Occupational skin products – skin protection in the work place

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European Journal of Medical Technologies
2019; 4(25): 1-5

www. medical-technologies.eu
Published online 23.12.2019

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Abstract

Skin diseases constitute 3.4% of annually reported occupational diseases. One of the prevention methods developed and accepted by dermatologists and occupational medicine specialists is a 3-step skin protection program that involves the use of individual skin protection agents in the form of protective preparations – cosmetics. These preparations are available in the form of emulsions (o/w, w/o), gels and ointments. They are intended to prevent or reduce the penetration and absorption of hazardous substances through the skin. *In vitro* and *in vivo* methods are used to assess their effectiveness. These methods are not universal, they are controversial and provide a limited possibility of testing the substances that cause irritation. What is more, due to legal regulations, i.e. The Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009
on cosmetic products, the possibility of animal testing is ruled out. Disturbing reports about their ineffectiveness and the lack of standardised and official test methods for these preparations warrant seeking new research methods but also investigating new substances with increased bioadhesion to the skin, extended skin retention time, improved barrier properties and occlusion capacity.

Key words:

occupational disease, skin protection, occupational skin products

Introduction

Skin is the largest organ of the human body. Medicines and cosmetics are applied to it and up to 60% are absorbed. Unfortunately, the skin is also the largest route of entry for toxins. The sources of harmful factors are cosmetics, medicines and cleaning agents we use, as well as the environment in which we live and work. In some work environments, the exposure to harmful factors is much higher and so is the probability of occurrence of diseases [1,2].

Occupational skin diseases

Disease is a condition that can affect anyone at any time of their life, but there is a group of specific diseases that can be predicted. They are so-called occupational diseases [3-5]. According to the definition included in the Labour Code (the Law of June 26, 1974): "An occupational disease is a disease listed in the occupational disease specification if, as a result of the assessment of working conditions, it can be concluded decisively or with high probability that it has been caused by harmful factors occurring in the work environment or is associated with the way the work is performed, which are collectively referred to as occupational exposure" [6]. It is estimated that in Poland skin occupational diseases constitute 3.4% of all reported occupational diseases. Cleaning staff, physicians, nurses, hairdressers, laboratory personnel, beauticians, mechanics, and people working in food processing are particularly vulnerable [4,7,8].

Prevention of occupational skin diseases

The systematics of occupational diseases and the determination of factors contributing to the occurrence of occupational skin diseases dates back to 1700 [9]. Currently, these factors are divided into chemical (sensitizers, irritants and caustic agents), physical (ultraviolet radiation, ionizing radiation, low temperature), mechanical (friction, occlusion) and biological (pathogenic fungi, allergens of animal and plant origin) [7,10,11]. Knowledge of the factors that negatively affect our skin allows us to develop preventive measures against occupational diseases. They mainly include: limiting the exposure to skin irritants, using appropriate personal protection clothing, proper hygiene and early diagnostics of dermatoses [12,13].

The most popular skin protection measures are protective gloves. This product, however, protects only 1% of our body surface, does not protect the face, neck and neckline, and its use is burdensome and even impossible in some professions. In addition, 6.4% of the population are allergic to latex gloves [4,14].

Protective preparations

The currently observed progress in understanding the phenomenon of occupational skin diseases has facilitated the development of preventive methods, which have been accepted by both dermatologists and occupational physicians [13,15]. One of such methods is a 3-step skin protection program involving the use of individual skin protection agents in the form of cosmetic preparations. Skin cleaning after work followed by skin care and regeneration.

The protective preparations are available in the form of emulsions (o/w, w/o), gels and ointments [13,15.] They prevent or reduce the penetration and absorption of hazardous substances through the skin. They should be applied to the skin easily, without hindering one's daily activities. They must not sensitize or irritate the skin. It is worth pointing out that these preparations do not protect against injuries caused by mechanical and thermal factors, toxic or corrosive substances and abrasive particles such as sand, glass powder or metal filings [7,11,13,15].

According to their purpose, they are divided into:

- hydrophilic skin protection agents that protect the skin against hydrophobic organic compounds such as: oils, greases, tar, hardeners, adhesives, various types of dust (glass fibre, building materials, resins, polymers, dyes),
- hydrophobic skin protection agents that form a thin film on the skin surface, protecting the

skin against water, aqueous salt solutions, soap and detergents,
- UV protection agents [7,11,16,17].

Effectiveness of protective preparations – assessment of the effects of their activity

The effectiveness of protective preparations is closely related to their formulation but also to the appropriate application on skin [18]. The product should be applied on clean and dry skin, free from any wounds and cuts, not forgetting about such places as: fingers and skin between them as well as nails and the area around them. They should be applied every time before starting work. You should wait for a few minutes after applying the cream and use a new portion after washing your hands or every 2-4 hours of work [12,18-21].

