การศึกษาภาวะผิวหนังอักเสบ ภายหลังยกเลิกการใช้ถุงมือยางทางการแพทย์ชนิดมีแป้ง ในบุคลากรทางการแพทย์ของห้องผ่าตัด

ฉัตรพงศ์ งามโชควัฒนา[1] เนสินี ไชยเอีย[1] จิตต์ลัดดา ศักดาภิพาณิชย์[2] สุรศักดิ์ วงศ์รัตนชีวิน[3] สุมาลัย เดชโยธิน[4] สมสมัย ศรีประไหม[5] ประภัสสร ขจรพิพัฒน์[6]

[1]สาขาวิชาอาชีวเวชศาสตร์ ภาควิชาเวชศาสตร์ชุมชน คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น
[2]ภาควิชาเคมี คณะวิทยาศาสตร์ มหาวิทยาลัยมหิดล
[3]บัณฑิตวิทยาลัย มหาวิทยาลัยขอนแก่น
[4]งานห้องปฏิบัติการเวชศาสตร์ชันสูตร โรงพยาบาลศรีนครินทร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น
[5]งานบริการพยาบาล โรงพยาบาลศรีนครินทร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น
[6]ศูนย์หัวใจสิริกิติ์ ภาคตะวันออกเฉียงเหนือ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น

Received: May 30, 2022
Revised: June 15, 2022
Accepted: June 24, 2022

บทคัดย่อ

ภาวะผิวหนังอักเสบจากการใช้ถุงมือเป็นภาวะที่พบได้บ่อยในบุคลากรทางการแพทย์ โดยสามารถแบ่งภาวะดังกล่าวออกเป็น 2 ประเภท ได้แก่ ภาวะผิวหนังอักเสบจากถุงมือชนิดแพ้สัมผัส และชนิดระคายสัมผัส การสัมผัสถุงมือลาเท็กซ์ชนิดมีแป้งเป็นหนึ่งในปัจจัยสำคัญที่ก่อให้เกิดภาวะดังกล่าวได้ การศึกษานี้เป็นการวิจัยกึ่งทดลอง เพื่อศึกษาความสัมพันธ์ของสัดส่วนที่ลดลงของผู้ปฏิบัติงานพยาบาลห้องผ่าตัดที่มีภาวะผิวหนังอักเสบจากถุงมือ ภายหลังงดการใช้ถุงมือลาเท็กซ์ชนิดมีแป้ง และทดแทนด้วยถุงมือยางสังเคราะห์เป็นระยะเวลา 3 เดือน ณ ห้องผ่าตัดของโรงพยาบาลมหาวิทยาลัยแห่งหนึ่งในภาคตะวันออกเฉียงเหนือ โดยระหว่างงดการใช้ถุงมือลาเท็กซ์ชนิดมีแป้งดังกล่าว ยังคงมีการใช้ถุงมือลาเท็กซ์ชนิดไร้แป้ง และชนิดไร้แป้งโปรตีนต่ำ ดำเนินการเก็บข้อมูลด้วยการใช้แบบสอบถามชนิดตอบเอง ผลการศึกษาพบว่า มีอัตราการตอบกลับแบบสอบถามคิดเป็นร้อยละ 78.3 ความชุกของบุคลากรที่มีภาวะผิวหนังอักเสบจากการใช้ถุงมือก่อนและหลังการเปลี่ยนไปใช้ถุงมือยางสังเคราะห์คิดเป็นร้อยละ 17.8 (ความเชื่อมั่นร้อยละ 95 = 11.7 - 24.5) และ 4.9 (ความเชื่อมั่นร้อยละ 95 = 1.8 - 8.6) ตามลำดับ และมีความแตกต่างของความชุกอยู่ที่ร้อยละ 12.9 (ความเชื่อมั่นร้อยละ 95 = 8.6 - 17.8) โดยในระยะก่อนการเปลี่ยนไปใช้ถุงมือยางสังเคราะห์พบว่ามีผู้ที่มีภาวะผิวหนังอักเสบจากการใช้ถุงมือชนิดแพ้สัมผัสคิดเป็นร้อยละ 8.6 และชนิดระคายสัมผัสคิดเป็นร้อยละ 14.7 ในขณะที่ภายหลังการใช้ถุงมือยางสังเคราะห์พบภาวะดังกล่าวลดลงเหลือเพียงร้อยละ 2.5 และร้อยละ 3.7 ตามลำดับ ทั้งนี้พบว่า ภาวะผิวหนังอักเสบจากการใช้ถุงมือลดลงอย่างมีนัยสำคัญทางสถิติเมื่อเปรียบเทียบระหว่างก่อนและหลังงดการใช้ถุงมือลาเท็กซ์ชนิดมีแป้ง (OR 0.24, ความเชื่อมั่นร้อยละ 95 = 0.1 - 0.53) ทั้งชนิดแพ้สัมผัส (OR 0.27, ความเชื่อมั่นร้อยละ 95 = 0.075 - 0.8) และชนิดระคายสัมผัส (OR 0.22, ความเชื่อมั่นร้อยละ 95 = 0.08 - 0.54) โดยสรุปคือการใช้ถุงมือลาเท็กซ์ชนิดมีแป้งสัมพันธ์กับการเกิดภาวะผิวหนังอักเสบ การงดการใช้ถุงมือลาเท็กซ์ชนิดมีแป้งดังกล่าวสามารถลดการเกิดภาวะผิวหนังอักเสบจากการใช้ถุงมือในผู้ปฏิบัติงานพยาบาลได้

