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Ammonium Lactate for Xerotic Skin Conditions: Biomimetic Effects and Clinical Relevance

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Journal of Drugs in Dermatology

Ammonium Lactate in Dermatology: A Modern Approach to the Management of Xerosis

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INTRODUCTION

Xerosis is a common and clinically significant dermatologic concern, affecting patients across a broad spectrum of conditions, including atopic dermatitis, psoriasis, ichthyosis, and age- or environment-related dry skin. In addition to visible scaling and roughness, xerosis is frequently associated with pruritus and discomfort, and may negatively impact quality of life and treatment adherence when persistent or inadequately controlled. At a physiological level, xerosis reflects disruption of stratum corneum structure and function, including reduced water content, impaired corneocyte desquamation, and barrier dysfunction, processes that are closely linked to depletion of natural moisturizing factors (NMFs) and alterations in skin surface pH.[1,2]

Recognition of these interrelated mechanisms has driven increasing interest in therapeutic approaches that extend beyond symptomatic hydration and more directly address the underlying biology of the skin barrier. Conventional moisturizers, including occlusive and humectant formulations, typically have a single mechanistic approach in the management of xerosis; their primary effects are often limited to reducing transepidermal water loss or transient hydration. As a result, there has been growing focus on biomimetic strategies that aim to support endogenous processes involved in increasing water content at the skin surface and barrier maintenance.

Within this framework, ammonium lactate is a well-established therapeutic option with evolving insights into its mechanism of action and clinical application. As a pH-balanced source of L-lactic acid, it provides a key component of the NMF at therapeutic concentrations, while also modulating corneocyte desquamation. The activity of ammonium lactate is governed by pH-dependent equilibrium and formulation characteristics that influence the availability and distribution of L-lactic acid within the stratum corneum, enabling preferential activity in superficial layers where xerotic changes are most pronounced.[3,4] In this context, ammonium lactate may act as a physiologically aligned reservoir, allowing gradual bioavailability of L-lactic acid within the stratum corneum in response to local pH conditions while maintaining tolerability. Through this combination of humectant and corneodesmolytic effects, ammonium lactate supports hydration, improves skin texture, and contributes to improvements in barrier function, with modern formulations demonstrating clinically observable improvements in moisturization and desquamation.[5] Clinically, ammonium lactate has demonstrated utility across a range of xerotic and hyperkeratotic conditions, including ichthyosis and xerosis associated with inflammatory dermatoses. Its relevance is also notable in patients with skin of color, in whom xerosis may present as visible ashiness and contribute to both functional and cosmetic concerns. These features position ammonium lactate as an important component of contemporary management strategies, providing both symptomatic relief and support for underlying barrier processes. Its availability without prescription may also support broader integration into long-term therapeutic maintenance approaches and routine xerosis management.

This supplement reviews the mechanistic basis, formulation considerations, and clinical applications of ammonium lactate, with the aim of providing practical, evidence-based guidance for its use in dermatologic practice.

DISCLOSURES

Stephen Maida reports employment relationship with Advantice Health, LLC.

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ORIGINAL ARTICLE

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Beyond Moisturization: Ammonium Lactate as a Biomimetic Regulator of Skin Barrier Function

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ABSTRACT

The stratum corneum (SC) is essential for maintaining skin barrier integrity through coordinated interactions between corneocytes, intercellular lipids, and natural moisturizing factors (NMFs). Lactate is a key NMF component that contributes to hydration, pH regulation, and enzymatic activity within the SC. Recent advances in understanding the distinctions between lactate, lactic acid, and ammonium lactate have clarified their respective roles within the skin, providing a novel framework for their clinical use. The use of ammonium lactate, a pH-balanced source of L-lactic acid, in skincare offers a biomimetic approach to restoring skin barrier function. Its activity is governed by pH-dependent equilibrium and diffusion processes within the SC, enabling targeted availability of L-lactic acid in superficial layers where xerotic changes are most pronounced. Mechanisms of action include humectant effects, normalization of desquamation, and support of epidermal homeostasis. Clinical relevance extends across xerotic and hyperkeratotic conditions, including atopic dermatitis, ichthyosis, and psoriasis, as well as in skin of color, where xerosis may present as visible ashy skin. Benefit has also been shown in conditions such as acanthosis nigricans. This review summarizes the mechanistic and clinical rationale supporting ammonium lactate as a physiologically aligned and increasingly well-characterized therapeutic option.