In vitro and *in vivo* methods are used to assess the effectiveness of the protective preparations. These methods are not universal, they are controversial and provide a limited possibility of testing the substances that cause irritation [19,22,23].

What is more, due to legal regulations, i.e. the Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products, the possibility of animal testing is ruled out [24]. As there are no official test methods for these preparations, new test methods are still being sought.

CIOP-PIB technical methods

The Central Institute for Labour Protection–National Research Institute (CIOP-PIB) has developed technical methods that enable the testing of hydrophilic preparations in the scope of their: resistance to anhydrous organic solvents (determination of the time of solvent penetration through the protective preparation), resistance to oil/grease (determination of the rate of oil/grease penetration through the protective preparation using the planimetric method), resistance to the action of varnish – determination of anti-adhesive properties, i.e. the ease of removing dried varnish from the surface covered with the test preparation by means of the cross cut test method. In the case if hydrophobic preparations, the following are determined: resistance of the preparation to water and aqueous detergent solution (determination of the absorbability of samples coated with protective preparations), resistance of the preparation to aqueous 5-percent solutions of acids and bases [25-27].

A new approach – human factor

The basis of the activity of skin protection agents is the creation of a protective barrier on the skin in the form of a liquid membrane or film. It is closely related to the formula of the preparation and its ability to adhere to the skin to which they are applied for a specified, reasonable period of time, until they are removed by hand washing or through wear. The lack of effectiveness of barrier creams results from their insufficient adherence to the skin, which is the effect of inadequate preparation formula, inaccurate distribution of the preparation by the user, as well as the lack of maintaining the protective layer in the course of work [18].

One of the elements of the newly developed tool, the new test method, was the development of a procedure simulating the even application of the product on the skin by the user and then checking whether the structure is being restored after shear loss (hysteresis loop test, normal force dependence on shear rate). For this purpose, changes in the G' and G" values were tested under variable strain conditions (for the selected frequency) and then, in the 2nd stage, it was checked whether the structure of the system is restored. Testing of the course of normal force (F_n) dependence on the shear rate facilitates the classification of the tested products in terms of the durability and continuity of the film produced on the skin after even application. A component of the tool is also the measurement of flow curves and the determination of, among others, such parameters as apparent viscosity and flow limit because, in the users' opinion, high apparent viscosity

indicates high concentration of active substances, good performance and high quality of the product, on the other hand, it translates into its performance, including the time of the cosmetic's contact with skin or spreadability, but also its washing off. Execution of a series of tests defining textural properties provides further information on: the internal structure of the protective preparation, hardness (directly affecting the application of the product), cohesiveness – which provides information regarding the existence of internal interactions and thus the mechanical resistance of the protective layer formed. In order to determine the effect of the human factor, the product's application on skin, on the effectiveness of the protective preparations, the performance parameters of creams such as their spreadability or the feeling that the product leaves on skin during and after application, largely determining the consumer's willingness to use them regularly and properly, were correlated with the parameters obtained during texture analysis (adhesiveness, cohesiveness) and rheological properties (apparent viscosity at specific shear rates, flow limit). A good correlation of the results of instrumental tests with the organoleptic tests carried out in probands confirms the effectiveness of the developed method [16,18,27].

What's next?

Literature data demonstrate the lack of effect of protective preparations [18-20,27,28]. Probably the reason for this phenomenon is their inadequate ability to adhere to the skin [18,21]. It is therefore necessary to undertake new activities in the field of new compound synthesis – thiolated silicone oils characterised with increased bioadhesion to the skin, extended skin retention time, improved barrier properties and occlusion capacity, which can be effective and safe skin protection agents [30-32].

