Scientific Research Publishing

Modern Research in Inflammation, 2025, 14(2), 46-63
https://www.scirp.org/journal/mri
ISSN Online: 2169-9690
ISSN Print: 2169-9682

Risk of Adverse Reactions to Oat-Based Topical Therapies in Atopic Dermatitis Patients with Avenin Allergy

Alyssa Forsyth[1], Caroline Kruithoff[2], Amir Memarian[3], John Pineda[4], Sooin Choi[5], Sydney Barlow[6], Bradley Fong[3], Kelly Frasier[7]

[1]Texas College of Osteopathic Medicine, UNT Health Science Center, Fort Worth, USA
[2]Heritage College of Osteopathic Medicine, Ohio University, Cleveland, USA
[3]School of Osteopathic Medicine in Arizona, A.T. Still University, Mesa, USA
[4]University of Alaska Anchorage, Anchorage, USA
[5]College of Human Medicine, Michigan State University, Grand Rapids, USA
[6]University of Pittsburgh, Pittsburgh, USA
[7]Department of Dermatology, Northwell Health, New York, USA
Email: kellymariefrasier@gmail.com

How to cite this paper: Forsyth, A., Kruithoff, C., Memarian, A., Pineda, J., Choi, S., Barlow, S., Fong, B. and Frasier, K. (2025) Risk of Adverse Reactions to Oat-Based Topical Therapies in Atopic Dermatitis Patients with Avenin Allergy. *Modern Research in Inflammation*, **14**, 46-63.
https://doi.org/10.4236/mri.2025.142004

Received: February 10, 2025
Accepted: May 5, 2025
Published: May 8, 2025

Abstract

Oat-based topical therapies are widely used in the management of atopic dermatitis (AD), owing to their soothing, anti-inflammatory properties and their ability to support the repair of compromised skin barriers. However, oats contain several proteins, notably avenin, which can act as allergens in sensitive individuals. Given that AD is frequently associated with concomitant food allergies, including potential sensitivities to avenin, dermatologists must exercise caution when incorporating oat-based products into treatment regimens. Although transdermal allergen exposure is generally less likely to induce hypersensitivity compared to oral exposure, the impaired cutaneous barrier in AD patients heightens their susceptibility to allergens. As a result, the application of oat-based therapies may inadvertently provoke an adverse reaction in individuals with oat sensitivity. Of particular concern is the phenomenon of cutaneous sensitization, in which allergens are absorbed through the skin and may trigger the development of food allergies over time. This review critically examines the risks associated with topical oat exposure in patients with oat allergies, focusing on the potential for cutaneous sensitization and its implications for food allergy development. The findings highlight the need for heightened awareness and consideration among dermatologists when prescribing oat-containing products, particularly in vulnerable patient populations, and underscore the importance of further research to better understand the interplay between skin barrier dysfunction, allergen exposure, and im-

mune response in AD.

Keywords

Oat-Based Skincare, Avenin Allergy, Transdermal Absorption, Atopic Dermatitis, Cutaneous Sensitization, Compromised Skin Barrier

1. Introduction

Atopic dermatitis (AD) is a common inflammatory skin disease that affects around 204 million people worldwide [1]. AD is marked by pruritus, erythema, and eczematous lesions that can profoundly impact quality of life. The inflammation is marked by increased IgE levels and a compromised skin barrier due to reduced filaggrin expression [2]. This decrease in filaggrin, essential for maintaining skin integrity, is inhibited by the type 2 immune response, primarily mediated by T Helper 2 (Th2) cells [2]. AD is considered part of the atopic triad, which also includes allergic rhinitis and allergic asthma. Additionally, patients with AD frequently experience comorbidities such as food allergies, which can exacerbate symptoms and complicate management strategies [3]. These overlapping conditions often complicate management and treatment strategies, necessitating targeted treatments to address both skin symptoms and underlying triggers.

Oat-based topical treatments are commonly prescribed to patients who are diagnosed with AD. Treatments containing colloidal oatmeal have become a cornerstone in the management of AD due to their anti-inflammatory, soothing, and barrier-repairing properties [4]. These benefits are derived largely from the presence of avenanthramides, which have been shown to reduce inflammation and pruritus effectively in clinical settings [5]. Moreover, treatments help to restore the compromised skin barrier function commonly observed in AD patients by delivering essential lipids and enhancing skin hydration [6]. Through this mechanism, the skin barrier can repair itself and prevent the entry of allergens, initiating the immune response.

Despite their advantages, the application of oat-based products in AD care should be thoughtfully considered due to the potential risk of oat allergies. Avenin, the major storage protein in oats, is a prolamin that is similar to gluten found in wheat and other cereals. In individuals with AD, avenin may act as an allergen for those with oat sensitization, potentially triggering IgE-mediated hypersensitivity reactions that could exacerbate symptoms. These reactions occur when oat proteins bind to specific IgE antibodies on mast cells and basophils, leading to degranulation and the subsequent release of histamines, cytokines, and other inflammatory mediators [7]. This cascade can contribute to increased skin barrier dysfunction, pruritus, and eczematous lesions, thereby worsening AD severity [8]. Notably, 53% of people with AD are considered food sensitized [9]. Although less common than other food allergies, oat sensitization can lead to significant clinical concerns, particularly in the pediatric AD population, as they have more cases. Studies

have identified oat sensitization rates in children as high as 19.2% using skin prick-tested treatments and 14.6% using atopy patch tests [10]. The clinical relevance of oat sensitization becomes particularly pertinent given findings that repeated exposure to oat-containing products can elevate sensitization risks. Furthermore, oat proteins have been shown to activate Th2-mediated immune responses, which play a central role in AD pathogenesis by promoting eosinophilic inflammation and impairing epidermal barrier integrity [11].

While oat-based topical therapies offer significant benefits for many patients with AD, weighing these advantages against the potential risk of sensitization remains important. This analysis aims to dive into the intricate relationship between oat-based topical therapies and their safety in AD patients with oat allergies. By examining the balance between the therapeutic benefits and the risks of sensitization or allergic reactions, this review seeks to provide a comprehensive assessment of the appropriateness of oat-based products in managing AD, especially in populations known to exhibit higher rates of oat sensitization. This exploration is crucial for optimizing care and minimizing adverse outcomes in this vulnerable group.

2. Oat-Based Topical Therapies

Oat-based products continue to grow in popularity in both dermatological practice and over-the-counter consumer-ready skincare, primarily due to their overall efficacy and safety. Their use dates back to ancient Rome and the Arabian Peninsula, where they were used for a wide range of conditions from insomnia to inflammatory-based skin conditions, including eczema or pruritus [12]. The cultivation of common oats (*Avena sativa*) began in the Bronze Age [13]. By the mid-1900s, colloidal oatmeal became more widely used, and in 1989, the FDA recognized it as a safe over-the-counter skin protectant, later approving it as a monograph ingredient in 2003 [14]. Today, colloidal oatmeal is celebrated for its well-documented anti-inflammatory, barrier-restorative, and antipruritic properties, particularly in treating atopic dermatitis (AD). It is recognized by regulatory bodies, such as the FDA, for its protective and soothing properties, especially when applied to xerotic, sensitive, or ashen-presenting dermatoses. The growing consumer preference for natural and clean skincare has influenced the adoption of a variety of oat-based products. Colloidal oatmeal-containing products are available in numerous forms ranging from moisturizers to shampoos to creams, making them a flexible and versatile option when addressing a wide range of skin concerns.

