

The “barrier” creams in the workplace – How are the facts?
A review

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Summary

Background: Skin tissue is frequently exposed to the attack by various substances in the workplace which can lead to the development of contact dermatitis. There are “Barrier” creams (BC) available on the market and often presented as a good alternative to protective gloves.

Objective: A review of the published research on this subject.

Methods: A research of the literature from 1956 through October 2010 has been conducted using the Pubmed search engine.

Results: Forty-eight BC studies of the efficacy of BC on healthy skin tissue were found and are presented in a comparative table. The results differ significantly. Some authors demonstrate efficacy in case of exposure to irritants; others establish none.

Discussion: BCs reduce the irritating effects of dangerous work-related products but do not constitute a complete protection. It should therefore be limited to mild irritants. The methods used for the assessment of the creams are very different and the real conditions were not respected. Currently, there is no standardized approach to the study of these creams. The measures of collective prevention prevail over individual measures.

Conclusion: In vivo studies in the workplace are needed. The use of skin care creams allows to protect and maintain the skin, a natural barrier.

Keywords:

Barrier cream, skin protection, workplace, personal protective equipment, review.

Introduction

Background

The occupational environment often involves an exposure to a variety of substances which may come into contact with the skin such as alkaline agents, acids, solvents, detergents, antiseptics or microorganisms. Skin must also face attacks related to climate like low temperatures and wind. [1,2] Healthy skin itself forms a natural barrier against external attacks thanks to the stratum corneum (SC), the tissue which constitutes its first defence. Two factors are essential for this protection, the lipid layer and the degree of hydration of the SC. Damage to this tissular layer will induce an increased trans-epidermal water loss (TEWL). This layer also acts as a reservoir for the substances which have penetrated the skin. [3,2,4] It now seems obvious that skin contact is a more important source of contamination than inhalation via the respiratory tract.[5]

Acute or chronic exposures can have noxious effects. One can mainly distinguish: *irritant contact dermatitis* (ICD) and *allergic contact dermatitis* (ACD). The first is caused by a non-immunologic reaction which may be immediate or cumulative over time. It is found mainly in “wet-work” occupations such as hospital employees, hairdressers or machinists. The latter, characterized by a delayed reaction of hypersensitivity 24 to 72 hours after the exposure, are often caused by exposure to metal.[3,6] Damaged, dry and rough skin increases the penetration of substances in the SC.[4] Incidence rates in the world of occupational contact dermatitis vary between 24 to 170 per 100000 individuals and change of job occurs in 29% to 72% of the cases. [7]

“Barrier” creams (BC) were first formulated in the 1940s for the prevention of dermatitis which appeared in workers in the explosives industry.[8] They were “water in oil”

(lipophilic) or “oil in water” (hydrophilic) type emulsions, containing one or more active principles, supposed to protect respectively from hydrophilic and lipophilic irritants by forming a diffusion barrier between the skin and the irritant. Multiple hydrophilic emulsions “water in oil in water” also exist.[9,10] They have been called “invisible gloves”.

Among skin creams, classified in the cosmetic sector, one finds two types of products: *skin protective creams* (barrier creams) used to prevent attacks, which are recommended for application before and during work, and the *regeneration or conditioning creams*, intended to enhance hydration and to restore the skin’s natural barrier. The use of the latter is especially recommended after work. [9] BCs are classified differently from one author to the next. For Olivarius et al.[11], one can distinguish the passive creams (without active principles) and reactive creams (neutralizing). Chilcott et al.[12] and Duca et al.[8] consider only the presence or absence of silicone.

Prevention Advisors including ourselves are often asked by employers and workers to give an opinion on BC use in various occupational sectors in order to avoid the use of gloves by many not very compliant workers. But the question is what exactly do we know about these creams and what kind of recommendation can we responsibly give?

Objective

The objective of this article is to review the research on this subject and present the knowledge available today by comparing various published studies.