References

1. Taylor SC, Skin of color: biology, structure, function, and implications for dermatologic disease, J Am Acad Dermatol 2002; 46(2): 41-62.
2. Williams A, Transdermal and topical drug delivery. From theory to clinicalpractice, Pharmaceutical Press, London 2003.
3. Prüss-Ustün A, Wolf J, Corvalán C, Bos R, Neira M, Preventing disease throughhealthy environments A global assessment of the burden of disease from environmental risks, World Health Organization 2016, France.
4. Kurpiewska J, Liwkowicz J, Występowanie zawodowych chorób skóry w Unii Europejskiej, Bezpieczństwo Pracy Nauka Praktyka 2011; 6: 24-26.
5. Kanerva L, Elsner P, Wahlberg JE, Maibach HI, Condensed Handbook of Occupational Dermatology, Springer Verlag Berlin, Heidelberg 2004.
6. Ustawa z dn. 26 czerwca 1974 r. Kodeks pracy, Dz.U. 1998, nr 21, poz. 94.
7. Kulawik-Pióro A, Lament E, Skin protectors and their role in preventing skindiseases, Przem. Chem. 2015; 6: 868-871.
8. Diepgen TL, Occupational skin diseases, JDDG 2012; 10: 297-315.
9. Teuchman JK, Maści i pasty ochronne, Wydawnictwo Związkowe, 1957.
10. De Craecker W, Roskami N, Op de Beeck R, Occupational Skin Diseases and Dermal Exposure in the European Union (EU-25): Policy and Practice Overview, EuropeanAgency for Safety at Work, Luxemburg, 2008.
11. Kurpiewska J, Liwkowicz J, Środki Ochrony Skóry (kremy, żele barierowe) Wymagania, Dobór, Stosowanie, CIOP-PIB, Warszawa 2010,.
12. Schliemann S, Elsner P, Skin protection practical applications in the occupationalsettings, Curr. Probl. Dermatol. 2007, 34 (Karger).
13. European Risk Observation Report Occupational Skin Diseases and Dermal Exposure inthe European Union: Policy and Practice Overview. European Agency for Safety andHealth at Work, Belgium.
14. Chełmińska M, Latex allergy – part I, Pneumonol. Alergol. Pol. 2004;72:143-149.
15. Antonov D, Schliemann S, Elsner P, Occupational Skin Products, Kanervas's Occupational Dermatology, S. M. John et al, Springer Nature Switzerland AG 2019
16. Kulawik-Pióro A, Kurpiewska J, Kułaszka A, Rheological and sensory propertiesof hydrophilic skin protection gels based on polyacrylates, JOSE 2018; 24(1):129-134.

17. Kurpiewska J, Liwkowicz J, Hydrożele jako składniki hydrofilowych środków Chemik 2008; 61(2): 78-80.
18. Kulawik-Pióro A, Ptaszek A, Kruk J, Effective tool for assessment of the quality of barrier creams – relationships between rheological, textural and sensory properties, Regul Toxicol Pharmacol 2019; 103:113-123.
19. Schliemann S, Kleesz P, Elsner P, Protective creams fail to prevent solvent induced cumulative skin irritation – results of a randomized double-blind study, Contact Dermatitis 201; 69: 363-371.
20. Schliemann S, Petri M, Elsner P, Preventing irritant contact dermatitis withprotective creams: influence of the application dose, Contact Dermatitis 2013; 70:19-26.
21. Sadhra SS, Kurmi OP, Mohammed NI, Foulds IS, Protection afforded bycontrolled application of barrier cream: a study in a workplace setting, Br. J.Dermatol. 2014;171:813-818.
22. Casiraghi A, Ranzini F, Musazzi UM, Franze S, Meloni M, Minghetti P, In vitro metod to evaluate the barrier properties of medical devices for cutaneous use, Regul Toxicol Pharmacol 2017; 90:42-50.
23. Zhai H, Maibach HI, Testing and Efficacy of Barrier Creams, Bioengineering of the Skin. CRC Press, Boca Raton Nov 2005.
24. Rozporządzenie Parlamentu Europejskiego i Rady WE nr 1223/2009 z 30 listopada 2009 r. dotyczące produktów kosmetycznych.
25. Kurpiewska J, Liwkowicz J, Środki ochrony skóry zabezpieczające przed substancjami organicznymi, Podstawy i Metody Oceny Środowiska Pracy, 2013; 2(76):171-184
26. Kurpiewska J, Liwkowicz J, Środki ochrony skóry zabezpieczające przed wodą oraz wodnymi roztworami detergentów, kwasów i zasad, Podstawy i Metody Oceny Środowiska Pracy 2014;1(79):151-160.
27. Kulawik-Pióro A, Potykanowicz A, Determining the quality of hydrophobic barrier creams by rheological measurements, sensory analysis, pH determination and permeationtime measurements, Chemom. Intell. Lab. Syst. 2016;156: 14-20.
28. Kurpiewska J, Liwkowicz J, Padlewska K, The composition of waterproof barriercreams ingredients and their barrier properties, Chemik 2012; 66(9): 991-996.
29. Rieger T, Teichmann A, Richter H, Schanzer S, Sterry W, Lademann J, Evaluation ofbarrier creams – introduction and comparison of 3 in vivo methods, Contact Dermatitis2007; 56:347-354.
30. Partenhauser A, Laffleur F, Rohrer J, Bernkop--Schnurch A, Thiolated silicone oil: Synthesis, gelling and mucoadhesive properties, Acta Biomater., 2015; 16: 169-177.
31. Partenhauser A, Zupančič O, Rohrer J, Bonengel S, Bernkop-Schnürch A, Thiolated silicone oils as adhesive skin protectants for improved barrier function, Int J Cosm Sci 2016; 38(1): 257-265.
32. Partenhauser A, Thiolated silicone oils as novel skin care agents with enhanced adhesiveness and reinforced occlusivity, Pharmceutics and Novel Drug Delivery Systems, 2015; 6(1): 76.