Avenanthramides, the key bioactive compounds in colloidal oatmeal, play a crucial role in its effectiveness in treating atopic dermatitis (AD) by directly targeting inflammatory pathways. These polyphenolic compounds inhibit proinflammatory signaling, such as tumor necrosis factor-alpha (TNF-α) and nuclear factor kappa B (NF-kB), while suppressing chemokines like interleukin-8 (IL-8) and Th-2 mediated cytokines. By interrupting the inflammatory feedback loop, avenanthramides help reduce redness, irritation, and swelling in individuals with AD. In addition to interruption of inflammatory mediators and signaling pathways, avenanthramide molecules can donate electrons or hydrogen atoms to the reactive

oxygen species (ROS). ROS are generated by immune cells during repairing of damaged tissues or pathogen immune response and are converted into a less reactive molecule [15]. Collectively, these anti-inflammatory benefits aid in managing the symptoms commonly associated with AD.

Pruritus, a common presenting symptom in individuals with AD, often exacerbates the condition as scratching damages the skin barrier. While scratching temporarily relieves the itching sensation associated with increased levels of inflammatory-associated cytokines, the sensation often returns, resulting in an "itch-scratch" cycle. Scratching can mechanically disrupt the skin and can lead to development of AD in individuals that have a mutation in the epidermal barrier protein filaggrin (FLG). The breakdown of an effective skin barrier can trigger a heightened immune response due to increased penetration of irritants into the dermal layers, a phenomenon well-documented in the context of AD [16]. Oat-based products can help mitigate this by reducing inflammation, disrupting key inflammatory pathways, and protecting the skin barrier. In support of this, in a clinical study by Reynertson *et al.*, 29 subjects with mild to moderate pruritus were treated with colloidal oatmeal skin protectant lotion. At baseline (Day 0), nearly 80% of patients reported moderate to severe pruritus. By Day 14, this proportion had decreased to around 10%, demonstrating a sustained and significant reduction in itch intensity. These findings highlight the effectiveness of colloidal oatmeal in alleviating pruritus and supporting the integrity of the skin [15]. This dual benefit is especially important in AD, where the skin barrier is often compromised.

A compromised skin barrier is another hallmark of AD. Colloidal oatmeal and oat-based products have been found to upregulate cornified envelope-related gene promoters while downregulating barrier genes that are associated with differentiation defects and lowered lipid envelopes [17]. Polysaccharides, such as beta-glucans and proteins, present in colloidal oatmeal act as a protectant and moisturizer for the dermis reducing overall transepidermal water loss (TEWL). In a clinical study by Gunt *et al.* (2018), a colloidal oatmeal-based moisturizing cream demonstrated a significant reduction in TEWL in individuals with dry skin. After three days of use, TEWL decreased by 7%, with an overall improvement of 42% from baseline by the end of the treatment period. This supports its effectiveness in improving skin barrier function, helping to retain moisture and enhancing skin hydration throughout the treatment period [18]. The use of colloidal oatmeal in AD-affected regions has been shown to lower pH levels to normal buffer ranges, allowing for the preservation of skin barrier function and promotion of repair [19]. Colloidal oatmeal targets AD symptoms on a multi-front approach by targeting key pathways of inflammation, impaired skin barrier and function, and pruritus. Colloidal oatmeal's active components, soothing properties, and multi-front approach provide comprehensive relief for patients.

To ensure these benefits are delivered effectively, oat-based topical products are manufactured following strict protocols established by the U.S. Pharmacopeia,

which also minimizes the potential for allergenic proteins like avenin [4]. Oatmeal grain, specifically *Avena sativa*, is finely milled, increasing surface area and ensuring even distribution in formulations. Active target components such as avenanthramides, beta-glucans, and lipids are isolated through water or ethanol extraction methods. Protein hydrolysis and filtration can denature the allergenic proteins, reducing the potential for IgE binding and resulting in an immune response. Product stabilization involves implementation of preservatives and antioxidants to prevent degradation of the active target compounds. Processed oat extracts are incorporated into a variety of product bases for target application and absorption.

Although modern manufacturing processes aim to minimize the allergenic potential of oat proteins, hypersensitivity reactions can still occur in individuals with AD. A study involving 40 AD patients found that 35 of them tested positive for IgE-mediated type 1 hypersensitivity to oat proteins, underscoring the potential allergenic risks linked to oats [20]. Oat proteins showed weak cross-reactivity with other grains, suggesting a distinct specificity to oats. In another study of 302 children with AD, 14.6% had positive results for oat sensitization through atopy patch testing (APT), and 19.2% tested positive for oat proteins in skin prick tests (SPT). Notably, 32% of children who used oat-based creams exhibited positive APT results, compared to none in the non-users group [10]. This finding suggests that frequent topical exposure to oat proteins could increase the risk of sensitization, particularly in individuals with compromised skin barriers. As such, individuals with AD may be more prone to developing allergic reactions, including IgE-mediated responses, to oat protein-based topical products.

Given the many benefits of oat-based therapies, their use remains a valuable tool in dermatology. For the vast majority of patients, these products are well-tolerated and effective. However, individuals with AD may have an increased predisposition to allergies, and in rare cases, those with a specific sensitivity to avenin could experience reactions. While the overall risk remains low, understanding the underlying mechanisms of avenin allergy and how skin barrier dysfunction in AD may contribute to sensitization is essential for guiding clinical decision-making.

3. Pathophysiology of Avenin Allergy

Avenin is a prolamin, an alcohol-soluble storage protein found in oats, which is structurally akin to the gluten proteins found in wheat, barley, and rye [21]. Comprising approximately 10% - 15% of the total protein content in oat seeds, avenin is the principal allergenic component of oats. Its rich proline- and glutamine-based structure contributes to its immunogenicity, particularly in individuals predisposed to allergic responses [22]. Its structural homology with gluten makes avenin a potential allergen for individuals with wheat allergies or celiac disease, as shared amino acid sequences can elicit immune recognition. The immunogenicity of avenins can vary depending on their sequence homology to other prolamins, such as gluten. Differences in avenin peptide sequences among oat cultivars can result in varying levels of immune response, with some peptides triggering T-cell activation and cytokine release, while others remain non-immunogenic [23]. Thus,

the immunotoxicity of avenins varies between oat cultivars, underscoring the need for caution when using oat-based topical therapies in patients with wheat allergies, as the exact composition of avenins in these products is often unknown.