คำสำคัญ: ถุงมือลาเท็กซ์ ผิวหนังอักเสบ แพ้ลาเท็กซ์ แพ้ถุงมือ บุคลากรทางการแพทย์

ผู้นิพนธ์ประสานงาน:
เนสินี ไชยเอีย
สาขาวิชาอาชีวเวชศาสตร์ ภาควิชาเวชศาสตร์ชุมชน
คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น
123/2000 ถนนมิตรภาพ ตำบลในเมือง อำเภอเมือง จังหวัดขอนแก่น 40002
อีเมล: cnaesi@gmail.com

A study of contact dermatitis among operating theatre health personnel following the ban of powdered latex gloves

Chatpong Ngamchokwathana[1], Naesinee Chaiear[1], Jitladda Sakdapipanich[2], Surasakdi Wongratanacheewin[3], Sumalai Dechyotin[4], Somsamai Sripramai[5], Prapassorn Khajornpipat[6]

[1]Division of Occupational Medicine, Department of Community Medicine, Khon Kaen University

[2]Department of Chemistry, Faculty of Science, Mahidol University

[3]Graduate School, Khon Kaen University

[4]Clinical Laboratory Section, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University

[5]Nursing Department, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University

[6]Queen Sirikit Heart Center of the Northeast, Faculty of Medicine, Khon Kaen University

Abstract

Glove-related contact dermatitis is a common occupational disease in the healthcare industry, and it is categorized as a glove-related allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD). Exposure to powdered latex gloves is a contributing factor in developing glove-related ACD and ICD. This quasi-experimental study aimed to study the decline of glove-related contact dermatitis among nursing staff following a three-month ban on powdered latex gloves in the operating theatre at a university hospital in northeastern Thailand. During the ban, synthetic rubber gloves and nonpowdered latex gloves were used. Data were collected using a self-reported questionnaire sent to operating theatre nursing staff. The questionnaire response rate was 78.3%. The prevalence of glove-related contact dermatitis symptoms in the pre- and post-replacement phases was 17.8% (95%CI 11.7 - 24.5) and 4.9% (95%CI 1.8 - 8.6), respectively. In this case, the difference between those phases is 12.9% (95%CI 8.6 - 17.8). In the pre-replacement phase, glove-related ACD and ICD were reported at 8.6% and 14.7%, while it was 2.5% and 3.7% in the post-replacement phase, respectively. After replacement, there were significant decreases in glove-related contact dermatitis (OR 0.24, 95%CI 0.1 - 0.53), glove-related ACD (OR 0.27, 95%CI 0.075 - 0.8), and glove-related ICD (OR 0.22, 95%CI 0.08 - 0.54). In conclusion, powdered latex gloves are associated with glove-related contact dermatitis, and the ban on such gloves significantly reduces glove-related contact dermatitis among nursing staff.

