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The effectiveness of personal preventive measures against occupational contact dermatitis in healthcare workers: A systematic review

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ABSTRACT

Healthcare workers (HCWs) embody the principles of hand hygiene and protective attire to support self- and patient safety, but the materials involved in this process are found to be offending agents. The incidence of occupational contact dermatitis (OCD) among HCWs keeps increasing. This review aimed to evaluate the effectiveness, investigate the outcome and clinical skin condition improvement with the implementation of primary preventive measures (PPM), specifically: barrier cream, emollient, moisturiser, gloves use, and education. All relevant literature about PPM against OCD among HCWs published between 1995 to 2020 was searched. The data search was performed using the PUBMED, Cochrane Library, and ScienceDirect databases. There were 16 studies comprised of 8 randomised controlled trials (RCTs), 7 clinical trials, and one comparative study. The study results showed that using barrier cream, moisturiser or emollient, gloves, and education were effective tools in reducing the number of clinical symptoms in cases of OCD. There was no significant difference in the effect between barrier cream use and moisturiser or emollient. The gloves were advised to be used non-latex gloves or powder-free latex gloves. Education was also observed to improve preventive behaviour among workers. The use of barrier cream, emollient, moisturiser, and gloves is recommended to be educated to ascertain the proper use of preventive measures, increase knowledge and awareness, and promote positive preventive behaviour.

Tenaga kesehatan harus menerapkan prinsip-prinsip kebersihan tangan dan pakaian pelindung untuk mendukung keselamatan diri dan pasien, tetapi bahan yang dipakai dalam proses ini dapat menyebabkan dermatitis kontak. Insiden dermatitis kontak akibat kerja pada tenaga kesehatan terus meningkat. Telaah sistematik ini bertujuan untuk mengevaluasi efektivitas, mengetahui hasil dan perbaikan kondisi klinis kulit dengan penerapan tindakan pencegahan primer (TPP) khususnya: krim pelindung, pelembap, penggunaan sarung tangan, dan edukasi. Semua literatur yang relevan tentang TPP terhadap dermatitis kontak akibat kerja pada tenaga kesehatan yang diterbitkan antara 1995 hingga 2020 ditelaah. Pencarian data dilakukan dengan menggunakan basis data PUBMED, Cochrane Library, dan ScienceDirect. Terdapat

16 studi yang terdiri dari 8 RCT, 7 uji klinis, dan satu studi perbandingan. Hasil penelitian menunjukkan bahwa penggunaan krim pelindung, pelembap atau emolien, sarung tangan, dan edukasi merupakan alat yang efektif dalam mengurangi gejala klinis pada kasus dermatitis kontak akibat kerja. Tidak ada perbedaan pengaruh yang signifikan antara penggunaan krim pelembab atau emolien. Sarung tangan yang disarankan untuk digunakan adalah sarung tangan non-lateks atau sarung tangan lateks bebas bedak. Edukasi juga dapat meningkatkan perilaku pencegahan di kalangan pekerja. Pelaksanaan penggunaan krim pelindung, pelembap, dan sarung tangan, direkomendasikan untuk dilengkapi dengan edukasi untuk memastikan penggunaan tindakan pencegahan yang tepat, dalam rangka meningkatkan pengetahuan dan kesadaran, serta mendorong perilaku pencegahan yang positif.

INTRODUCTION

Healthcare workers (HCWs) are at risk of developing occupational contact dermatitis (OCD) due to the offending agents involved in the working environment, such as in hand-washing, scrubbing, patient preparation, and wearing protective attire as the principles of patient care and safety.[1] Glove, sterilising solution, and soap are found to be the most frequent allergens involved in exposures from the working environment of HCWs.[2] The use of alcohol gel and recurrent hand washing are also known to irritate the skin.[3]

Occupational contact dermatitis dominates 90% of occupational skin diseases and can mainly be categorised as irritant contact dermatitis (ICD) and allergic contact dermatitis (ACD).[4] Occupational contact dermatitis is an inflammatory skin reaction which is induced or worsened by particular agents found in the workplace.[5] In a recent study, it was investigated that 193 of 311 (62%) HCWs present with OCD. Allergic contact dermatitis was found in 22 of 193 (11%) HCWs with predominating allergens such as rubber additives in gloves, myristyl alcohol, and formaldehyde.6 Among HCWs, the number of cases of ICD is found to be larger than ACD.[7]

Primary preventive measures (PPM) may include engineering control, personal protection, personal hygiene, work practices, health promotion, motivation, administrative control, and regulation. Primary prevention is believed to be a critical effort in reducing the number of OCD cases.[8] A three-year educational training among nurses reported a significant improvement in the hand integumentary condition and suggested that PPM education should be included in the curriculum.[9] Using moisturiser and emollient plays an important role in repairing the skin barrier by maintaining skin hydration, protecting, and strengthening the skin barrier function. However, irritant reactions and ACD were reported as adverse reactions from moisturiser or emollient use.[10]

Gloves act as a protector against offending agents by limiting the contact between the hands and offending agents. However, among other occupations, HCWs are considered at risk for glove-induced ACD. A study conducted in an Italian hospital estimated that 1 in 4 HCWs have clinical skin symptoms due to frequent glove use.[11]

Barrier cream acts as a physical barrier from exposure to offending agents found in the workplace.[12] The use of barrier cream by HCWs showed a clinical improvement of the hand integumentary condition.[13] On the contrary, induced hypersensitivity reactions were observed (28 of 109 cases) among HCWs who applied skin protection cream while wearing gloves.[14]

The health and safety of HCWs concern issues in which preventive measures can be useful to provide clinical improvement. The effectiveness of PPM, specifically the administration of barrier cream, moisturisers or emollients, use of rubber or cotton gloves, and educational training against OCD, remains inconclusive. Therefore, the authors aimed to evaluate the effectiveness, outcome, and clinical skin improvement of PPM implementation in preventing OCD among HCWs by systemically analysing the available evidence.

METHODS

Type and study design

The study was a qualitative systematic

review which followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.

Inclusion and exclusion criteria

The type of participants included in this review were HCWs or all workers involved in the medical occupation or health institutions. The types of interventions included in this review were: (1) the administration of barrier cream, (2) moisturiser or emollient, (3) the use of rubber or cotton gloves, and (4) educational training. The type of studies included in this review was primarily selected from experimental studies such as randomised controlled trials (RCT), non-RCT, before and after studies, quasi-experimental studies, and case report studies.