The allergic response to avenin in oat allergies is primarily driven by T-helper 2 (Th2) cells. Th2 cells produce cytokines such as IL-4, IL-5, and IL-13, which are crucial in the allergic response. These cytokines promote the class switching of B cells to produce IgE antibodies, which bind to mast cells and basophils, leading to the release of histamine and other inflammatory mediators upon exposure to the allergen [10] [24]. This type 2 inflammation, driven by Th2 cytokines, is a central feature of both food allergies and AD, emphasizing the overlap in the immunological mechanisms underlying these conditions.

Moreover, compromised skin barriers in atopic dermatitis (AD) can significantly increase the risk of developing food allergies through cutaneous sensitization. Genetic predispositions and comorbid conditions significantly modulate the likelihood of avenin sensitization. Filaggrin (FLG) gene mutations, which impair skin barrier function, have been strongly linked to both AD and food allergies, increasing susceptibility to epicutaneous sensitization by environmental allergens [25]. Patients with these mutations exhibit heightened transepidermal water loss, facilitating allergen penetration and Th2-skewed immune activation [26]. This is particularly relevant in infants, who have inherently weaker skin barriers that are further compromised by AD. The disrupted skin barrier allows for transdermal exposure to allergens, such as avenin from oats, which can lead to an increased T-helper 2 (Th2) immune response and subsequent food allergy development. Skin barrier disruption in AD can lead to increased transepidermal water loss and facilitate allergen penetration, which in turn activates immune responses that promote food allergies [27]. In a mouse model designed by Walker *et al.* (2018), skin barrier mutations combined with environmental allergen exposure predisposed mice to food allergen sensitization and anaphylaxis, which bring to light the roles of genetic predisposition and environmental factors in this process [28]. These findings point to the critical importance of skin barrier integrity in preventing food allergen sensitization and the subsequent development of food allergies.

The connection between skin barrier disruption and allergen sensitization is further supported by research. Boussault *et al.* (2007) found that children with AD who used oat-containing topical products had a higher prevalence of oat sensitization, suggesting that repeated application of such products on compromised skin can lead to sensitization and subsequent food allergy [10]. This finding aligns with evidence on epicutaneous sensitization and strengthens the importance of skin barrier integrity in preventing food allergies [29]. In a related study, Tordesillas *et al.* (2014) demonstrated that skin exposure to peanut proteins in mice resulted in Th2-dependent sensitization and anaphylaxis upon rechallenge [30]. This process was further elucidated by Noti *et al.* (2014), who reviewed epicutaneous sensitization to food allergens on inflamed skin and showed that it promoted intestinal food allergies through the thymic stromal lymphopoietin (TSLP)-basophil axis, which is crucial for Th2 cytokine responses [31]. These studies col-

lectively illustrate that oat allergens, specifically avenin, can trigger an immune response when they come into contact with a compromised skin barrier in individuals with AD, potentially leading to the development of food allergies.

4. Topical Oat Exposure in Atopic Dermatitis Patients with Avenin Allergy: Current Research

Studies show that individuals with atopic dermatitis (AD) exhibit nearly double the rate of skin absorption compared to those without the condition [32]. This heightened permeability stems from structural and functional defects in the stratum corneum, the skin's outermost layer responsible for maintaining the barrier function. These defects involve diminished levels of critical proteins such as filaggrin and involucrin, along with disorganized lipid structures [33]. Thus, AD patients are at a heightened risk for developing allergic contact reactions and other cutaneous responses to topical products. Rastogi *et al.* (2018) conducted a retrospective chart review of 502 adults with AD who demonstrated increased positive patch test results to topically applied products when compared to the placebo group [34]. Similarly, Mailhol *et al.* (2009) explored allergic contact dermatitis (ACD) in children with AD. Their findings revealed that 6.2% of children tested positive for reactions to topical treatments, including emollients. Risk factors included moderate to severe AD, early-onset AD, and IgE-mediated sensitization [35]. This study illustrates the importance of selecting hypoallergenic formulations and closely monitoring children with AD to reduce the risk of sensitization and effectively manage their condition.

Recognizing the significance of allergic contact dermatitis (ACD) in patients with atopic dermatitis (AD), the American Academy of Dermatology emphasizes the importance of thoroughly evaluating ACD as both a potential coexisting condition and an alternative diagnosis. This distinction is crucial because ACD can mimic or exacerbate the symptoms of AD, leading to persistent inflammation, itching, and discomfort if not accurately identified and addressed. The recommendation to perform patch testing plays a key role in pinpointing specific allergens responsible for triggering reactions. Identifying these allergens enables clinicians to tailor treatment strategies, such as advising avoidance of offending substances or selecting hypoallergenic alternatives, ultimately improving patient outcomes and reducing symptom severity [36]. Furthermore, the predisposition of AD patients to food allergies, including oats, compounds their vulnerability to adverse reactions from topical products containing oat derivatives. This heightened risk arises from the impaired skin barrier typical of AD, which facilitates increased absorption of potential allergens and sensitizing agents. For instance, exposure to oat-containing personal care products may lead to both immediate hypersensitivity reactions and delayed allergic responses, particularly in individuals who are already sensitized to oat proteins.

Research examining the impact of topical oat exposure in patients with oat allergies, particularly those with atopic dermatitis (AD), presents a complex and inconclusive picture. While some studies suggest that oat-based products are gen-

erally well-tolerated, others caution about its potential risks, especially in populations with preexisting sensitivities or compromised skin barriers. Goujon *et al.* (2009) investigated the safety of topical oat exposure in cereal-sensitized adults with AD, concluding that participants tolerated significant amounts of oat-containing cosmetics without experiencing either immediate or delayed hypersensitivity reactions [37]. These findings suggest that, for some individuals with AD, oat-based skincare products may be safe, even in the presence of oat sensitization. In contrast, Boussault *et al.* (2007) showed that repeated exposure to oat-containing topical products could lead to sensitization, particularly in infants with impaired skin barriers [10]. Similarly, Pootongkam & Nedorost emphasized the vulnerability of individuals with impaired skin barrier functions, such as those with AD, to sensitization from oat and wheat proteins. They documented both immediate and delayed hypersensitivity reactions to oat-containing personal care products in patients with AD [38]. Their findings support the need for regular patch testing for oat and wheat proteins, particularly in atopic children, and recommend avoiding products containing oat or wheat derivatives in individuals with confirmed allergies. This underscores the importance of personalized skincare recommendations and the need for continued research to better understand the safety of oat-based products, particularly for vulnerable populations like infants and individuals with impaired skin barriers.