Keywords: latex gloves, contact dermatitis, latex allergy, glove allergy, healthcare worker

Corresponding Author:

Naesinee Chaiear

Division of Occupational Medicine,
Faculty of Medicine, Khon Kaen University
123/2000 Mittraphap Road, Nai Muang, Muang District,
Khon Kaen 40002, Thailand.
E-mail: cnaesi@gmail.com

Introduction

Occupational skin diseases are the second most common occupational disease in the workplace, and 90% of those skin problems are occupational contact dermatitis (OCD)[1]. OCD is generally found in many workplace settings, including healthcare settings where workers are typically exposed to several irritant and allergic agents such as soaps, wet work, biocides, hand sanitizers, or even personal protective equipment (PPE) (e.g., rubber gloves and rubber-containing products)[1,2]. Several reports describe the prevalence and primary cause of OCD in healthcare workers (HCWs). For example, 21.2% of HCWs experienced contact dermatitis of the hands or forearm in Italy, and 12.3% had undesirably subsequent effects due to gloves[3]. The prevalence of self-reported OCD in HCWs in Ethiopia was 31.5% higher[1]. Furthermore, latex gloves are a major cause of OCD in HCWs in Poland[4]. UK surveillance reported that healthcare workers (HCWs) account for 18.5% of OCD cases and that latex is the most common cause in nurses[5].

Glove-related contact dermatitis is categorized as allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD)[6]. Glove-related ACD is a type-IV hypersensitivity reaction caused by exposure to chemical additives (e.g., Carba mix, Thiuram mix) in rubber-containing products. Glove-related ACD occurs only in susceptible individuals because it depends on the immunological process[7,8]. By contrast, glove-related ICD can result from exposure to rubber in all individuals. Rubber gloves may induce skin irritation through various mechanisms; for instance, occlusion in prolonged glove-wearing, friction effect, and maceration. In addition, cornstarch powder on rubber gloves can result in glove-related ICD as it provokes cutaneous irritants and affects skin roughness[9,10].

Since the 1980s, powdered latex gloves have been widely used for protecting against infectious agents due to their excellent features of biological hazard protection and dexterity[11]. Consequently, the prevalence of powdered latex glove-related diseases—particularly in HCWs—has grown continuously and dramatically during the COVID-19 pandemic[12-14]. Furthermore, latex glove-related diseases in HCWs, primarily due to working conditions, affect the quality of life and decrease work productivity[11].

Recognizing the importance of controlling glove-related disease is key to management. For example, in the UK, the imposition of a latex gloves replacement policy (e.g., substitution with nonpowdered/non-latex gloves) led to a significant decrease in latex allergy and glove-related ACD in HCWs[13]. Similarly, establishing a powder-free latex gloves policy in Sweden resulted in a substantial reduction in glove-related contact dermatitis cases among HCWs[15].

In Thailand, however, replacing powdered latex gloves with nonpowdered latex or non-latex gloves has not been enforced because of financial constraints. Consequently, powdered latex gloves largely remain in use, especially in the healthcare

industry. According to a study in a tertiary hospital, 85% of HCWs were regularly exposed to powdered latex gloves[16], and 11.3% of those experienced glove-related cutaneous symptoms[17]. In 2019, latex allergy and post-operative complications raised government concern after exposure to powdered latex gloves. The Ministry of Public Health, therefore, prohibited producing, trading, and importing surgical powdered latex gloves since 2020[18]. Notwithstanding, disposable powdered latex gloves remain in use.