The primary outcome included in this review was the prevention of OCD among HCWs. Meanwhile, the secondary outcomes included in this review were: (1) improvement of clinical skin conditions of subjects who experienced signs and symptoms of OCD, (2) incidence rate of OCD, and (3) incidence of adverse reactions attributed to the implementation of primary preventive interventions. Meanwhile, the exclusion criteria were other wet workers or occupational field workers with similar risk of developing OCD, and other studies unavailable in English, German, and Indonesian.

Electronic search strategy

The studies involved in this review were systematically selected from PUBMED, Cochrane Library, and ScienceDirect databases that were published in the timeframe of 1995-2020 with keywords comprised of: "barrier cream", "skin protection cream", "gloves", "moisturiser", "emollient", "education", "training", "occupational contact dermatitis", "irritant contact dermatitis", "allergic contact dermatitis", "healthcare worker", "health professional" and "primary prevention" in all languages and all forms of publication status. The available studies were first screened from the title and abstract according to the eligibility criteria, then further screened for the availability of the full text to be included in this review.

Research instruments

Access to databases and Microsoft Excel as software for data extraction and analysis were available. The authors independently screened, manually assessed the risk of bias, extracted, and analysed the selected studies according to the eligibility criteria. Each selected study's evidence level was classified based on the Oxford Centre for Evidence-Based Medicine guidelines. The relevance of the selected studies was assessed using the critical appraisal sheet for RCT provided by the Critical Appraisal Skills Program (CASP). Any disagreements among authors were resolved through discussion.

Data extraction and analysis

The collected data from the selected studies were extracted in the form of tabulation, which consisted of: (1) title, (2) study authors and the year of publication, (3) study design, (4) study subjects, (5) study intervention, (6) study outcome, and (7) level of evidence. The extracted data were presented in the form of tables using Microsoft Excel and then manually analysed.

RESULTS

After the inclusion and exclusion criteria were applied to the search methods, there were 1.633 identified studies retrieved from the electronic databases. Based on the screening of titles and abstracts, there were 31 studies which were included to be assessed further for full-text eligibility. As a result, there were a total of 16 studies included in this review to answer the research question on the effectiveness of PPM against OCD in HCWs (Figure 1).

Among the 16 included studies, eight were RCT, seven were clinical trials, and one was a comparative study. Among these were three studies about barrier cream, emollient, and moisturiser, four about gloves

use, and nine about educational intervention. No studies met the intervention criteria (administration of barrier cream, emollients, moisturisers, gloves use, and educational training) comparing other PPM against OCD in HCWs. The included studies reported the outcomes as a reduction in the number of clinical skin symptoms cases, skin condition improvement, and changes in preventive behaviours. All extracted data are summarised in Table 1. There was no disagreement in analysing the data and discussions regarding the arrangement of the data extraction writing and the categorisation of the level of evidence of each research conducted between the authors through online and offline meetings.

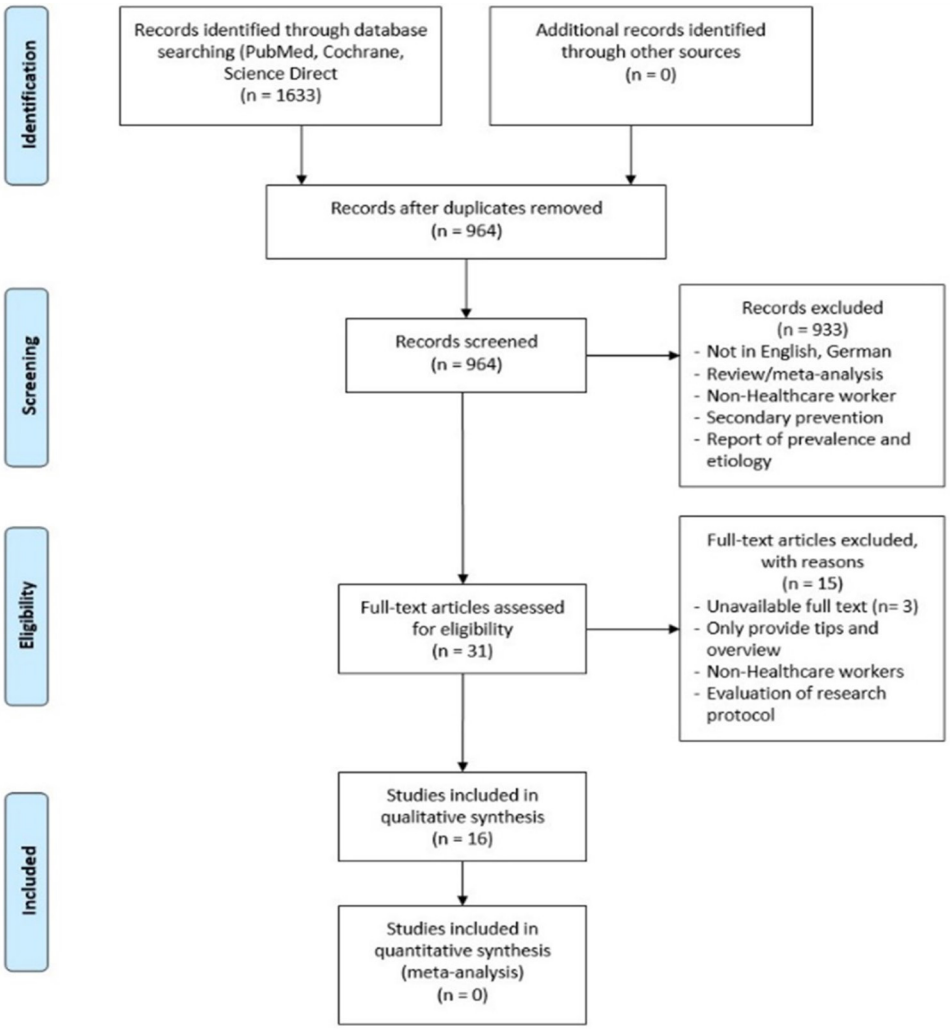

Figure 1. Systematic search results using Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Use of barrier cream as primary preventive measure of OCD in HCWs

There were three studies investigated that used barrier cream as their main intervention. All three studies reported significant clinical skin improvement after the intervention. However, two of three studies reported that skin improvement was greater in the control group (CG) that used oil-containing hand lotion. Which resolved full-thickness breaks and pain of the hand, and moisturisers, respectively, compared to the intervention group (IG), which used barrier cream.[14,15] The barrier cream and its vehicle only differed in their ingredients.