5. Considerations for Dermatologists

There are currently no official guidelines regarding the recommendation of oat-based therapies to patients with atopic dermatitis (AD) or a suspected oat allergy. The American Academy of Dermatology guidelines for treating AD include the use of moisturizers but do not specifically mention the use of oat-based therapies [39]. With this, clinicians should take a thorough medical history before prescribing or recommending oat-based therapies, particularly for patients with AD. This includes reviewing any personal or family history of food allergies, focusing on oat-containing or wheat-containing foods, and checking for any history of contact dermatitis from products that may have contained oats. If an oat allergy is suspected, referring the patient to an allergist for skin patch or prick testing can help confirm the allergy. If confirmed, the clinician should provide strategies to avoid exposure to the allergen or related allergens [40]. Clinicians can also suggest alternative products that do not contain oats or oat protein but still offer similar soothing effects. In place of oat-based therapies, additional interventions for managing AD might include daily gentle cleansing, minimizing rapid wet-to-dry transitions, and using emollients as tolerated to prevent future sensitization. Hypoallergenic products should be considered with care, as they may still contain allergens such as oats [40]. Importance should be placed on both clinician and patient education on the individualized treatment approach for AD, the potential risks of allergic reaction and sensitization with oat-based products, product cross-contamination, warning signs of an adverse reaction, and when to seek medical attention or emer-

gency treatment. If oat-based therapies are to be used, close patient follow-up should be implemented to assess treatment effectiveness and monitor for any adverse events.

Patch testing is an important diagnostic procedure that is used to identify suspected contact dermatitis allergens. Performing a detailed history and physical examination is the first step in diagnosing allergic contact dermatitis; however, these steps alone are not sufficient to make the clinical diagnosis [41]. Patch testing is the gold standard for diagnosing allergic contact dermatitis and should be performed on any patient with AD who is suspected to have allergic contact dermatitis, as atopic patients have an overall increased risk of contact sensitization. Additionally, AD patients are more likely to be exposed to allergens through repetitive and chronic use of topical treatments. As patch testing is usually performed on a patient's upper back, individuals with extensive or generalized dermatitis in this area should not undergo patch testing until their dermatitis has been controlled. With this, individuals utilizing immunosuppressive medications or corticosteroids, either topical or systemic, may have suppressed patch-testing reactions, leading to a false-negative result. This may also occur in the setting of skin that has been exposed to ultraviolet radiation. Various core or baseline series patch test allergen panels are available, although supplemental allergens, including the patient's personal products, should be considered as well. The protocol for patch testing application first involves cleansing the upper back, which may be followed by marking the desired application area with a grid. Of note, the area on the back must also be free of hair. Once the chosen allergens have been loaded into the patch chambers, the patches may be applied to the skin. The adhesive should be secured to the skin, and gentle pressure should be placed on top of each chamber to ensure uniform allergen distribution. The final step is labeling each chamber on the skin with ink and ensuring the corresponding allergen is recorded on a record sheet. The patches are to remain in place on the patient's skin for 48 hours. After 48 hours, the first reading may take place. A second reading is done between three to seven days after the initial application [42] [43]. The gold standard for patch testing result interpretation is The International Contact Dermatitis Research Group (ICDRG) grading, which correlates the degree of the skin reaction to a grading scale. Interpretations include a negative reaction, a doubtful reaction, an irritant reaction, and positive reactions that range from 1+ to 3+ based on the presence and degree of erythema, infiltration, papules, and vesicles [44]. Once allergens have been identified, patients must be educated about them, instructed on how to avoid them, and provided with a list of allergen-free products to use. Clinicians may benefit from utilizing online databases such as the Contact Allergen Management Program and Mayo Clinic's SkinSAFE Database to find products that are free of allergens [42]. Patient education is crucial in the management of positive reactions, and clinicians must work with patients to review their current products and provide suitable alternatives.

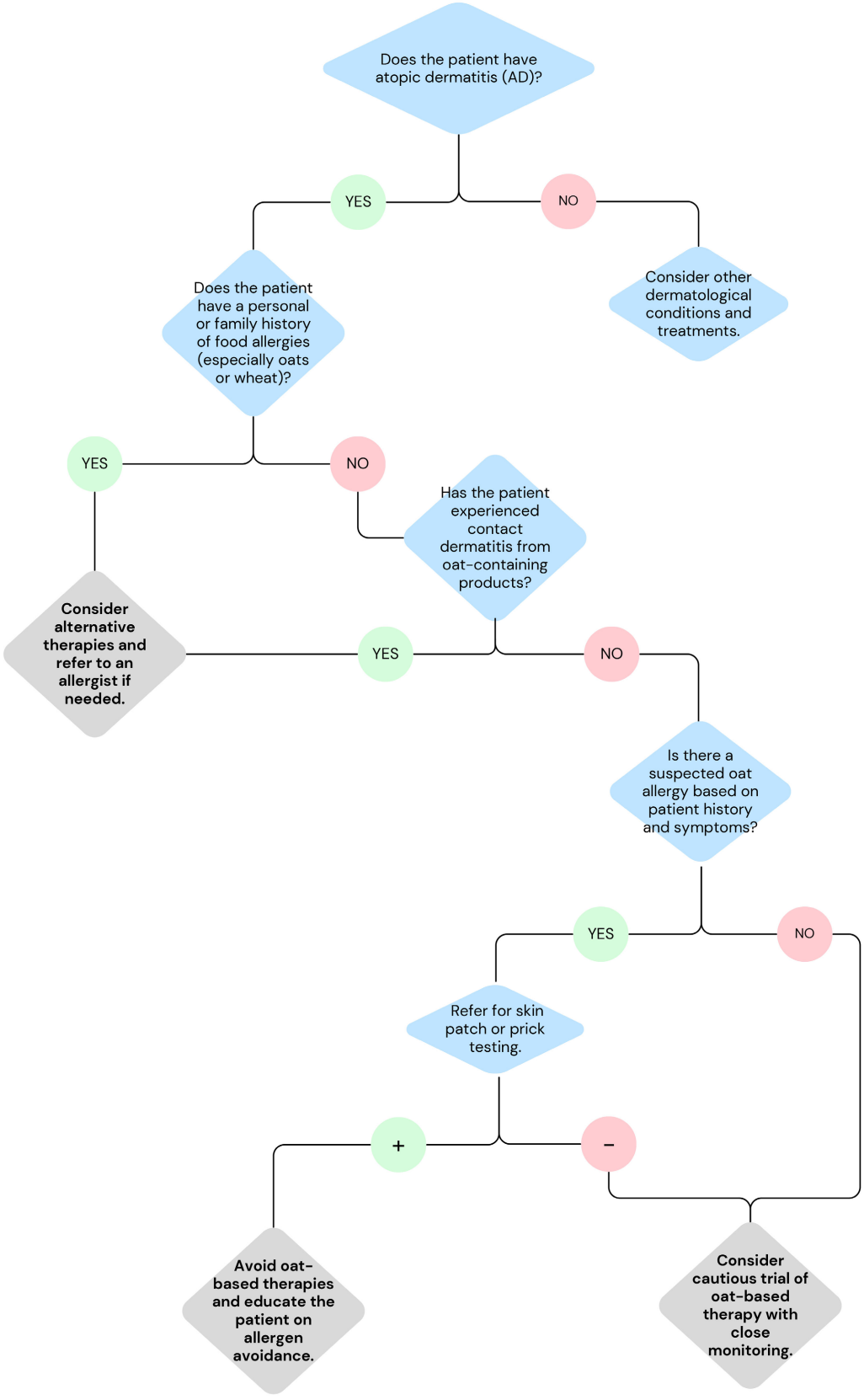

Figure 1. Decision tree for evaluating oat-based therapies in atopic dermatitis (AD) patients.