In short, glove-related contact dermatitis is a crucial occupational skin disease in HCWs. The establishment of a policy banning powdered latex gloves is beneficial for lowering the prevalence of glove-related contact dermatitis. Thus, it is essential to explore the outcomes of replacing powdered latex gloves with nonpowdered latex gloves and synthetic rubber gloves in Thailand.

Objectives

The current study aimed to study the decline of glove-related contact dermatitis among nursing staff after powdered latex gloves were banned in the operating theatre.

Material and Methods

This quasi-experimental study was conducted at Srinagarind Hospital, Khon Kaen University (KKU), after replacing disposable powdered latex gloves with synthetic rubber gloves in January 2022. All nursing staff in the operating theatre were asked to complete the self-administered questionnaire between March and April 2022. In addition to replacing synthetic rubber gloves, sterile hypoallergenic latex gloves—including nonpowdered and nonpowdered low protein latex gloves—have been used for many years.

The current study is part of a study on the association between low allergenic latex gloves and latex sensitization among nursing staff at a tertiary university hospital. The Khon Kaen University Ethics Committee for Human Research reviewed and approved ethical considerations as per the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines (approval HE641367).

Research tools

The self-administered questionnaire was modified from the Thai version generated by Chaiear et al. (KKU)[19] to describe symptoms related to natural rubber latex products and Boonchai et al. (Mahidol University)[16] to explore the characteristics of latex glove usage and its related symptoms. In addition, three experts assessed the validity in dermatology, allergy and immunology, and occupational medicine. Finally, the questionnaire explores demographic data (i.e., sex, age, occupational history, and underlying atopic diseases), gloves and other causes of contact dermatitis exposure characteristics, and glove-related contact dermatitis symptoms.

Study populations

The entire 212 nursing staff in the operating theatre (i.e., registered nurses, assistant nurses, and nurse aids) who used at least three pairs of low allergenic latex gloves per day were included. In addition, nursing

staff who use powdered latex gloves in other settings (e.g., at home) were excluded.

Statistical analysis

Statistical analyses were performed using the IBM SPSS statistic version 28.0 (IBM, Armonk, NY, USA). Categorical variables—demographic data, exposure characteristics, and dermatitis symptoms—were expressed as n (%) and 95% confidence intervals. Continuous variables—age, duration of employment, and exposure characteristics—were presented as mean (SD) or median (IQR). Chi-square or Fisher exact test was employed in analyzing dermatitis symptoms between pre- and post-replacement. OpenEpi was utilized to determine an Odds ratio and 95% confidence intervals. A *p*-value < 0.05 was considered significant.

Results

Most (78.3%; 166/212) of the nursing staff responded to the self-administered questionnaire. Three staff were excluded due to exposure to powdered latex gloves in the household setting (1) or at another job (2). The majority of respondents were females (92.0%) and registered nurses (76.7%). The age of responders ranged between 20 and 60. The respective median age and duration of employment was 30 years old and 7 years. Seventeen staff had another job, 7 of whom were exposed to nonpowdered latex products (i.e., latex glue and dishwashing gloves). Six of the 9 staff had previous jobs where they were exposed to latex products. Furthermore, 106 (62.6%) staff experienced atopic diseases, including atopic dermatitis (40.5%), allergic rhinitis (44.2%), and asthma (6.1%). Demographic data, job position, and related-underlying factors are presented in Table 1.

Table 1 Demographic data of participants

Demographic data	N (%)
Sex	
male	13 (8.0%)
female	150 (92.0%)
Median age, IQR (year)	30 (25, 37)
Job position	
registered nurse	125 (76.7%)
assistant nurse	37 (22.7%)
nurse aid	1 (0.6%)
Median duration of employment, IQR (year)	7 (2, 12)
Extra job	
yes	17 (10.4%)
no	146 (89.6%)

Table 1 (Con.)