Methods

The search engine Pubmed has been used for our bibliographic research of published articles about BCs on the basis of the following keywords: *skin, cream, barrier* and *protection*. Years reviewed: from 1956 to October 2010. We have taken into consideration all articles about BCs in general and about work-related skin protection. Concerning efficacy tests of skin creams in case of exposure to various irritants, no distinction between the methods used has been made. We also took into account the references quoted by the selected articles and related publications suggested by Pubmed. Articles written in a language other than English, French or Italian have been excluded.

Results

Forty-eight publications about BC assessment in cases of exposure of healthy skin to various irritants have been found [1,4-6,8,10-53] as well as six reviews of literature on the subject [3,7,9,54-56] and a “case report”[57]. All the studies on BC efficacy are presented in a table (table 1) featuring the first author and the date of publication, the creams tested, the type of study, the control used in the case of controlled studies, the irritant used, the subjects tested, the efficacy according to the author and the assessment methods used.

Only the controlled studies have been selected, among which there are ten randomized and four double blind studies. In the great majority, the control subjects were not previously treated with a BC or only received a placebo (excipients without active principles). Thirty-one publications show results of in vivo studies on human beings.

Stokoderm®, Taktosan®, Kerodex 71®, Arretil®, Lindesa® or Petrogard® are the most frequently used creams. However, some articles do not mention the names of the creams which were studied.

The most-used irritants are sodium lauryl sulfate, hydrophilic model, found in 17 studies and toluene, lipophilic model, used in 15 studies. Sodium hydroxide, lactic acid, benzene, some metals (nickel, cobalt, copper, chromium,...), latex gloves, some colouring agents (patent blue, methylene blue, methylene violet,...) or cutting oils have also been tested.

The assessment methods used are very different. Often, these consist of cutaneous tests (patch tests or immersion). In some cases, authors have used Franz cells, which allow the study of percutaneous permeability of substances, or Finn chambers, isolation chambers developed specially for epicutaneous tests, ensuring a complete occlusion. One can find as assessment methods, objective clinical scoring (presence of erythema, edema, fissures, dryness,...) and subjective assessment (the tested subject's impression), biopsies and histology, blood analyses (solvents, IgE, Hb or DNA adduct, cholinesterase activity), urinary and respiratory analyses of the substances studied or their metabolites, radioactivity counts, skin hydration measurements using cutaneous capacitance or corneometry, reflectance by UV spectrophotometry, skin colorimetry, cutaneous blood flow velocimetry by Doppler laser or trans-epidermal water loss or laser spectroscopy. Complete efficacy is demonstrated in 13 studies while inefficacy is found in 10 articles. Five studies show an increase in the absorption of the irritant [21,22,24,39,47]. The irritation increases despite the use of the cream in four articles.[32,43,44,51] In the other

cases, the efficacy of the cream varies depending on the type of irritant, its concentration and the assessment method.

Discussion

Three different mechanisms can distort the penetration of the substance in the skin: interaction between the BC and the SC by modification of the resistance to the substance diffusion, interaction between the BC and the substance by alteration of the activity or chemical inactivation of the substance.[12,18,9] The paper of Korinth et al.[22] points out that BCs do not distort chemical agents diffusion through the skin but their partition in the SC. The objective of the BCs is to inhibit or delay cutaneous penetration of substances which could have deleterious effects at the time of skin contact or induce systemic effects due to percutaneous absorption.[25] They are used therefore to reduce the irritant effect of hazardous products used in the workplace and at home and thus the development of dermatitis by diminution of the allergen's availability to the Langerhans cells (cells which present antigens).[2,4,9,12,16,18,23,24]