In clinical practice, it is important that dermatologists initially assess the presumed benefit of oat-based therapies against the potential harm they may pose, especially in patients with a suspected oat allergy. The most prevalent risks of oat-based therapies include sensitization and allergic reactions, which may manifest cutaneously or even, if severe, systemically. Skin that is inflamed, in the case of AD, can become sensitized to allergens that typically may not be viewed as irritants. When applying allergen-containing products to areas of the body with a compromised skin barrier, there is a risk of future adverse reactions if the allergen becomes ingested [45]. For example, in AD patients who have chronically inflamed skin, sensitization to food proteins may lead to systemic contact dermatitis once the allergen is orally ingested. **Figure 1** illustrates the decision-making process for dermatologists when evaluating the use of oat-based therapies in AD patients, taking into consideration allergy risk and testing results. Various studies have reported adverse reactions ranging from atopic dermatitis to anaphylaxis. Radhakrishna *et al.* (2016) reported a case of a patient with a history of atopic dermatitis who experienced anaphylaxis that presented with symptoms of chest pain, dyspnea, and diffuse urticaria after ingesting an oat-containing food. This patient subsequently required emergency treatment with three doses of intramuscular epinephrine. Interestingly, in the years prior to this event, the patient had been using a topical moisturizer that contained oats. Though the patient had no prior reaction to ingested oat-based foods, they began to experience a burning sensation on the skin and dyspnea after topical application of the moisturizer. The patient later developed adverse gastrointestinal symptoms upon oat ingestion, which was hypothesized to be due to a developed oat IgE-mediated sensitization [45]. Additional research has shown that children with AD have an increased sensitization to oats and suggests that infants with AD should avoid any oat-containing products [10]. These reports support the recommendation to avoid any topical products that may contain a food allergen, especially in patients with a history of AD.

This decision tree provides a clinical approach for dermatologists evaluating the use of oat-based therapies in patients with AD. The decision-making process considers patient history, allergy risk assessment, patch testing, alternative treatments, and follow-up care. If oat allergy is suspected, referral for allergy testing is recommended before initiating oat-based treatments. Alternative therapies such as ceramide-based or petroleum-based emollients should be considered for patients with confirmed oat sensitization.

With increasing research investigating the potential risks of oat-based therapies, it is beneficial to understand the history of these products within the field of dermatology. Since its approval as a skin protectant over two decades ago, colloidal oatmeal has popularly been used as a staple ingredient in adjunct treatments for AD. Over recent years, many commercial oat-containing products have been developed including moisturizers, soaps, shampoos, and shaving gels [5]. The National Eczema Foundation currently recommends colloidal oatmeal to reduce itching and has a National Eczema Association Seal of Acceptance placed on many

oat-containing consumer products. It is proposed that colloidal oatmeal reduces inflammation and itch while serving as a source of antioxidants for the skin. Additionally, colloidal oatmeal is believed to effectively moisturize dry skin, provide adequate barrier protection, display antiviral and antifungal properties, improve the composition of the skin microbiome, and decrease the use of other pharmacological AD treatments such as corticosteroids and calcineurin inhibitors [46] [47]. Research explaining the mechanism of action of colloidal oatmeal still remains limited [15]. Previous studies have evaluated the risk of sensitization and allergic reaction and have reported oat-containing products to be overall well-tolerated in the AD population. It was formerly thought that any studies showing potential risks of allergic reactions or sensitization were rare or flawed anomalies. The FDA has additionally acknowledged the safety and efficacy of colloidal ointment as an effective treatment for AD [5]. However, a rising number of studies demonstrating the risks of adverse reactions to oat-containing products raise concerns regarding their continued use.

The transition away from oat-containing products will require changing the previous perception of the use of colloidal oatmeal in the treatment of AD. While oat-containing products have previously been viewed favorably in the public eye, it should not be dismissed that food allergies are on the rise globally, and the increasing use of natural oat-based ingredients may present new challenges that need further exploration. A promising alternative to traditional oat-based therapies is emollients that contain Rhealba oat plantlet extract. This extract lacks the oat proteins that are known to induce an allergic response and pose minimal risk of an allergic reaction or sensitization. These emollients contain saponins and flavonoids as the active components and have been shown to have similar anti-inflammatory effects to colloidal oatmeal while additionally helping to repair the skin barrier. Though cross-contamination is a serious risk, there is a specific extraction process that results in the Rhealba extract being completely free of oat proteins. These extract-containing emollients may be a suitable alternative for treating AD in patients of all ages, including neonates and infants, and may have the potential to treat conditions beyond AD including acne and chronic pruritus [6]. Though the transition away from the use of colloidal oatmeal may require some time, it is important that patients be made aware of any available alternative products that can provide effects similar to the proposed effects of oat-based therapies without increasing the risk of potentially severe side effects. Ultimately, the risk-benefit assessment of using oat-containing therapies will be an important conversation between the clinical and patient in determining an effective treatment regimen that will maximize patient comfort and satisfaction while reducing potential harm.

The mainstay treatment for atopic dermatitis is topical corticosteroids and regular emollient or moisturizer use. Alternative therapies for oat-containing products include ceramide-based creams or moisturizers and petroleum-based emollients. An ideal emollient contains occlusive agents, humectants, and lubricants to main-

tain the skin barrier, attract water, and reduce friction [48]. Ingredients that help maintain the skin barrier and reduce transepidermal water loss include ceramides, lanolin, ectoin, mineral oils, olive oil, paraffin, and silicone. Products containing glycerin, alpha hydroxy acids, hyaluronic acid, and sorbitol can help attract and bind water to the skin to provide adequate moisture. Other ingredients such as shea butter, elastin, and collagen are beneficial as they smoothen the skin [48] [49]. One study by Gunt *et al.* (2018) showed that a natural ingredient-based moisturizing cream delivered comparable clinical improvements in treating dry skin to that of a colloidal oat-containing product [18]. As for more natural therapies, aloe vera is a plant-derived ingredient that holds moisturizing, antibacterial, and antifungal properties. Coconut oil is another commonly utilized plant-derived ingredient that has been shown to potentially have some benefit in treating AD and may hold antibacterial properties, although further clinical studies are indicated to confirm these effects [48]. With ongoing clinical trials and evolving research regarding the treatment of AD, it is necessary that clinicians remain up-to-date on current evidence-based practices and provide patients with this information.