Demographic data	N (%)
History of atopic diseases	
presence	106 (62.6%)
atopic dermatitis	66 (40.5%)
allergic rhinitis	73 (44.2%)
asthma	10 (6.1%)

The characteristics of medical gloves and other causes of contact dermatitis exposure are presented in Table 2. Disposable synthetic rubber gloves were mostly used, followed by low-protein and nonpowdered latex gloves. The median pairs of gloves used per day were 7 (IQR 5 - 10), for 6 hours per day (IQR 4 - 8), 5 days per week (IQR 5 - 6). Additionally, 156 (95.7%) staff reported exposure to other causes of contact dermatitis in their practice (e.g., alcohol-based hand rub, Hibiscrub, chlorhexidine, soap, detergent, formaldehyde and disinfectant).

Table 2 Characteristics of medical gloves and other causes of contact dermatitis exposure of the participants

Exposure characteristics	n (%)
Type of gloves used	
disposable nonpowdered latex gloves	9 (5.5%)
sterile low protein latex gloves	156 (95.7%)
disposable nitrile gloves	159 (97.5%)
Duration of gloves used per day	
≤ 1 hour per day	15 (9.2%)
1 - 3 hours per day	14 (8.6%)
> 3 hours per day	134 (82.2%)
Quantity of gloves used per day	
3 - 10 pairs per day	62 (38.0%)
11 - 20 pairs per day	76 (46.6%)
> 20 pairs per day	25 (15.3%)
Other causes of contact dermatitis exposure	
yes	156 (95.7%)
no	7 (4.2%)

Prior to their replacement, 41 (25.2%, 95%CI 18.5 - 33.1) cases experienced dermatitis symptoms during the pre-replacement phase, including burning, fissure and cracking, hand drying, scaling, vesicle, and itching. Only three (1.8%) were diagnosed with hand eczema. Twenty-nine (17.8%, 95%CI 11.7 - 24.5) cases reported that their symptoms were related to latex gloves exposure, including powdered latex gloves (28 cases; 17.2%) and other latex gloves (1 case).

After the replacement, namely the post-replacement phase, 10 (6.1%, 95%CI 2.5 - 10.4) cases experienced at least one dermatitis symptom, and only eight (4.9%) related to glove exposure; in this case, the prevalence of glove-related contact dermatitis in the post-replacement phase is 4.9% (95%CI 1.9 - 8.6). Four (2.5%, 95%CI 0.6 - 4.8) cases had vesicle and itching lesions on both hands with a suspected glove-related ACD. Six (3.7%, 95%CI 1.2 - 6.7) cases experienced irritant symptoms related to glove-related ICD, including burning sensation, dry skin, scaling, or fissure lesion. This means that two cases suffered from both glove-related ACD and ICD. In addition, six of the eight cases with glove-related contact dermatitis were also exposed to other agents, and two of them had dermatitis symptoms related to alcohol-based handrub, chlorhexidine, and Hibiscrub.

Comparing the pre- and post-replacement, there was a significant decrease in dermatitis symptoms and glove-related dermatitis, including ICD and ACD. The prevalence and crude OR of glove-related symptoms and diseases in the pre- and post-replacement phase are presented in Table 3.