A significant decrease in the visual scoring of clinical examination and a significant increase in stratum corneum hydration was found, but no significant difference in effect was found between the barrier cream and its vehicle.[16] The participants also rated the moisturiser to be superior to the barrier cream. Using moisturiser resulted in better transepidermal water loss (TEWL) value compared to using barrier cream.[14]

Gloves use as PPM against OCD in HCWs

There were four studies found that used gloves as interventions. The subjects self-rated their skin as less dry, more hydrated, and smoother after wearing gloves coated with dermal therapy formula.[17] Positive reactions of itching, wheals, and flare were found greater in the wearing test of powdered natural rubber latex (NRL) gloves made with rich proteins and allergens with applied skin protection cream.[13] Among other non-latex gloves, neoprene gloves (DermaPrene® DermaShield and Biogel® Neotech) gave the best protection, whereas gloves made with polythene, copolymer plastic material (Medett® Super Sensi Touch glove) gave the poorest protection against dentin bonding product.[18] Gloves which used ethylene-vinyl-alcohol-polyethene material (4H® glove) gave the best protection among other gloves tested, but it is mainly used for industrial purposes. Gloves suitable for dentistry and given the second best protection were obtained from nitrile gloves with a thicker wall (Nitra Touch®), while the poorest protection was obtained from thinner latex gloves and vinyl gloves.[19]

Education as PPM against OCD in HCWs

There were nine studies found that used education as the intervention. A prominent decrease in NRL-associated allergy was found after substituting NRL gloves with lower protein and powder.[20,21] Significant drops in the number of subjects with skin symptoms and contact urticaria and ACD cases were reported.[22,23] An increased number of ICD cases were obtained from both IG and CG, in which the IG received a skin care protection program, whereas the CG received training on lifting techniques and assistive device use.[23] Improvement of hand eczema was seen from a decreased Hand Eczema Severity Index (HECSI) score, and the severity of hand dermatitis was significantly improved in those with mild hand dermatitis only.[24]

Regarding the preventive behaviours, a higher reduction in the frequency of hand-washing was found in the IG, and a higher intention of hand-washing only when appropriate by the IG was recorded.[9,25,26] Special training regarding skin care recommendations resulted in the more frequent use of moisturiser or hand cream from the IG.[22,24-26] The cotton provision under gloves was significantly increased in the IG and they were more likely to wear cotton under gloves than the CG.[22,25]

DISCUSSION

Our results showed that the outcomes from the included interventions were reducing the number of clinical skin symptoms cases, improving skin conditions, and transforming preventive behaviours. The populations, study subjects, control groups, interventions, and outcome measures of these 16 included studies were different from one another and heterogeneous. Therefore, statistical pooling or quantitative analysis was considered to be unsuitable.

Most of the subjects had tried various hand-care products to resolve their symptoms but had not regularly used them on a scheduled basis. The intervention of scheduled use of barrier cream and oil-containing lotion resulted in significant improvement of the hand integumentary condition with complete remedy from full thickness breaks and pain.[15]

The use of moisturisers after work was shown to be more beneficial and was judged superior to barrier cream according to subjects' self-rating.[14] Based on a review conducted in 2016, barrier creams gave some degree of protection against irritants. In addition, the combination of barrier cream and moisturisers gave the best protective effect.[27] The outcome of no significant difference in the effect between the barrier cream and its

vehicle gave rise to the argumentation of the need for specific skin protection cream if other preparations were as effective as the barrier cream.[16] Thus, the debate on a clear distinction between "skin care" and "skin protection" products remained uncertain. The glycerin content on the vehicle made it able to act as a good moisturiser and alternate the skin care status.

Greater skin improvement was found in the CG, who used hand lotion, compared to the IG, who used barrier cream.[15] This was similar to the CG who used moisturiser, which resulted in greater skin improvement and TEWL value than the IG who used barrier cream.[14] It was reported that the hand irritations were contributed more by the frequency of gloves that were donned daily instead of the prolonged duration of gloves used.[15] Thus, it was possible that the workers who used barrier cream may have donned more gloves each day than the CG, but, unfortunately, the frequency of gloves that were donned each day was not recorded. The subjects recruited already had severe and long-standing irritation.[15] Repeated work-related skin changes were also reported from the subjects.[14] Meanwhile, barrier creams were suggested to be used for mild irritants exposure since they could not nullify high doses of irritants.[27]

The likeliest factor for OCD was improper methods of applying the barrier cream. It is known that self-application of skin protection cream resulted in an insufficient layer on certain areas of the hands.[27] However, including subjects with impaired skin conditions might lead to the interpretation of therapeutic effect instead of its preventive effect since skin protection cream is advised to be used on intact skin and actually cannot replace appropriate dermatological treatment in manifested hand eczema.[28]

The application of skin protection cream increased the number of hypersensitivity reactions in those who used powdered and powder-free NRL gloves. This finding suggested the possibility of transferring allergens from the gloves onto the skin even with a very minimum level of allergens and inner film provided by the gloves, and the skin protection cream might be considered a medium for allergen transmission.[13] It is known that after saturation, the agents not inactivated by barrier creams but trapped within the layer of the cream will be able to permeate further onto the skin.[27]

Positive wearing test results were found more in those who wore powdered NRL gloves rich in proteins and allergens than powder-free NRL gloves with low protein and allergen content.13 It is known that NRL is one of the allergens which most frequently give rise to the development of type 1 hypersensitivity reactions and the leading cause of ACD.[11]

Clinical skin condition improvement was observed in a one-day, clinical self-assessment study, in which HCWs who were tested using gloves coated with a dermal therapy reported their skin to be less dry, more hydrated or moisturised, smoother and suppler. The dermal therapy formula comprised glycerin, gluconolactone, sorbitol, citric acid, chitosan, and panthenol or provitamin B5, in which each ingredient was known to moisturise, support skin repair, and provide protection of the skin barrier whether they were used individually or combined.[17] However, it was known that prolonged use of gloves might lead to occlusion, sweating and maceration, which may proceed to cause skin irritation.[29]