In a similar vein, another treatment option worth exploring in this context is dupilumab, an IL-4 receptor α monoclonal antibody. Dupilumab has demonstrated effectiveness in addressing the shared immune pathways involved in both food allergies and AD. This makes it particularly interesting to investigate whether dupilumab could reduce the risk of adverse reactions to oat-based topical therapies in AD patients with avenin allergy. Clinical studies have shown that dupilumab can target the Th2-driven inflammation common to both conditions, offering therapeutic benefits. For instance, Sernicola *et al.* (2024) found that dupilumab treatment reduced IgE levels in pediatric patients with polysensitized AD, including those sensitized to oat proteins [50]. This reduction in IgE was associated with a decrease in allergic sensitization and symptoms, suggesting that dupilumab may help control food allergies by addressing the underlying immune dysregulation.

Further supporting dupilumab's potential, it has also been shown to reduce the risk of new or worsening allergic events. This is particularly significant in the context of the "atopic march," where AD often precedes the development of food allergies, asthma, and rhinitis. In a study by Geba *et al.* (2023), dupilumab treatment significantly reduced the incidence of new allergic events, including food allergies such as oat sensitivity [51]. Given the prevalence of oat sensitization in patients with AD, it would be valuable to investigate whether dupilumab can mitigate hypersensitivity to avenin in oat-based topical treatments. If effective, this could further expand the therapeutic potential of dupilumab, improving both systemic and localized management of AD.

6. Future Directions

Although there is a growing body of research on oat based therapies, research particularly focusing on the risk associated with topical oat exposures for individuals with oat allergies remains scarce. Most existing studies have been cross-sectional,

which limits our ability to assess the long-term consequences of such exposures. Future research should adopt longitudinal designs to examine the development of food allergies following transdermal allergen exposure in AD patients.

In addition to this, research should focus on the immune response to oat allergens in AD patients, investigating how the immune system interacts with these allergens over time. It would also be valuable to study genetic factors that may predispose AD patients to develop oat allergies via transdermal exposure. This could identify high-risk individuals and inform more personalized treatment strategies. Furthermore, regular patch testing for AD patients using oat-based products could be a proactive step to identify at-risk individuals early.

Another promising direction for future research is the long-term safety and efficacy of protein-free oat-based formulations in managing AD. These formulations could provide a safer alternative for individuals with sensitivities while still delivering therapeutic benefits. This could be especially important for individuals who are at risk of allergic reactions to avenin.

Finally, as dupilumab has shown efficacy in addressing shared immune pathways in food allergies and AD, further investigation is needed to determine whether this treatment can reduce the risk of adverse reactions to oat-based topical therapies in AD patients with avenin allergy. Investigating whether dupilumab can reduce hypersensitivity to avenin may enhance its therapeutic scope, offering improved management of both systemic and localized AD symptoms.

7. Conclusions

Overall, the current body of evidence highlights the complex interplay between atopic dermatitis (AD), impaired skin barrier function, and the potential risks associated with oat-containing products. While the anti-inflammatory and barrier-repairing properties of oat-based formulations offer promise for many individuals with AD, these benefits must be weighed against the heightened susceptibility to sensitization and allergic contact dermatitis (ACD) that is prevalent in this population. The increased skin permeability in AD patients underscores the need for heightened vigilance in selecting topical products, particularly for those with preexisting oat allergies or other sensitivities. The variability in individual responses to oat-containing products, as demonstrated by conflicting study results, further reinforces the importance of a personalized approach to treatment. For patients with AD, thorough clinical evaluation, including patch testing for oat proteins and other potential allergens, can help clinicians identify safe and effective skincare options. In cases where oat sensitization is identified, protein-free oat extracts emerge as a viable alternative, offering therapeutic benefits while minimizing allergenic risk.

Future research should focus on refining guidelines for the use of oat-based products in AD patients, with an emphasis on long-term safety, efficacy, and the role of novel formulations such as protein-free extracts. Additionally, studies exploring the impact of age, severity of skin barrier dysfunction, and concurrent aller-

gies could provide more nuanced insights into managing AD in sensitive populations. By prioritizing patient-centered care and leveraging advancements in hypoallergenic formulations, clinicians can better address the challenges of AD while minimizing the risk of adverse reactions, ultimately improving the quality of life for those affected.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Tian, J., Zhang, D., Yang, Y., Huang, Y., Wang, L., Yao, X. and Lu, Q. (2024) Global Epidemiology of Atopic Dermatitis: A Comprehensive Systematic Analysis and Modelling Study. *British Journal of Dermatology*, **190**, 55-61. https://doi.org/10.1093/bjd/ljad339

[2] Furue, M., Chiba, T., Tsuji, G., Ulzii, D., Kido-Nakahara, M., Nakahara, T., *et al.* (2017) Atopic Dermatitis: Immune Deviation, Barrier Dysfunction, Ige Autoreactivity and New Therapies. *Allergology International*, **66**, 398-403. https://doi.org/10.1016/j.alit.2016.12.002

[3] Han, H., Roan, F. and Ziegler, S.F. (2017) The Atopic March: Current Insights into Skin Barrier Dysfunction and Epithelial Cell-Derived Cytokines. *Immunological Reviews*, **278**, 116-130. https://doi.org/10.1111/imr.12546

[4] Allais, B. and Friedman, A. (2020) ARTICLE: Colloidal Oatmeal Part I: History, Basic Science, Mechanism of Action, and Clinical Efficacy in the Treatment of Atopic Dermatitis. *Journal of Drugs in Dermatology*, **19**, S4-S7.

[5] Fowler, J.F. (2014) Colloidal Oatmeal Formulations and the Treatment of Atopic Dermatitis. *Journal of Drugs in Dermatology*, **13**, 1180-1185.

[6] Wollenberg, A., Fölster-Holst, R., Saint Aroman, M., Sampogna, F. and Vestergaard, C. (2018) Effects of a Protein-free Oat Plantlet Extract on Microinflammation and Skin Barrier Function in Atopic Dermatitis Patients. *Journal of the European Academy of Dermatology and Venereology*, **32**, 1-15. https://doi.org/10.1111/jdv.14846

[7] Nguyen, S.M.T., Rupprecht, C.P., Haque, A., Pattanaik, D., Yusin, J. and Krishnaswamy, G. (2021) Mechanisms Governing Anaphylaxis: Inflammatory Cells, Mediators, Endothelial Gap Junctions and Beyond. *International Journal of Molecular Sciences*, **22**, Article 7785. https://doi.org/10.3390/ijms22157785

[8] Chu, D.K., Schneider, L., Asiniwasis, R.N., Boguniewicz, M., De Benedetto, A., Ellison, K., *et al.* (2024) Atopic Dermatitis (Eczema) Guidelines: 2023 American Academy of Allergy, Asthma and Immunology/American College of Allergy, Asthma and Immunology Joint Task Force on Practice Parameters GRADE and Institute of Medicine-Based Recommendations. *Annals of Allergy, Asthma & Immunology*, **132**, 274-312. https://doi.org/10.1016/j.anai.2023.11.009