Table 3 Proportion of participants who acquired different types of glove-related contact dermatitis in the pre- replacement (exposure to powdered gloves) and post-replacement (non-exposure to powdered gloves)

Symptoms/diseases	Pre-replacement N (%)	Post-replacement N (%)	Crude OR (95%CI)	*p*-value
Dermatitis symptoms	41 (25.2%)	10 (6.1%)	0.20 (0.09 - 0.40)	<0.001
Glove-related dermatitis	29 (17.8%)	8 (4.9%)	0.24 (0.10 - 0.53)	<0.001
- glove-related ICD	24 (14.7%)	6 (3.7%)	0.22 (0.08 - 0.54)	<0.001
- glove-related ACD	14 (8.6%)	4 (2.5%)	0.27 (0.07 - 0.80)	0.02
- both ACD and ICD	9 (5.5%)	2 (1.2%)	0.21 (0.03 - 0.91)	0.04

In the pre-replacement phase, 23 of 29 cases who experienced glove-related contact dermatitis had atopic diseases compared to all eight cases who had glove-related contact dermatitis in the post-replacement phase. Chi-square and Fisher exact test revealed that individuals with atopic diseases significantly increase the risk of developing glove-related contact dermatitis in the pre-replacement phase with OR

2.65 (95%CI 1.05 - 7.56, p = 0.04) and post-replacement phase OR 7.1 (95%CI 0.89 - 208.6, p = 0.02). However, there was no statistically significant association between atopic diseases and glove-related ACD in the pre-replacement phase (p = 0.34) and post-replacement phase (p = 0.15).

Discussion

Exposure to rubber gloves, especially powdered latex gloves, cause contact dermatitis through different mechanisms. For instance, exposure to allergens in gloves such as rubber accelerators (e.g., Thiuram and Carba mix) and latex cause ACD in sensitized individuals through a type-IV hypersensitivity reaction—interaction between CD4+ T cell lymphocytes and exogenous allergens[20,21]. Furthermore, prolonged contact of gloves, friction effect, and powder and accelerators in gloves cause skin irritation (e.g., physical injury of a superficial layer of skin and skin barrier damage) which can develop into an ICD[7,11,22].

The study demonstrated a substantial contribution to reducing glove-related dermatitis issues in Thailand. The results showed that glove-related dermatitis significantly decreased after removal of powdered latex gloves. Our findings are similar to many studies. In the UK, banning powdered latex gloves has indicated a significant reduction in allergy or ACD with an incidence rate ratio of 0.67 (95%CI 0.61 - 0.74)[13]. Likewise, ACD symptoms dropped from 25% to 22% after powdered latex gloves were removed in Sweden[23]. A prospective cohort study between 2000 to 2009 in Italy also found a low incidence of ACD and ICD after the use of nonpowdered latex gloves[24].

Although synthetic rubber gloves are being used, eight cases nevertheless experienced glove-related contact dermatitis. Since there were no changes in the work process or changes in other allergic and irritant agents used in the work practice, a possible reason is that dermatitis symptoms are dose-dependently associated with the duration of glove exposure regardless of the type of gloves. For example, exposure to gloves for three hours daily is associated with a high risk of developing dermatitis symptoms[25,26]. For this reason, we found that all eight nursing staff were exposed to gloves for more than four hours per day. Furthermore, in the present study, 134 (82.2%) nursing staff were exposed to gloves for more than three hours per day, and the median duration was six hours per day. Thus, those nurses were at risk of developing contact dermatitis.

In addition, the replacement synthetic rubber gloves were accelerator-free rubber gloves. Chemical accelerators and additives in rubber gloves can induce type-IV hypersensitivity reaction—glove-related ACD; hence, the use of accelerator-free rubber gloves can also reduce glove-related ACD problems[20,27]. This study observed that glove-related ACD was significantly reduced from 14 to 4 cases after gloves accelerators exposure were reduced (OR 0.27, 95%CI 0.08 - 0.80).

The current study found that glove-related ICD significantly decreased from 24 to 6 cases, OR 0.27 (95%CI 0.07 - 0.80), after replacement. Cornstarch powder on rubber gloves can provoke skin irritation resulting in glove-related ICD[10,25,28]. For this reason, removing powdered-containing gloves could decrease the incidence of glove-related ICD. However, our results were different from the UK surveillance report, in which the glove-related ICD cases remained steady after introducing the powdered glove replacement policy[13]. At the same time, a hand hygiene policy was also implemented in the UK to reduce healthcare-associated infection[29]. Prolonged contact with water enhances skin permeability and susceptibility to irritants[30]. Given that both policies coincided, the incidence of glove-related ICD remained constant rather than decreased.