The neoprene and nitrile gloves obtained the best protection against dentin bonding products. Nitrile gloves protect the hands from chlorinated solvents, oils, greases, caustics, alcohols, and acids, with the exception of aromatic solvents, ketones, strong oxidising materials, and acetates. Neoprene gloves provide a good level of protection against methyl methacrylate, organic acids and alkalis, gasoline, alcohol, and hydraulic fluids. Neoprene gloves are manufactured with high density, tear resistance, finger dexterity, and good pliability and are known to provide greater chemical and wear resistance than natural rubber gloves.[30]

Most of the educational interventions were augmented with other interventions. The outcomes showed a reduction in the

number of clinical cases with skin symptoms after implementing preventive measures. The outcomes of included studies were in line with the results of a cohort study with the intervention of a one-time skin protection seminar in which reduction of prevalence and incidence of any skin changes of the hands in the health-related workers were reported.[31] A review also provided evidence that health education was suggested to be an effective effort for stages of prevention of skin disorders which are primary prevention when the workers were still trainees or apprentices, secondary prevention or at work, and tertiary prevention when the worker already experienced the symptoms.[32] A review concluded that there was moderate evidence regarding the effectiveness of teaching intervention in the prevention of hand dermatitis in the case of minimising the incidence of hand dermatitis and upgrading compliance towards preventive measures contrary to the commonly used intervention or no intervention. Low-level evidence was also reported regarding the influence of teaching interventions on clinical outcomes and self-reported outcomes' refinement.[33]

Implementing educational intervention through curriculum and routine advisory services is strongly suggested. Greater skin improvement, more frequent use of moisturiser, and hand disinfectant instead of soap and water were found in the IG, as well as a significant reduction in the frequency of skin changes. The provision of cotton gloves and barrier cream products and the display of skin protection guidelines were found to be increasing. The study pointed out that written guidelines alone would not transform the real practice and therefore it should be accompanied by routine advisory services training regarding correct methods of implementing the preventive measures, especially in institutions with regular changes of human resources in order to reach staff adherence.[22]

A 3-year training program resulted in a similar finding of a higher reduction in the prevalence of irritant skin changes and hand dermatitis among healthcare trainees who received education compared to those who did not.[9] These findings were correlated to the skin improvement and increasing reports of no symptoms which were observed in the group of HCWs who received education on skin protection and skin care.[24] In another included study, access to an online behaviour change package (BCP) targeted for the nurses resulted in less occurrence of dermatitis and positive changes regarding their health beliefs.[26] Significant drop was also observed in 'latex' associated contact urticaria cases and ACD cases after the BCP intervention. However, a significant increase in ICD cases following the implementation of advice in published guidelines and legal decisions was assumed to be triggered by hand-washing, soaps, scrubs and hand cleansers following the establishment of interventions to decrease healthcare-associated infection transmission involving infection control strategies and risk assessments that were also conducted during the study period.[23]

Coincidence with substituting powdered NRL gloves into powder-free NRL gloves decreased NRL-caused skin allergy.[20,23] This finding was associated with another included study, as previously stated, in which higher hypersensitivity reaction was found in subjects who used powdered NRL gloves rich in proteins and allergens compared to those who used powder-free NRL gloves of low protein and allergen content.[13] The decreased number of NRL allergy cases and clinic visits might have also resulted from the symptomatic staff who did not report their symptoms which was triggered by fear of adverse outcomes at work or other reasons.[21] A prospective cohort study also showed that the utilisation of non-powdered latex gloves, which included all workers and the utilisation of non-latex gloves specifically for workers who presented with symptoms or sensitisation might lead to a significantly smaller number of cases with gloves-related symptoms.[34]

Changes in preventive behaviours varied from one study to the others. The decreased frequency of hand washing using water and soap was reported more in the IG compared to the CG.[9,25] In

addition, the substitution of hand washing with hand disinfectant was found to be significantly higher in the IG, and the intention to wash hands only in certain appropriate conditions was also higher in the IG compared to the CG.[23,26] The use of disinfectant was found to be less in IG.[35] Whereas, another study reported that the use of hand rubs was significantly higher in the IG.[26]

Increased frequency of moisturiser and hand cream used in the IG were recorded.[22,24-26] It was reported that the amount of skin protection cream dispensed might not represent the proper use of the cream itself. Further, the amount of skin protection cream applied was not correlated with the proportion or severity of the skin changes on the workers' hands. This might also be due to the lack of control regarding the dispensation of the skin protection cream, no clear control of skin protection cream used for the hands only or all over the body, and no clear control over the possibility that the cream might be dispensed for another person.[9] The provision of cotton under gloves was reported to be significantly higher in demand in the IG compared to the CG.[22] This was in accordance with the findings that the IG was 3.94 times more likely to wear cotton under gloves.[25]

After the intervention, the IG was reported to be more likely to be aware, receive information, and gain a higher score of knowledge regarding the prevention and reduction of occupational hand eczema.[25] Increasing self-reported skin problems were observed after educational interventions and it is suggested that raised awareness among the healthcare workers might have contributed to this finding.[22,35] Specifically to the atopic subjects who already understood their sensitive skin, it was reported that they were more likely to transform the teaching material into action than other subjects.[9] This finding was similar to the geriatric nurses who already know they are susceptible to developing extremely dry skin, and they were reported to be more aware of minor skin symptoms and keener to the protective measures introduced.[22]

In terms of real practice, some studies reported commercially available barrier creams, moisturisers, and gloves.[15] It was reported that glove replacement using low-protein, low-powder, and powder-free NRL gloves or non-NRL gloves was more expensive than the usually powdered gloves.[21] Neoprene gloves (DermaPrene® DermaShield and Biogel® Neotech) and gloves made of styrene (Tactylon™ glove and Elastyren® glove) were available as sterilised surgeon's gloves at a higher price range. The nitrile gloves (N-dex® gloves) were commercially available as non-sterile gloves and in the form of big packages with a relatively low price.[18] However, no information was stated regarding the cost of delivering the educational material and training.