Classic protective gloves are considered good barriers against attacks, offering good protection.[4] But, they can give a false sense of security. Indeed, they might present permeability to lower molecular weight agents. Some substances are soluble in rubber while others can modify their membrane. Skin properties can also be modified by maceration in these occlusive conditions. Glove use can also diminish dexterity and furthermore, there is a risk of allergy to latex.[4,9,45] If the glove is torn, the irritant will seep between the membrane and the skin which will in turn provoke an increase of exposure.[19] In the studies of Boman et al.[38], the gloves and the BCs effects are

short-lived. A study comparing the use of gloves, BCs and the absence of protection in case of exposure to three different solvents (toluene, benzene, trichloroethane) in guinea-pigs has shown that blood concentrations were the same after two or three hours. Two other authors, Boman et al. [47] and Sun et al. [49], confirm these results. The study of Baur et al.[17] has revealed that BCs increase the allergen intake of latex gloves and thus enhance the occurrence of allergic reaction. As per Wang et al.[5], BCs could be more efficient than gloves because gloves are only worn in case of high level exposure while BCs could be more efficient for low and high doses. The BC cannot neutralize a high dose of irritant.[16] Indeed, after saturation, the agents sequestered in the layer of cream continue to penetrate the skin.[11,18] This explains the BCs potential to induce contact dermatitis.[3]

ACD can be avoided if the protection is complete. As BCs offer only incomplete protection, they would be efficient only against ICD, due to mild irritants.[9, 6] The benefit of BCs in the prevention of ACD is the object of controversy.[55] If the cream layer can modify the penetration of a substance, it should not interfere with the worker's performance. But an efficient layer and an efficient drying time are needed.[18, 47] The BCs should only be used for exposure to mild irritants (water, detergents, organic solvents, cutting oils). The use of gloves is still recommended for highly corrosive agents as, for example, acid and alkaline based substances, mutagenic and carcinogenic agents.[9,16,24] It has been shown in the study of Wigger-Alberti et al. [58] concerning the self-application of a protection cream that certain areas of the hands were not sufficiently protected. It appears, as per De Paepe et al.[2], that long-term use of the BCs could increase the skin's susceptibility to irritants. As per Nouaigui et al.[1], it is

excessive to use the term “barrier’ cream and even more so that of “invisible gloves” as the BCs do not prevent irritation but significantly reduce it. The terms “penetration modulator or penetration inhibiting creams” would be more appropriate.

The ideal profile for a BC should take into account various criteria: it should be insoluble and impenetrable for irritants, in order to completely prevent the contact between the agent and the skin, it should be easy to apply and should dry in a short time, it should not present any toxicity in conjunction with the substances used, it should not interfere with other materials in the workplace, it should not interfere with the worker’s dexterity, it should form a resistant film but be easy to remove, it should not contain irritating or sensitizing agents (perfumes, preservatives, emulsifiers, emollients, ...), and be at low cost.[3,6,8,9] An efficient BC should be, as per Chilcott et al.[10], a cream which would lengthen the time allowed between exposure and the application of the decontaminant. Use of the cream by the worker is based on a subjective choice depending on the worker’s impression of rapid skin penetration, texture, attractive packaging and presence of perfume.[35] It is recommended to apply the cream two hours before the exposure to detrimental substances; but in fact, the creams are often applied just before beginning of work.[16] BCs can be removed by contact with water, solvents or by friction (abrasion, wiping). They are then less efficient.[16,59] It is therefore necessary to apply the cream again and the workers must be educated on this.[3] Before a new application, the skin must be washed and dried to avoid penetration of any remaining irritants.[9] While it is established that washing hands reduces contact with irritants, if done repetitiously, it can contribute to the occurrence of irritative dermatitis by the increased frictions which in turn increase exposure.[60,61] Drexelius et al.[19] indicated in his study that the BC’s