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INTRODUCTION

The skin barrier is a highly organized system in which structural proteins, intercellular lipids, and natural moisturizing factors (NMFs) work together to maintain moisture content, regulate desquamation, and protect against environmental insults. The stratum corneum (SC), the outermost layer of the epidermis, plays a central role in these processes and serves as the primary determinant of structural integrity.[1]

Beyond its structural role, the stratum corneum functions as a dynamic biochemical environment in which water balance, enzymatic activity, and lipid organization are tightly interdependent. Disruption of any of these elements can impair overall barrier performance. Maintenance of adequate water content is essential not only for skin flexibility but also for the activity of enzymes involved in corneocyte desquamation.

The importance of the acidic pH of the stratum corneum, often referred to as the "acid mantle," has been well established.[2] This acidic environment supports lipid-processing enzymes and serine proteases involved in desquamation, as well as antimicrobial defense mechanisms. Alterations in pH are therefore closely linked to barrier dysfunction and the development of xerotic skin conditions.

In this context, therapeutic approaches that promote both water-binding capacity and physiological pH are of particular interest. This has led to increasing interest in biomimetic strategies aimed at restoring structural elements of the stratum corneum, rather than relying solely on occlusive or water-binding effects.[2,3]

Natural moisturizing factors (NMFs), derived primarily from filaggrin degradation, include amino acids, pyrrolidone carboxylic acid (PCA), urea, and lactate. These hygroscopic components are essential for maintaining stratum corneum hydration, plasticity, and enzymatic activity.[2,3] Lactate is a major component of natural moisturizing factor and plays a central role in both water binding and maintenance of the acidic pH environment required for optimal barrier function.[4,5] Reductions in lactate and other NMF constituents have been associated with increased transepidermal water loss (TEWL), reduced water content, and impaired barrier function parameters seen in xerotic skin conditions.[4,5]

Conventional moisturizers typically act through occlusion or water binding; however, these approaches do not directly restore physiological constituents of the SC. In contrast, ammonium lactate takes a biomimetic approach to moisturization by replenishing endogenous components of the skin barrier. It acts as a pH-balanced source of L-lactic acid, the naturally occurring form present in human skin, thereby regulating intrinsic mechanisms of hydration and barrier homeostasis. Ammonium lactate functions as a precursor that delivers L-lactic acid, the biologically active form found in the skin. Topically, it may act as a physiologic reservoir that maintains moisture balance and barrier processes.

Although lactic acid and its derivatives have been used in dermatology for decades, the distinctions between lactate, lactic acid, and ammonium lactate have not always been clearly understood in clinical practice. More recent mechanistic insights into pH-dependent equilibrium,

stratum corneum physiology, and formulation science have provided greater clarity regarding how these forms function within the skin, offering a more refined perspective on their therapeutic use.

Mechanism of Action: A Biomimetic Moisturization Action

Topical lactic acid and its derivatives have been described in the dermatologic literature for over 80 years, with early reports in the 1940s describing their use in the treatment of xerotic and hyperkeratotic skin conditions.[6] These effects can be summarized into three complementary mechanisms: improvement of moisture levels, restoration of corneocyte turnover, and support of barrier integrity.

pH-Dependent Availability of L-Lactic Acid

The activity of ammonium lactate is governed by a pH-dependent equilibrium between lactate and lactic acid rather than enzymatic conversion (see Figure 1).[7] This equilibrium is rapid and diffusion-controlled in hydrated skin environments, allowing rapid availability of L-lactic acid following topical application.