CONCLUSION

The primary preventive measures included in this review effectively reduced the incidence of skin symptoms, improved skin conditions related to OCD, and improved the workers' preventive behaviours. There was no significant difference in the effect of using barrier cream compared to its vehicle or moisturiser. However, the presence of moisturising agents is essential for workers with the risk of developing occupational contact dermatitis. The use of non-latex or powder-free latex gloves is advised instead of latex gloves. Neoprene gloves were recommended to give the best protection against offending dental agents. Skin protection and skin care education were suggested to be included in the curriculum or the form of routine advisory services training. In implementing other interventions, education is essential to be added to ascertain the proper use of preventive measures, increase awareness and knowledge, and promote transformation into positive preventive behaviour.

CONFLICT OF INTEREST

The authors report no conflicts of interest in this work.

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REFERENCES

1. Schlarbaum JP, Hylwa SA. Allergic contact dermatitis to operating room scrubs and disinfectants. Dermatitis. 2019;30:363-70.
2. Warshaw EM, Schram SE, Maibach HI, Belsito D V., Marks JG, Fowler JF, et al. Occupation-related contact dermatitis in North American health care workers referred for patch testing: cross-sectional data, 1998 to 2004. Dermatitis. 2008;19:261-74.
3. Malik M, English J. Irritant hand dermatitis in health care workers. Occupational Medicine (Chic Ill). 2015;65:474-6.
4. Sasseville D. Occupational contact dermatitis. Allergy, Asthma & Clinical Immunology. 2008;4:59-65.
5. Holness DL. Occupational dermatoses. Current Allergy and Asthma Reports. 2019;19:42.
6. Hamnerius N, Svedman C, Bergendorff O, Björk J, Bruze M, Engfeldt M, et al. Hand eczema and occupational contact allergies in healthcare workers with a focus on rubber additives. Contact Dermatitis. 2018;79:149-56.
7. Nettis E, Colanardi MC, Soccio AL, Ferrannini A, Tursi A. Occupational irritant and allergic contact dermatitis among healthcare workers. Contact Dermatitis. 2002;46:101-7.
8. Al-Otaibi ST. Prevention of occupational contact dermatitis. Journal of Ergonomics. 2016;6:9-11.
9. Löffler H, Bruckner T, Diepgen T, Effendy I. Primary prevention in health care employees: a prospective intervention study with a 3-year training period. Contact Dermatitis. 2006;54:202-9.
10. Purnamawati S, Indrastuti N, Danarti R, Saefudin T. The role of moisturisers in addressing various kinds of dermatitis: a review. Clinical Medicine & Research. 2017;15:75-87.
11. Kersh AE, Helms S, De La Feld S. Glove-related allergic contact dermatitis. Dermatitis. 2018;29:13-21.
12. Alvarez MS, Brown LH, Brancaccio RR. Are barrier creams actually effective? Current Allergy and Asthma Reports. 2001;1:337-41.
13. Baur X, Chen Z, Allmers H, Raulf-Heimsoth M. Results of wearing test with two different latex gloves with and without the use of skin-protection cream. Allergy. 1998;53:441-3.
14. Frosch PJ, Peiler D, Grunert V, Grunenberg B. Wirksamkeit von hautschutzprodukten im vergleich zu hautpflegeprodukten bei zahntechnikern - Eine kontrollierte feldstudie. JDDG - Journal of The German Society of Dermatology. 2003;1:547-57.
15. McCormick RD, Buchman TL, Maki DG. Double-blind, randomised trial of scheduled use of a novel barrier cream and an oil-containing lotion for protecting the hands of health care workers. American Journal of Infection Control. 2000;28:302-10.
16. Berndt U, Wigger-Alberti W, Gabard B, Elsner P. Efficacy of a barrier cream and its vehicle as protective measures against occupational irritant contact dermatitis. Contact Dermatitis. 2000;42:77-80.
17. Andersson T, Bruze M, Björkner B. In vivo testing of the protection of gloves against acrylates in dentin-bonding systems on patients with known contact allergy to acrylates. Contact Dermatitis. 1999;41:254-9.
18. Andersson T, Bruze M, Gruvberger B, Björkner B. In vivo testing of the protection provided by non-latex gloves against a 2-hydroxyethyl methacrylate-containing acetone-based dentin-bonding product. Acta Dermato-Venereologica. 2000;80:435-7.
19. Held E, Wolff C, Gyntelberg F, Agner T. Prevention of work-related skin problems in student auxiliary nurses: an intervention study. Contact Dermatitis. 2001;44:297-303.
20. Tarlo SM, Easty A, Eubanks K, Parsons CR, Min F, Juvet S, et al. Outcomes of a natural rubber latex control program in an Ontario teaching hospital. Journal of Allergy and Clinical Immunology. 2001;108:628-33.
21. Allmers H, Schmengler J, Skudlik C. Primary prevention of natural rubber latex allergy in

the German health care system through education and intervention. Journal of Allergy and Clinical Immunology. 2002;110: 318-23.
22. Davis DD, Harper RA. Using gloves coated with a dermal therapy formula to improve skin condition. AORN Journal. 2005;81:157-62.
23. Dulon M, Pohrt U, Skudlik C, Nienhaus A. Prevention of occupational skin disease: a workplace intervention study in geriatric nurses. British Journal of Dermatology. 2009;161:337-44.
24. Turner S, McNamee R, Agius R, Wilkinson SM, Carder M, Stocks SJ. Evaluating interventions aimed at reducing occupational exposure to latex and rubber glove allergens. Occupational and Environmental Medicine. 2012;69:925-31.
25. Van Der Meer EWC, Boot CRL, Twisk JWR, Coenraads PJ, Jungbauer FHW, Van Der Gulden JWJ, et al. Hands4U: The effectiveness of a multifaceted implementation strategy on behaviour related to the prevention of hand eczema: a randomised controlled trial among healthcare workers. Occupational and Environmental Medicine. 2014;71:492-99.
26. Soltanipoor M, Kezic S, Sluiter JK, de Wit F, Bosma AL, van Asperen R, et al. effectiveness of a skin care programme for the prevention of contact dermatitis in healthcare workers (the Healthy Hands Project): a single-centre, cluster randomised controlled trial. Contact Dermatitis. 2019;80:365-73.
27. Madan I, Parsons V, Ntani G, Wright A, English J, Coggon D, et al. A behaviour change package to prevent hand dermatitis in nurses working in health care: the SCIN cluster RCT. Health Technology Assessment. 2019;23:1-92.
28. Mostosi C, Simonart T. Effectiveness of barrier creams against irritant contact dermatitis. Dermatology. 2016;232:353-62.
29. Mahler V. Skin protection in the healthcare setting. Current Problems in Dermatology. 2007;34:120-32.
30. Schalock PC, Zug KA. Protection from occupational allergens. Current Problems in Dermatology. 2007;34:58-75.
31. OSHA (2004) 'Personal Protective Equipment - Eyes and Face Protection', Occupational Safety and Health Administration, 5(1), pp. 8–16.
32. Wilke A, Brans R, Nordheider K, Braumann A, Hübner A, Sonsmann FK, et al. Skin protection seminars to prevent occupational skin diseases: results of a prospective longitudinal study in apprentices of high-risk professions. Safety and Health at Work. 2018;9:398-407.
33. Brown TP. Strategies for prevention: occupational contact dermatitis. Occupational Medicine (Chic Ill). 2004;54:450-57.
34. Van Gils RF, Boot CRL, Van Gils PF, Bruynzeel D, Coenraads PJ, Van Mechelen W, et al. Effectiveness of prevention programmes for hand dermatitis: a systematic review of the literature. Contact Dermatitis. 2011;64:63-72.
35. Filon FL, Bochdanovits L, Capuzzo C, Cerchi R, Rui F. Ten years incidence of natural rubber latex sensitisation and symptoms in a prospective cohort of health care workers using non-powdered latex gloves 2000-2009. International Archive of Occupational and Environmental Health. 2013;87:463-9.