[9] Tsakok, T., Marrs, T., Mohsin, M., Baron, S., du Toit, G., Till, S., *et al.* (2016) Does Atopic Dermatitis Cause Food Allergy? A Systematic Review. *Journal of Allergy and Clinical Immunology*, **137**, 1071-1078. https://doi.org/10.1016/j.jaci.2015.10.049

[10] Boussault, P., Léauté-Labrèze, C., Saubusse, E., Maurice-Tison, S., Perromat, M., Roul, S., *et al.* (2007) Oat Sensitization in Children with Atopic Dermatitis: Prevalence, Risks and Associated Factors. *Allergy*, **62**, 1251-1256. https://doi.org/10.1111/j.1398-9995.2007.01527.x

[11] Akdis, C.A., Arkwright, P.D., Brüggen, M., Busse, W., Gadina, M., Guttman-Yassky, E., *et al.* (2020) Type 2 Immunity in the Skin and Lungs. *Allergy*, **75**, 1582-1605. https://doi.org/10.1111/all.14318

[12] Baumann, L.S. (2007) Less-Known Botanical Cosmeceuticals. *Dermatologic Therapy*, **20**, 330-342. https://doi.org/10.1111/j.1529-8019.2007.00147.x

[13] Stika, H. and Heiss, A.G. (2014) Plant Cultivation in the Bronze Age. In: *Online Only—Archaeology*, Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199935413.013.44

[14] Kurtz, E.S. and Wallo, W. (2007) Colloidal Oatmeal: History, Chemistry and Clinical Properties. *Journal of Drugs in Dermatology*, **6**, 167-170.

[15] Reynertson, K.A., Garay, M., Nebus, J., Chon, S., Kaur, S., Mahmood, K., Kizoulis, M. and Southall, M.D. (2015) Anti-Inflammatory Activities of Colloidal Oatmeal (*Avena sativa*) Contribute to the Effectiveness of Oats in Treatment of Itch Associated with Dry, Irritated Skin. *Journal of Drugs in Dermatology*, **14**, 43-48.

[16] Mack, M.R. and Kim, B.S. (2018) The Itch–Scratch Cycle: A Neuroimmune Perspective. *Trends in Immunology*, **39**, 980-991. https://doi.org/10.1016/j.it.2018.10.001

[17] Ilnytska, O., Kaur, S., Chon, S., Reynertson, K.A., Nebus, J., Garay, M., Mahmood, K. and Southall, M.D. (2016) Colloidal Oatmeal (*Avena sativa*) Improves Skin Barrier through Multi-Therapy Activity. *Journal of Drugs in Dermatology*, **15**, 684-690.

[18] Gunt, H.B., Levy, S.B. and Lutrario, C.A. (2018) Clinical Improvements in Very Dry Skin from a Natural Ingredient-Based Moisturizing Cream Compared with a Leading Colloidal Oatmeal Control. *Journal of Drugs in Dermatology*, **17**, 758-764.

[19] Cerio, R., Dohil, M., Jeanine, D., Magina, S., Mahé, E. and Stratigos, A.J. (2010) Mechanism of Action and Clinical Benefits of Colloidal Oatmeal for Dermatologic Practice. *Journal of Drugs in Dermatology*, **9**, 1116-1120.

[20] Becker, L.C., Bergfeld, W.F., Belsito, D.V., Hill, R.A., Klaassen, C.D., Liebler, D.C., *et al.* (2019) Safety Assessment of *Avena sativa* (Oat)-Derived Ingredients as Used in Cosmetics. *International Journal of Toxicology*, **38**, 23S-47S. https://doi.org/10.1177/1091581819889904

[21] Cebolla, Á., Moreno, M.D.L., Coto, L. and Sousa, C. (2018) Gluten Immunogenic Peptides as Standard for the Evaluation of Potential Harmful Prolamin Content in Food and Human Specimen. *Nutrients*, **10**, Article 1927. https://doi.org/10.3390/nu10121927

[22] Zhang, W., Zhang, G., Liang, W., Tian, J., Sun, S., Zhang, X., *et al.* (2024) Structure, Functional Properties, and Applications of Foxtail Millet Prolamin: A Review. *Biomolecules*, **14**, Article 913. https://doi.org/10.3390/biom14080913

[23] Real, A., Comino, I., de Lorenzo, L., Merchán, F., Gil-Humanes, J., Giménez, M.J., *et al.* (2012) Molecular and Immunological Characterization of Gluten Proteins Isolated from Oat Cultivars That Differ in Toxicity for Celiac Disease. *PLOS ONE*, **7**, e48365. https://doi.org/10.1371/journal.pone.0048365

[24] Michelet, M., Balbino, B., Guilleminault, L. and Reber, L.L. (2021) IgE in the Pathophysiology and Therapy of Food Allergy. *European Journal of Immunology*, **51**, 531-543. https://doi.org/10.1002/eji.202048833

[25] Kalb, B., Marenholz, I., Jeanrenaud, A.C.S.N., Meixner, L., Arnau-Soler, A., Rosillo-Salazar, O.D., *et al.* (2022) Filaggrin Loss-Of-Function Mutations Are Associated with Persistence of Egg and Milk Allergy. *Journal of Allergy and Clinical Immunology*, **150**, 1125-1134. https://doi.org/10.1016/j.jaci.2022.05.018

[26] McAleer, M.A. and Irvine, A.D. (2013) The Multifunctional Role of Filaggrin in Al-

lergic Skin Disease. *Journal of Allergy and Clinical Immunology*, **131**, 280-291. https://doi.org/10.1016/j.jaci.2012.12.668

[27] Cook-Mills, J.M. and Emmerson, L.N. (2022) Epithelial Barrier Regulation, Antigen Sampling, and Food Allergy. *Journal of Allergy and Clinical Immunology*, **150**, 493-502. https://doi.org/10.1016/j.jaci.2022.06.018

[28] Walker, M.T., Green, J.E., Ferrie, R.P., Queener, A.M., Kaplan, M.H. and Cook-Mills, J.M. (2018) Mechanism for Initiation of Food Allergy: Dependence on Skin Barrier Mutations and Environmental Allergen Costimulation. *Journal of Allergy and Clinical Immunology*, **141**, 1711-1725.e9. https://doi.org/10.1016/j.jaci.2018.02.003

[29] Brough, H.A., Nadeau, K.C., Sindher, S.B., Alkotob, S.S., Chan, S., Bahnson, H.T., *et al.* (2020) Epicutaneous Sensitization in the Development of Food Allergy: What Is the Evidence and How Can This Be Prevented? *Allergy*, **75**, 2185-2205. https://doi.org/10.1111/all.14304

[30] Tordesillas, L., Goswami, R., Benedé, S., Grishina, G., Dunkin, D., Järvinen, K.M., *et al.* (2014) Skin Exposure Promotes a Th2-Dependent Sensitization to Peanut Allergens. *Journal of Clinical Investigation*, **124**, 4965-4975. https://doi.org/10.1172/jci75660