The stratum corneum exhibits a pH gradient, ranging from approximately 4.5–5.3 at the surface to near-neutral pH in deeper layers[2] The pH gradient determines the proportion of active lactic acid, with greater availability at the more acidic skin surface. Consequently, ammonium lactate shows greater activity in superficial stratum corneum layers, where xerotic and hyperkeratotic changes are most pronounced. The acidic pH of the stratum corneum is essential for the activity of enzymes involved in lipid processing and desquamation, including β-glucocerebrosidase and acidic sphingomyelinase, as well as serine proteases that regulate corneodesmosome degradation.[1,2] Disruption of this pH balance is associated with impaired lipid organization and abnormal desquamation. Maintaining an acidic pH environment is therefore essential for normalizing both lipid processing and corneocyte turnover within the SC.

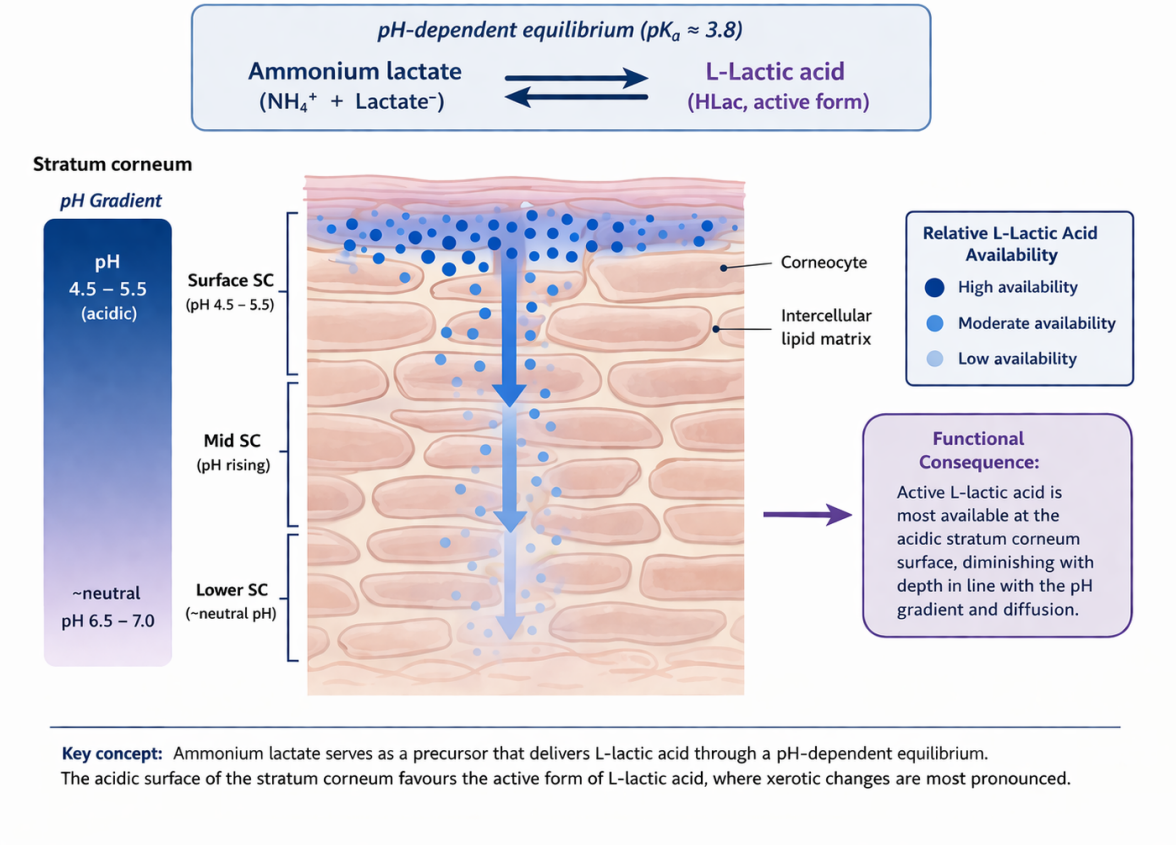
Diffusion and partitioning processes further govern the distribution and local bioavailability of topical lactic acid within the SC. These processes depend on formulation characteristics and local pH conditions, allowing controlled delivery and localized activity.[7]

In contrast to formulations containing free lactic acid at lower pH, which may result in a rapid increase in concentration and irritation, ammonium lactate enables gradual, physiologically moderated local bioavailability of L-lactic acid within the skin. This enables effective activity while preserving tolerability.[7]

The targeted distribution of ammonium lactate promotes normalization of corneocyte cohesion and skin surface texture where barrier dysfunction and scaling are most prominent.