Table 1. Data extraction of systematic search.

No	Title	Authors, year	Study design	Study subjects	Study intervention	Study outcome	Level of evidence
1.	Results of wearing test with two different latex gloves with and without the use of skin-protection cream	Baur et al., 1998 [13].	Clinical trial.	109 subjects, 99 were healthcare workers, who had attended the medical department since 1994 because of suspected cutaneous immediate-type allergy to NRL gloves and history of repeated work-related symptoms.	- All subjects were tested for IgE antibodies to latex testing and skin prick test (SPT) with natural rubber latex (NRL) extracts. - Wearing test of powdered and powder-free NRL gloves on both hands, with skin protection cream applied on one hand. - Intraindividual comparison of tests using both glove types, with and without skin protection cream.	Hypersensitivity skin reaction shown from positive wearing test was found more on the subjects using powdered NRL gloves rich in proteins and allergens and with applied skin protection cream. Those with positive wearing test were mostly had latex-IgE positive and SPT positive.	2B
2.	In vivo testing of the protection of gloves against acrylates in dentin-bonding systems on patients with known contact allergy to acrylates	Andersson et al., 1999 [17].	In vivo study.	Eight patients (6 worked or had worked in the dentistry and 2 were nurses) who had contact allergy to 2-HEMA and additional acrylate allergies. Five of the patients were contact allergic to TREGDMA.	- Six different types of gloves were tested on the back of the skin of each subject using an open chamber system for glove testing. - The positive control: 2 test positions which was left uncovered (chamber without glove). - All subjects received serial dilution (20 µl) patch test with the adhesive in ethanol corresponding to various concentrations of 2-HEMA.	- Positive reaction of 0.2% (w/v) 2-HEMA was found in all subjects from the serial dilution test. - The best protection was obtained from the 4H® glove, followed by a thicker nitrile glove (Nitra Touch®), thinner nitrile glove (N-dex®), thicker latex glove (Biogel D®), and the poorest were the thinner latex glove and the vinyl glove.	2B

3.	Double-blind, randomised trial of scheduled use of a novel barrier cream and an oil-containing lotion for protecting the hands of health care workers	McCormick et al., 2000 [15].	Prospective, randomised, double-blind trial.	Fifty-four hospital employees with severe and long-standing hand irritation with mostly showed extensive scaling.	- IG: application of barrier cream over the entire surface of each hand at least 4 times daily for 4 weeks. - CG: application of oil-containing control lotion over the entire surface of each hand at least 4 times daily for 4 weeks. - Both groups: received supplemental oil-based lotion to use as needed at home, mechanical counters to record the frequency of hand-washing; wearing gloves; applications of the study agent; supplemental hand lotion, and hand scoring, quantitative hand cultures.	- Subjects in both groups showed significant improvement in hand integumentary condition. - Subjects in the control oil-containing lotion group showed greater improvement compared to the barrier cream group. - The hand flora at the outset and at the end of the trial showed similar levels and profiles.	1B
4.	In vivo Testing of the Protection Provided by Non-latex Gloves against a 2-Hydroxyethyl Methacrylate-containing Acetone-based Dentin-bonding Product	Andersson et al., 2000 [18].	In vivo study.	Eight patients, 7 worked or had worked in dentistry and 1 was a hairdresser, with previous patch test-verified contact allergy to 2-hydroxyethyl methacrylate (2-HEMA) and had acrylate allergies.	- Seven different non-latex gloves were tested on the back of the trunk of each subject using an open chamber system for glove testing. - The positive control: one test position which was left uncovered (chamber without glove). - All subject received serial dilution (20 µl) patch test with the adhesive in ethanol corresponding to various concentrations of 2-HEMA.	- Positive reactions to concentration as low as 0.63% (w/v) 2-HEMA was found in all patients. - The best protection was obtained from 2 neoprene gloves (DermaPrene® DermaShield and Biogel® Neotech), followed by the Tactylon™ glove, N-dex® glove, Elastyren® glove, Medett® Super Strong glove, and the poorest was the Medett® Super Sensi Touch glove.	2B

5.	Efficacy of a barrier cream and its vehicle as protective measures against occupational irritant contact dermatitis	Berndt et al., 2000 [16].	Randomised, double blinded study.	Fifty hospital nurses with mild signs of compromised skin on their hands.	- IG (verum group): application of barrier cream frequently during workday. - CG (vehicle group): application of the barrier cream's vehicle (the same preparation without aluminum chlorohydrate) frequently during workday. - Both groups: received history taking, atopy scoring, tube weighing, clinical skin examination, non-invasive bioengineering parameters (measurement of TEWL, erythema, and hydration of stratum corneum).	- The visual score from clinical examination decreased significantly in both groups, but no significant difference between the two. - The measurement of TEWL and erythema showed no significant change in both groups during the study period. - The hydration of stratum corneum showed significant increase in both groups from the beginning until the end of the study.	1B
6.	Prevention of work-related skin problems in student auxiliary nurses: An intervention study	Held et al., 2001 [19].	Clinical trial.	107 student auxiliary nurses were included in the study.	- IG: received 2X2 h educational course equipped with video, booklet, evidence-based skin care program, and given moisturiser. - CG: did not receive any educational program and moisturiser. - Both groups: received patch test, questionnaire administration, clinical hand examination and hand scoring, TEWL measurement.	- Significant positive effect on behavior was observed in the IG in disinfectant use compared to the CG. - Significant increase in the number of participants with skin problems was observed in both groups, but no significant difference between them. - More subjects in the CG developed skin irritation or had aggravation of already existing skin irritation. - Both groups showed increased TEWL value, but the increase was only statistically significant in the CG.	2B