benefit disappears if washing hands comes just after exposure. The use of BC's is useful when washing hands is not immediately feasible. Some excipients, like glycerine or urea, enhance skin permeability.[22] Water-based emulsifiers provoke a cutaneous dehydration by lipid loss in the SC, glycerol is therefore used to improve hydration.[62] In case of exposure to NaOH, the stearic acid present in some BCs reacts with it by producing sodium stearate, which can worsen the irritation.[34] The presence of silicone has little or no effect on protection and is a surface contaminant in certain occupations. [1,47,56] Workers tend to more readily accept the use of BCs because this is less restricting than the use of gloves and that they do not need to worry about it. The use of gloves or creams can also affect the sense of manliness of some men.[5,63] Though some studies show an in vivo and/or in vitro efficacy of the BCs, many of these studies have not been conducted under the same conditions; the results may not therefore be interpreted identically. One must take into account skin temperature, pH, the thickness of the cream layer, the number of applications, drying time before the exposure, time required for the application, time in contact with the irritant, concentrations of the irritating agents, body areas studied (back, hands, forearms,...), subjects studied (permeability differences between animals and humans), presence or absence of occlusion, the length of the study and the assessment methods used.[3,11,20,21] Overall, the studies have not taken into account friction movements which occur in realistic situations nor do they consider perspiration, with the result of overestimating the efficacy of BCs.[8,11] Several studies show acute exposure. Therefore, to get closer to realistic situations, Frosch et al. [16,33] developed a Repetitive Irritation Test. Other authors studied BCs with a technique called Repeated Occlusive Irritation Test or Tandem

Repeated Irritation Test. [36,48] Human skin is also characterized by an interindividual variability.[33] In the workplace, the irritants are often a mixture of various substances, yet, the studies are carried out with isolated irritants. Only one article pointed out an additive effect of two irritants. Elsner [36] found that susceptibility to irritation in the presence of toluene was increased when there had been a previous exposure to sodium lauryl sulphate. According to Frosch et al. [32,34] and Schlütter-Wigger et al.[43], it seems that the dogma, asserting that lipophobic and hydrophilic emulsions are efficient respectively against hydrophilic and lipophilic irritants, has not been proven scientifically. For Zhai et al.[24], skin biopsy is a good quantitative method for in vivo study of humans. For other authors, the measure of TEWL is the best parameter of the barrier's alteration, even though some substances alter this parameter only slightly.[16,23,33,46,48] Colorimetry can be influenced by the presence of an edema. Only clinical assessment of the erythema appears to be an appropriate method.[48] The "Gold Standard" would be a double-blind placebo-controlled in vivo study of human volunteers, with analysis of the air exhaled, of biophysical measurements and an histopathological examination. It should however be limited to mild irritants.[11,54] The BCs are never intended to totally replace a personal protection equipment (PPE).[9,11] It is important to respect first and foremost the general principles of prevention: avoid exposure, use substances of lesser toxicity, take measures of individual prevention if exposure cannot be avoided. The PPE must also be chosen based on a specific risks assessment. Bauer et al.[62] showed in their study with apprentice bakers that information and education on the use of gloves or the application of creams

improved significantly the long term compliance. The use of gloves must be as long as necessary but as short as possible.[55]

Conclusions

There is a vast choice of BCs available, some whose efficacy has been validated, some not (or even dubious). As there is no standardized approach to assessing their efficacy, additional in vivo studies in the work environment are needed to avoid extrapolating only animal studies.[9] The BCs use must be adapted to each occupational situation, specific protection means must be used for each specific irritant.[1,41] For the moment, their use must be limited to exposure to mild irritants. The compatibility of BCs to existing protection means must also be assessed.[11]

The occupational physician must also be very careful about any possible recommendations that he might give an enterprise wishing to use a BC. The collective preventive measures (elimination of exposure, use of less toxic substances) will always be favored over individual measures (PPE associations depending on the activity, irritant agents or work conditions). A risk analysis will help to choose the PPE. Their use will be ensured by adequate information and education to their use and their maintenance.

It is true, however, that application of skin care creams after the last shift, after the end of the work day, allows optimal protection by the skin's natural barrier.[22,61]

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