were older than those without chapped skin, and most of them were between 30 and 39 years old.

3.3. Protective clothing

Of the 61 HCWs who regularly wore protective clothing, only 37 (60.7%) reported adverse skin reactions, including dry skin (36.1%), itching (34.4%), rash (11.5%), and wheals (3.28%). One person reported that protective clothing was airtight and led to the development of sweat herpes. Muggy heat was reported by other people. One individual reported dampness. Table 4 lists the adverse reactions reported by HCWs who used protective clothing. The protective clothing used is disposable and is worn for an average of 10 hours a day for an average of 3.5 months. Given the strong transmission of COVID-19, all HCWs continue to use protective clothing regardless of symptoms. Two of the 37 people sought treatment from a doctor because of the symptoms of wheals, while the others did not take any measures. There was no significant difference in adverse skin reactions caused by occupation. Among the HCWs with itching, the proportion of women was significantly higher than that of men, and the age of respondents was mostly between 20 and 29 years old. The proportion of women HCWs with itching was higher than that of men HCWs.

Table 4

Adverse skin reactions of using protective clothing.

Dry skin	22	36.1%
Itching	21	34.4%
Rash	7	11.5%
Wheals	2	3.3%

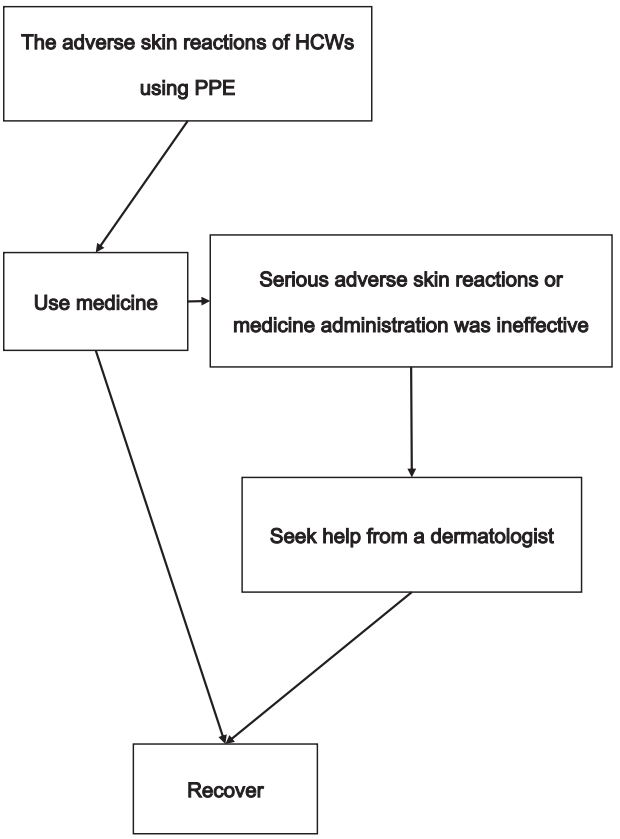

Figure 1. The steps to follow after experiencing adverse skin reactions.

In order to release itching and rash, we give some suggestions that are shown in the flowchart (Fig. 1). These suggestions have been proved to be effective among HCWs in Hubei.

4. Discussion

Due to the highly contagious and nationwide spread of COVID-19, HCWs across China who volunteer in Hubei Province are required to wear PPE, such as N95 masks, latex gloves, and protective clothing.[5] The use of PPE may cause adverse skin reactions. However, existing studies on adverse skin reactions due to the use of PPE by HCWs are limited. In this case, it is possible to study the adverse reactions caused by the use of PPE to propose solutions, which can help HCWs who are still fighting COVID-19 to effectively reduce adverse skin reactions. In the future, this study may still be useful for HCWs. Therefore, I used a questionnaire to conduct a quantitative study to determine the incidence of adverse skin reactions caused by the use of PPE by HCWs. Ultimately, a total of 61 valid questionnaires were collected. The results of the study showed that the most common adverse skin reactions among HCWs using PPE included nasal bridge scarring, facial itching, skin damage, dry skin, rash, chapped skin, and wheals.

Medical masks are a kind of PPE that are used to prevent the spread of respiratory tract infections. The mask can cover the

mouth and nose of the wearer and, if worn properly, may effectively help prevent the spread of respiratory viruses and bacteria.[7] During the SARS outbreak in 2003, the WHO and the Centers for Disease Control and Prevention of the United States issued preventive measures in the care of SARS patients, suggesting that the time of exposure to air should be reduced to decrease the probability of airborne droplet transmission.[8] In particular, it is recommended to use protective masks that meet the certification of the National Institute of Occupational Safety and Health. "N" stands for the National Institute of Occupational Safety and Health, and "95" indicates its filtering efficiency. As a result, the mask has a 95% filtration efficiency in filtering particles with a size of ≥300 nm. The N95 mask can block 95% of the air particles and fits closely with the facial skin to prevent the inhalation of smaller infectious particles, which can travel long distances through the air after an infected person coughs or sneezes. Diseases that require the use of the N95 mask include tuberculosis, chicken pox, SARS, and measles.[9] The diameter of SARS-CoV-2 is between 80 and 120 nm, but when the virus is excreted from an infected person, it will be wrapped in saliva to form larger droplets. Because the N95 mask can effectively filter out particles ≥300 nm in size, it can effectively block the spread of SARS-CoV-2.[6] HCWs must wear masks for a long period of time every day because of the infectivity of COVID-19. Therefore, it is necessary to detect adverse skin reactions using the N95 mask.