[31] Noti, M., Kim, B.S., Siracusa, M.C., Rak, G.D., Kubo, M., Moghaddam, A.E., *et al.* (2014) Exposure to Food Allergens through Inflamed Skin Promotes Intestinal Food Allergy through the Thymic Stromal Lymphopoietin–Basophil Axis. *Journal of Allergy and Clinical Immunology*, **133**, 1390-1399.e6. https://doi.org/10.1016/j.jaci.2014.01.021

[32] Halling-Overgaard, A.-S., Kezic, S., Jakasa, I., Engebretsen, K.A., Maibach, H. and Thyssen, J.P. (2017) Skin Absorption through Atopic Dermatitis Skin: A Systematic Review. *British Journal of Dermatology*, **177**, 84-106. https://doi.org/10.1111/bjd.15065

[33] Fang, Y., Yang, S., Lee, C., Aljuffali, I.A., Kao, H. and Fang, J. (2016) What Is the Discrepancy between Drug Permeation into/across Intact and Diseased Skins? Atopic Dermatitis as a Model. *International Journal of Pharmaceutics*, **497**, 277-286. https://doi.org/10.1016/j.ijpharm.2015.12.006

[34] Rastogi, S., Patel, K.R., Singam, V. and Silverberg, J.I. (2018) Allergic Contact Dermatitis to Personal Care Products and Topical Medications in Adults with Atopic Dermatitis. *Journal of the American Academy of Dermatology*, **79**, 1028-1033.e6. https://doi.org/10.1016/j.jaad.2018.07.017

[35] Mailhol, C., Lauwers-Cances, V., Rancé, F., Paul, C. and Giordano-Labadie, F. (2009) Prevalence and Risk Factors for Allergic Contact Dermatitis to Topical Treatment in Atopic Dermatitis: A Study in 641 Children. *Allergy*, **64**, 801-806. https://doi.org/10.1111/j.1398-9995.2008.01890.x

[36] Sidbury, R., Tom, W.L., Bergman, J.N., Cooper, K.D., Silverman, R.A., Berger, T.G., *et al.* (2014) Guidelines of Care for the Management of Atopic Dermatitis. *Journal of the American Academy of Dermatology*, **71**, 1218-1233. https://doi.org/10.1016/j.jaad.2014.08.038

[37] Goujon, C., Jean-Decoster, C., Dahel, K., Bottigioli, D., Lahbari, F., Nicolas, J., *et al.* (2009) Tolerance of Oat-Based Topical Products in Cereal-Sensitized Adults with Atopic Dermatitis. *Dermatology*, **218**, 327-333. https://doi.org/10.1159/000203649

[38] Pootongkam, S. and Nedorost, S. (2013) Oat and Wheat as Contact Allergens in Personal Care Products. *Dermatitis*, **24**, 291-295. https://doi.org/10.1097/der.0b013e3182a745f8

[39] Eichenfield, L.F., Tom, W.L., Berger, T.G., Krol, A., Paller, A.S., Schwarzenberger, K.,

et al. (2014) Guidelines of Care for the Management of Atopic Dermatitis. *Journal of the American Academy of Dermatology*, **71**, 116-132. https://doi.org/10.1016/j.jaad.2014.03.023

[40] Nedorost, S. and Hammond, M. (2020) Art of Prevention: Allergic Sensitization through Damaged Skin: Atopic, Occupational, and Stasis Dermatitis. *International Journal of Women's Dermatology*, **6**, 381-383. https://doi.org/10.1016/j.ijwd.2020.08.004

[41] Burden, C. (2000) Accuracy of Questions Related to Allergic Contact Dermatitis. *American Journal of Contact Dermatitis*, **11**, 218-221. https://doi.org/10.1053/ajcd.2000.8587

[42] Fonacier, L. (2015) A Practical Guide to Patch Testing. *The Journal of Allergy and Clinical Immunology*: *In Practice*, **3**, 669-675. https://doi.org/10.1016/j.jaip.2015.05.001

[43] Lazzarini, R., Duarte, I. and Ferreira, A.L. (2013) Patch Tests. *Anais Brasileiros de Dermatologia*, **88**, 879-888. https://doi.org/10.1590/abd1806-4841.20132323

[44] Jasly, K., Goyal, S., Ashwini, P., Kanthraj, G.R., Chethana, S.G. and Ranugha, S. (2024) Three-Part Scoring System (Tripartite) for Teledermatology versus International Contact Dermatitis Research Group Criteria to Interpret Patch Test Readings: A Comparative, Observational Study. *Indian Journal of Dermatology, Venereology and Leprology*, **90**, 575-580. https://doi.org/10.25259/ijdvl_118_2023

[45] Radhakrishna, N., Prickett, S., Phan, T., Rolland, J.M., Puy, R. and O'Hehir, R.E. (2016) Anaphylaxis to Oats after Cutaneous Sensitization by Oatmeal in Skin Products Used for the Treatment of Atopic Dermatitis. *The Journal of Allergy and Clinical Immunology*: *In Practice*, **4**, 152-153. https://doi.org/10.1016/j.jaip.2015.07.005

[46] Capone, K., Kirchner, F., Klein, S. and Tierney, N. (2020) Effects of Colloidal Oatmeal Topical Atopic Dermatitis Cream on Skin Microbiome and Skin Barrier Properties. *Journal of Drugs in Dermatology*, **19**, 524-531. https://doi.org/10.36849/jdd.2020.4924

[47] Feily, A., Kazerouni, A., Pazyar, N. and Yaghoobi, R. (2012) Oatmeal in Dermatology: A Brief Review. *Indian Journal of Dermatology, Venereology, and Leprology*, **78**, 142-145. https://doi.org/10.4103/0378-6323.93629

[48] Hon, K.L., Kung, J.S.C., Ng, W.G.G. and Leung, T.F. (2018) Emollient Treatment of Atopic Dermatitis: Latest Evidence and Clinical Considerations. *Drugs in Context*, **7**, 1-14. https://doi.org/10.7573/dic.212530

[49] Giam, Y.C., Hebert, A.A., Dizon, M.V., Van Bever, H., Tiongco-Recto, M., Kim, K., *et al.* (2016) A Review on the Role of Moisturizers for Atopic Dermatitis. *Asia Pacific Allergy*, **6**, 120-128. https://doi.org/10.5415/apallergy.2016.6.2.120

[50] Sernicola, A., Amore, E., Rizzuto, G., Rallo, A., Greco, M.E., Battilotti, C., *et al.* (2024) Dupilumab as Therapeutic Option in Polysensitized Atopic Dermatitis Patients Suffering from Food Allergy. *Nutrients*, **16**, Article 2797. https://doi.org/10.3390/nu16162797

[51] Geba, G.P., Li, D., Xu, M., Mohammadi, K., Attre, R., Ardeleanu, M., *et al.* (2023) Attenuating the Atopic March: Meta-Analysis of the Dupilumab Atopic Dermatitis Database for Incident Allergic Events. *Journal of Allergy and Clinical Immunology*, **151**, 756-766. https://doi.org/10.1016/j.jaci.2022.08.026