7.	Outcomes of a natural rubber latex control program in an Ontario teaching hospital	Tarlo et al., 2001 [20].	Clinical trial.	Toronto General and Toronto Western Hospital with approximately 8000 employees, including 2500 nurses, 400 laboratory technicians, and 350 housekeeping staff who use gloves during their usual work.	- Provision of non-NRL gloves and local avoidance measures for workers with diagnosed natural rubber latex (NRL) allergy. - Education program establishment in 1994 by the hospital latex committee which was delivered in newsletters, in-service education sessions, and educational rounds. - Availability of voluntary medical surveillance, administration of questionnaire, skin prick testing, allergy assessment, and NRL-free kits. - Replacement of NRL gloves with lower protein, low-powder NRL gloves in 1995.	- The report of NRL allergy incident was peaked in 1994, coincident with the education program established in 1994. Coincident with the substitution of NRL gloves, the number of cases fell in 1995 until no new case was reported in 1999. - The new clinic visits were fewer in 1993 and 1994, but after the education program and medical surveillance was established, greater number of new clinic visits were reported. - The yearly rates of clinic visits and new onset of symptoms fell following the substitution of glove in 1995.	2B

8.	Primary prevention of natural rubber latex allergy in the German health care system through education and intervention	Allmers et al., 2002 [21].	Clinical trial.	History of 70 healthcare workers (HCWs) which were referred to the BGFA (Berufsgenossenschaftliches Forschungsinstitut für Arbeitsmedizin) from local BGW (Berufsgenossenschaft für Gesundheitsdienst und Wohlfahrtspflege) offices on between the September 1992 and December 1997.	- Guideline for hospital administrators and personnel on the recommendation of prevention of NRL allergy in HCWs and allergic patients by the BGFA in 1995. - Informational material and questionnaires for hospital administrators about the use and avoidance of powdered NRL gloves by North Rhine Westphalia and Bavaria in 1997 and 1998. - Informational leaflet concerning NRL allergy and avoidance of powdered NRL gloves by semigovernmental statutory accident insurance companies in 1997. - Information campaigns consist of information package with scientific and popular information concerning NRL allergy by BGW in 1997 and 1998. - Regional informational events that addressed the need of preventive measures. - The compulsory technical regulations for dangerous substances (TRGS 540) in 1997 about the use of powdered NRL glove that was not permissible in the workplace.	- In 2000, powder-free sterile surgical NRL gloves were purchased more than the powdered one. - There was an increase of suspected cases of NRL allergy in 1996 to 1998, then it subsequently fell until 2001 for both skin and respiratory diseases.	2B

9.	Efficacy of barrier creams in comparison to skin care products in dental laboratory technicians - a controlled trial	Frosch et al., 2003 [14].	Randomised controlled trial.	192 dental laboratory technicians from 5 laboratories.	- Every technician used one barrier cream (HS-1 or HS-2) several applications during working hours and one moisturiser (HP-1 or HP-2) applied at home at least once daily for 4 weeks each with a wash-out period of 2 weeks in between. - Self-rate the products. - Clinical skin examination. - TEWL measurement.	- Moisturisers were judged superior to either of the barrier creams. - Improvement of the skin condition was shown better by moisturiser use compare to barrier cream use. - TEWL value was better from the moisturiser use compare to barrier cream use.	1B
10.	Using Gloves Coated with a Dermal Therapy - Formula to Improve Skin Condition	Davis et al., 2005 [22].	Clinical trial.	31 HCWs who consisted of 24 perioperative nurses, 2 medical/surgical nurses, 3 physical and occupational therapies, a medical assistant, and a laboratory technician.	- Self-assessment consisted of performing a surgical scrub and completing a questionnaire. - Application of a surgical glove coated with dermal therapy formula on one hand for three, one-hour wear periods, with 5 minutes rest between the first two wear period. - Self-rate the feel and appearance of their skin after the glove use.	- Frequent hand washing was perceived by most of the subjects as the cause of dry and irritated hands. - After the coated gloves use, the subjects rated their skin as less dry, more hydrated or moisturised, smoother and suppler. - The coated gloves were non-irritating.	2B

11.	Primary prevention in health care employees: a prospective intervention study with a 3-year training period	Löffler et al., 2006 [9].	Randomised controlled trial.	521 nurse trainees, 276 of them were general nursing trainees from 6 centers, 149 were geriatric nursing trainees from 3 centers, 56 were pediatric nursing trainees from 3 centers, and 40 were midwives trainees from 2 centers.	- IG: received in the first year 3 times and in the following twice a year an educational lecture with practical parts, skin care practice, and given a skin care cream. - CG: received one information paper at the beginning of the study and given a skin care cream. - Both groups: received interview, atopy scoring, specific IgE testing, clinical skin examination to evaluate skin changes and hand dermatitis.	- Both the prevalence of irritant skin changes and hand dermatitis were decreased in the IG and increased in the CG at the end of the study. - After 3 years of training, the risk of skin changes on the hands was 4.8 times higher in the control group.	1B
12.	Prevention of occupational skin disease: a workplace intervention study in geriatric nurses	Dulon et al., 2009 [23].	Cluster randomised controlled trial.	Twenty-six nursing homes in four regions in North Germany from the BGW (Berufsgenossen-schaft für Gesun-dheitsdienst und Wohlfahrtspflege) database.	- IG: received kick of meeting (a 4 h course) for senior managers, advisory service training in skin protection, 2 h training course for the nurses, and closing meeting. - CG: received training of lifting technique and use of assistance devices. - Both groups: received clinical examination, questionnaire, and standardised of documentation record of organisational protective measures.	- The frequency of skin symptoms was significantly decreased in IG and minor non-significantly decreased in CG. - The ratio of improved to worsened skin findings was significantly higher in the IG than in the CG. - The provision of cotton gloves, barrier cream, written guideline, moisturiser use and substitution of hand-washing with hand disinfectant was significantly increased in the IG compare to CG.	1B