Furthermore, we observed that all nursing staff with glove-related ICDs following the replacement also reported a history of atopic diseases. In that case, a chronically impaired skin barrier in atopic individuals could be explained as the disrupted epithelial barrier increases susceptibility to irritants resulting in ICD. Therefore, workers with atopic diseases are more likely to develop ICD than non-atopic individuals, which has also been reported by other researchers[8,31].

Lastly, using a self-administered questionnaire may induce a reporting bias, which is a limitation of the study. Glove-related symptoms may not be reported in the post-replacement phase since nonpowdered gloves are recommended, and disadvantages of powdered latex gloves have been recognized by the informed consent process and the occupational health program.

Conclusion

In conclusion, this study found that replacing powdered latex gloves with synthetic rubber gloves can reduce the symptoms of glove-related contact dermatitis among operating theatre nursing staff. In effect, establishing a powder-free rubber glove policy is mutually beneficial to reduce the suffering of glove-related contact dermatitis among nursing staff.

Acknowledgments

The authors thank (a) the participants for their cooperation (b) the Faculty of Medicine, Khon Kaen University for its support (IN65206), (c) the National Research Council of Thailand (NRCT), and (d) Mr. Bryan Roderick Hamman for assistance with the English-language presentation of the manuscript.

References

1. Mekonnen TH, Yenealem DG, Tolosa BM. Self-report occupational-related contact dermatitis: prevalence and risk factors among healthcare workers in Gondar town, Northwest Ethiopia, 2018—a cross-sectional study. Environ Health Prev Med 2019;24:11.
2. Anderson SE, Meade BJ. Potential health effects associated with dermal exposure to occupational chemicals. Environ Health Insights 2014;8:51-62.

3. Stingeni L, Lapomarda V, Lisi P. Occupational hand dermatitis in hospital environments. Contact Dermatitis 1995;33:172-6.
4. Kurpiewska J, Liwkowicz J, Benczek K, et al. A survey of work-related skin diseases in different occupations in Poland. Int J Occup Saf Ergon 2011;17:207-14.
5. Meyer JD, Chen Y, Holt DL, et al. Occupational contact dermatitis in the UK: a surveillance report from EPIDERM and OPRA. Occup Med 2000;50:265-73.
6. Chern A, Chern CM, Lushniak BD. Chapter 27: occupational skin diseases. In: Kang S, Masayaki A, Bruckner AL, Enk AH, Margolis DJ, McMicheal AJ, et al. Fitzpatrick's Dermatology. 9th ed. New York: McGraw-Hill, Medical Pub. Division; 2019. Accessed April 18, 2022. https://accessmedicine.mhmedical.com/content.aspx?bookid=2570&sectionid=210414623.
7. Lampel HP, Powell HB. Occupational and hand dermatitis: a practical approach. Clin Rev Allergy Immunol 2019;56:60-71.
8. Bains SN, Nash P, Fonacier L. Irritant contact dermatitis. Clin Rev Allergy Immunol 2019;56:99-109.
9. Stingeni L, Lapomarda V, Lisi P. Undesirable effects from latex gloves in hospital healthcare personnel. J Eur Acad Dermatol Venereol 1996;7:44-8.
10. Brehler R, Voss W, Muller S. Glove powder affects skin roughness, one parameter of skin irritation. Contact Dermatitis 1998;39: 227-30.
11. Hollins LC, Flamm A. Occupational contact dermatitis. Dermatol Clin 2020;38:329-38.
12. Wiszniewska M, Walusiak-Skorupa J. Recent trends in occupational contact dermatitis. Curr Allergy Asthma Rep 2015;15:43.
13. Turner S, McNamee R, Agius R, et al. Evaluating interventions aimed at reducing occupational exposure to latex and rubber glove allergens. Occup Environ Med 2012;69:925-31.
14. Kiely LF, Moloney E, O'Sullivan G, et al. Irritant contact dermatitis in healthcare workers as a result of the COVID-19 pandemic: a cross-sectional study. Clin Exp Dermatol 2021;46:142-4.
15. Edelstam G, Arvanius L, Karlsson G. Glove powder in the hospital environment – consequences for healthcare workers. Int Arch Occup Environ Health 2002;75:267-71.
16. Boonchai W, Sirikudta W, Kasemsarn P. Characteristics of latex glove usage and glove-related symptoms among health care workers in each work sector of a university hospital. J Med Assoc Thai 2017;100:7.
17. Boonchai W, Sirikudta W, Iamtharachai P, et al. latex glove–related symptoms among health care workers: a self-report questionnaire-based survey. Dermatitis 2014;25:135-9.
18. Royal Gazette. Notification of the Ministry of Public Health RE: Prohibition of produced, sold, or imported surgical powdered latex gloves B.E. 2563 (2020); Bangkok.