Series of researches have explored the related adverse reactions of HCWs wearing N95 mask. Foo et al[6] reported the most common adverse skin reactions were acne, facial itching, and rash. Furthermore, headache was highlighted in Lim research.[10] However, there is no headache in the present study. It probably because the participants in Lim research have been wearing N95 mask for >1 year and the long-term utilization could result in hypoxemia and hypercapnia which led to headache. In this study, we found that the most common adverse reaction of the N95 mask was nasal bridge scarring, followed by facial pruritus. Because the medical staff must have adequate personal protection, they will tie the mask tightly and squeeze the metal clip hard to ensure the tightness of the mask. Therefore, the scar on the bridge of the nose may be caused by the excessive pressure of the mask and the hardness of the metal clip. The cause of itching may be discomfort due to wearing a mask for too long a period of a time, combined with an excessively humid internal environment. Itching may also result from irritating contact dermatitis attributed to an allergic reaction to the mask material. Skin damage may be due to the excessive binding of the mask, such that the edge of the mask is in close contact with the skin, coupled with wearing the mask for a long period of time.[11]

In light of the above situations, when wearing a mask, HCWs can reduce the intensity of binding to achieve moderate tightness, gently pinch the metal clip at the bridge of the nose, and add a surgical mask to line the inside of the N95 mask, which can effectively reduce adverse skin reactions.

It has been reported that COVID-19 can be transmitted through contact, so hand protection is one of the most important ways of preventing COVID-19 infection.[5] Wearing latex gloves can effectively prevent the chance of contact infection among HCWs. The most common adverse reactions to wearing latex gloves in this study were dry skin, itching, and rash. It was similar to the skin adverse reactions of wearing gloves during SARS.[6] There may be 3 reasons why these situations occur. One is Immunoglobulin E-mediated hypersensitivity to latex[12,13]; the second is latex allergy[14]; and the third may be irritant contact dermatitis,[15] which arises from repeated hand washing with soap and detergent and not completely drying the hands. Therefore, the inside of the glove will not be able to absorb air, resulting in irritation. If it is a dry powder glove, it is likely to be caused by the stimulation of talcum powder in the gloves. In this case, it is necessary to rinse off the soap or detergent before putting on gloves and dry one's hands before wearing gloves. If the gloves are dry, there should not be too much talcum powder inside. Another solution is to wear a layer of plastic gloves inside the latex gloves. These measures can prevent the occurrence of irritant dermatitis. If the symptoms of irritant contact dermatitis cannot be resolved, latex allergy testing is necessary, and latex gloves should be avoided.[16]

HCWs must wear protective clothing for a long period of time every day to protect themselves. Therefore, adverse skin reactions have emerged. The adverse skin reactions of HCWs who have been using protective clothing are relatively less common. The most common symptoms were dry skin and itching. The main reason for these situations is probably due to the protective clothing being muggy and the need to wear it for a long period of time. The frequent replacement of protective clothing can effectively reduce the occurrence of the above symptoms.

Our study investigated the long-term use of PPE in Hubei Province and found that most HCWs have adverse skin reactions when wearing masks, gloves, and protective clothing. These adverse skin reactions are usually mild because most HCWs continue to use the equipment. Therefore, the wearer will not seek the help of a dermatologist or self-medicate. In our study, skin adverse reactions using PPE were mainly concentrated in itching and rash. So, we suggest that after the occurrence of adverse skin reactions, second-generation antihistamines or glucocorticoids were recommended for HCWs. If any serious adverse skin reactions to PPE occurred or medicine administration was ineffective, they should seek help from a dermatologist. To date, there have been no reports of adverse skin reactions caused by the use of PPE in COVID-19. The adverse skin reactions of HCWs reported in questionnaires cannot be verified by professionals, as they are the subjective assessment of HCWs. Nevertheless, the study provides a perspective on the incidence of adverse skin reactions that can be caused by the long-term use of PPE.

There is no doubt that the threat of COVID-19 worldwide remains uncontrollable, and the possible solutions proposed in this study can help HCWs who are still fighting COVID-19 to effectively reduce adverse skin reactions. This study may be useful to HCWs in the future.

Author contributions

Xiang Zhou contributed to the design, overall planning and all-round consideration of the study. Kaihui Hu contributed to the data verification and paper writing. Xinyuan Li was fully in charge of the revising work including the reference updating and the manuscript review, besides, he offered some thoughts for the study's design. Xin Gou contributed to the design of the study. Jing Fan and Xueqin Li contributed to the data analysis. All authors read and approved the final manuscript.

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