13.	Evaluating interventions aimed at reducing occupational exposure to latex and rubber glove allergens	Turner et al., 2012 [24].	Before and after comparison study.	Total of 13,858 case reports of HCWs and non-HCWs from EPIDERM (the occupational skin surveillance scheme) data for the period of January 1996 to December 2007.	- The 1998 advice from the UK Medical Devices Agency to increase awareness in glove users regarding the latex's allergic potential and risk which was stated in a published guideline. - The 2002 legal decision made by the England and Wales Court of Appeal (Civil Division) regarding the timescales of when the employers should have known about the potential risk and sensitisation of latex gloves.	- The latex-associated contact urticaria (CU) and latex-associated ACD cases in HCWs had a marginally significant fell at post intervention period. - The ICD cases in HCWs were significantly increased in both latex-associated and non-latex associated cases at post intervention period.	1B
14.	Hands4U: the effectiveness of a multifaceted implementation strategy on behavior related to the prevention of hand eczema - a randomised controlled trial among healthcare workers	van der Meer et al., 2014 [25].	Randomised controlled trial.	A total of 48 departments from three university hospital, one academic center for dentistry, two general hospitals and two nursing homes from different parts of the Netherlands.	- IG: received multifaceted implementation strategy comprised of leaflet containing recommendations from NVAB guideline to prevent and reduce hand eczema, participatory working group, role model training, education session program and preventive measure training, and a bag of moisturiser, disinfectant, and a pair of cotton under gloves. - CG: received leaflet containing recommendations from NVAB guideline to prevent and reduce hand eczema. - Both groups: received questionnaire.	- The IG was statistically significant to be more aware and received information and gained higher score on knowledge compare to the CG at the end of the study. - Statistically significant effects on preventive behaviors were found in the IG compared to the CG at the end of the study. - No significant effect was found on behavioral determinants (attitude, self-efficacy, and intention).	1B

15.	Effectiveness of a skin care program for the prevention of contact dermatitis in healthcare workers (the Healthy Hands Project): A single-center, cluster randomised controlled trial	Soltanipoor et al., 2019 [26].	Single-center, cluster randomised, parallel-group controlled trial.	501 nurses from 19 wards which known to have substantial exposure to wet work.	- IG: received basic education on skin care and skin protection behavior, provision of hand cream dispensers in the wards, continuous electronic monitoring of cream use, and feedback on cream use at ward level. - CG: received basic education on skin care and skin protection behavior. - Both groups: received clinical measurements HECSI (Hand Eczema Severity Index) scoring, SC samples collection for NMF (Natural Moisturizing Factor) analysis and fill in questionnaires.	- The decrease in HECSI scores was significant in both groups but the mean decrease point was higher in the IG compare to the CG. - The increase in the proportion of HCWs reporting no symptoms was higher in the IG than the CG. - Significant effect on hand dermatitis severity was found in the subgroup of nurses with mild hand dermatitis only. - Higher cream use was found in the IG compare to CG. - The NMF levels were decreased in both groups, but no significant difference between them.	1B

16.	A behavior change package to prevent hand dermatitis in nurses working in health care: the SCIN cluster RCT	Madan et al., 2019 [27].	Cluster Randomized controlled trial.	35 sites, in which 5 sites enrolled student nurses only, 18 sites enrolled ICU/special-care baby unit (SCBU) nurses only and 12 enrolled both student nurses and ICU/SCBU nurses.	ICU/SCBU nurses - Intervention plus: received email instructions on how to access BCP (Behavior Change Package), e-mail reminder at 4 and 8 months to attend occupational health department if developed symptoms of hand dermatitis, reminder to access online BCP, reminder to moisture their hands following hand-washing, displays of posters of online BCP access, oral promotion of the importance of optimisation of equipment for hand cleansing and dispensing hand moisturiser, reminder to log on to the online BCP and regular audits. - Intervention light: received e-mail reminder at 4 and 8 months to attend occupational health department if developed symptoms of hand dermatitis. Student nurses - Intervention plus: received e-mail instructions on how to access the BCP, supply of E45 cream with advice on how to request additional supplies, e-mail reminder at 4 and 8 months to attend occupational health department if developed symptoms of hand dermatitis.	- The prevalence of dermatitis of student nurses was decreased in the intervention plus arm and increased in the intervention light arm at the end of the follow-up. - The prevalence of dermatitis of ICU/SCBU nurses was decreased in the intervention plus arm and unchanged in the intervention light arm at the follow-up. - There was less dermatitis for those nurses in the intervention plus arm at the end of the study, but the effect was not statistically significant. - Both student nurses and ICU/SCBU nurses in the intervention plus arm showed more positive changes in almost all health beliefs and action plans compare to those in the intervention light arm, but no statistically significant difference between both intervention groups.	1B

				- Intervention light: received e-mail reminder at 4 and 8 months to attend occupational health department if developed symptoms of hand dermatitis. All subjects: received information sheet, individual study packs, questionnaires, GP information sheet, oral information on reporting symptoms of hand dermatitis to occupational health, dermatitis - occupational aspects of management leaflet, reminder of reading e-mail by SCIN research team and had their hand photographed.	

Abbreviations: IG, intervention group; CG, control group; ICD, irritant contact dermatitis; ACD, allergic contact dermatitis; CU, contact urticaria; SPT, skin prick test; NRL, natural rubber latex; HEMA, hydroxyethyl methacrylate; TREGDMA, triethylene glycol dimethacrylate; TEWL, transepidermal water loss; BGFA, berufsgenossenschaftliches forschungsinstitut für arbeitsmedizin; BGW, berufsgenossenschaft für gesundheitsdienst und wohlfahrtspflege; TRGS, technical regulations for dangerous substances; NVAB, netherlands society of occupational medicine; HECSI, hand eczema severity index; NMF, natural moisturizing factor; ICU, intensive care unit; SCBU, special-care baby unit; BCP, behavior change package.