19. Chaiear N, Med M, Jindawong B, et al. Glove allergy and sensitization to natural rubber latex among nursing staff at Srinagarind hospital, Khon Kaen, Thailand. J Med Assoc Thai 2006;89:9.
20. Kersh AE, Helms S. Glove-related allergic contact dermatitis. American Contact Dermatitis Society 2018;29:9.
21. Murphy PB, Atwater AR, Mueller M. Allergic Contact Dermatitis. [Updated 2021 Sep 20]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532866/.
22. Rattanarak A, Chaiear N, Sakdapipanich J, et al. An uncommon outbreak of irritant contact dermatitis caused by rubber accelerators: A historical cohort study. J Rubber Res 2019;22:145-52.
23. Edelstam G, Arvanius L, Karlsson G. Glove powder in the hospital environment -- consequences for healthcare workers. Int Arch Occup Environ Health 2002;75: 267-71.
24. Larese Filon F, Bochdanovits L, Capuzzo C, et al. Ten years incidence of natural rubber latex sensitization and symptoms in a prospective cohort of health care workers using non-powdered latex gloves 2000-2009. Int Arch Occup Environ Health 2014;87:463-9.
25. Jacobsen G, Rasmussen K, Bregnhøj A, et al. Causes of irritant contact dermatitis after occupational skin exposure: A systematic review. Int Arch Occup Environ Health 2022;95:35-65.
26. Hamnerius N, Svedman C, Bergendorff O, et al. Wet work exposure and hand eczema among healthcare workers: A cross-sectional study. Br J Dermatol 2018; 178:452-61.
27. Crepy MN, Lecuen J, Ratour-Bigot C, et al. Accelerator-free gloves as alternatives in cases of glove allergy in healthcare workers: Accelerator-free gloves in rubber glove allergy. Contact Dermatitis 2018; 78:28-32.
28. Nettis E, Colanardi MC, Soccio AL, et al. Occupational irritant and allergic contact dermatitis among healthcare workers. Contact Dermatitis 2002;46:101-7.
29. Stocks SJ, McNamee R, Turner S, et al. The impact of national-level interventions to improve hygiene on the incidence of irritant contact dermatitis in healthcare workers: Changes in incidence from 1996 to 2012 and interrupted times series analysis. Br J Dermatol 2015;173:165-71.
30. Ogawa-Fuse C, Morisaki N, Shima K, et al. Impact of water exposure on skin barrier permeability and ultrastructure. Contact Dermatitis 2019;80:228-33.
31. Johansson E, Hershey GKK. Contribution of an impaired epithelial barrier to the atopic march. Ann Allergy Asthma Immunol 2018;120:118-9.