The pH-dependent distribution of lactic acid within the stratum corneum is illustrated in Figure 1.

FIGURE 1. pH-Dependent Availability of L-Lactic Acid in the Stratum Corneum



Key concept: Ammonium lactate serves as a precursor that delivers L-lactic acid through a pH-dependent equilibrium. The acidic surface of the stratum corneum favours the active form of L-lactic acid, where xerotic changes are most pronounced.

Mechanisms Supporting Barrier Function

Ammonium lactate supports barrier regeneration through three complementary mechanisms:

Humectant Activity

Lactic acid enhances water retention within the SC by attracting and binding water molecules, improving hydration and flexibility.[3] Lactate is present within the stratum corneum, particularly in the superficial layers where natural moisturizing factors contribute to hydration and barrier integrity.[5]

Normalization of Desquamation

Lactic acid promotes controlled degradation of corneodesmosomes, allowing normal shedding of corneocytes and reducing scaling.[8] This process supports enzymatic activity within the SC.[2]

Alpha-hydroxy acids, including lactic acid, are well established to modulate corneocyte cohesion and skin surface properties in a concentration and pH-dependent manner.[9] Both pH and concentration influence the biological activity of lactic acid, with lower pH increasing the availability of the active 'free acid' form and enhancing desquamation.[10]

Support of Barrier Homeostasis

By improving hydration and normalizing epidermal turnover, ammonium lactate contributes to the restoration of stratum corneum structure and function.[11] Lactic acid has also been shown to influence epidermal lipid synthesis, including ceramide production, leading to improved structural integrity and reduced transepidermal water loss. In addition, ammonium lactate has been shown in some studies to enhance epidermal thickness and dermal glycosaminoglycan content, contributing to maintenance of skin structural integrity.[12]

These mechanisms and their associated clinical effects are summarized in Table 1.

Beyond its established physicochemical roles, emerging evidence indicates that lactate also functions as a signaling molecule within the skin. Lactate has been shown to regulate keratinocyte metabolism and cellular activity, and to influence gene expression through epigenetic mechanisms, including histone lactylation. In addition, lactate participates in immunometabolic pathways that modulate inflammatory responses and contribute to epidermal homeostasis. These insights suggest that lactate may play a broader role in coordinating barrier function, cellular turnover, and inflammatory signaling within the skin, further supporting its relevance in conditions characterized by barrier dysfunction and altered epidermal activity.[13]

Formulation Considerations

The efficacy and tolerability of alpha-hydroxy acid formulations are influenced by key formulation parameters, including pH, concentration, and vehicle composition, which collectively affect penetration, local bioavailability, and biological activity.[7] Ammonium lactate formulations are typically designed within a physiologic pH range, allowing controlled bioavailability of L-lactic acid within the stratum corneum. This enables effective activity while maintaining tolerability and may support the maintenance of an optimal stratum corneum pH environment.[2,7] In contrast, topical formulations containing free lactic acid at a lower pH are more likely to cause irritation, particularly in xerotic or barrier-compromised skin.

TABLE 1.

Mechanistic Basis and Clinical Effects of Ammonium Lactate in Xerotic Skin

Mechanism of Action	Biological Basis	Effect on Stratum Corneum	Clinical Relevance	Supporting Evidence
Humectant activity	Lactate is a key NMF component with hygroscopic properties that attract and retain water within corneocytes	Higher SC water content; improved plasticity and flexibility	Rapid improvement in dryness, roughness, and scaling; enhanced skin comfort	Watabe et al., 2013; Nakagawa et al., 2004
pH-dependent delivery of L-lactic acid	Ammonium lactate dissociates via pH-dependent equilibrium (pKa ~3.8), generating active L-lactic acid preferentially in acidic environments	Higher availability of active lactic acid at the SC surface; controlled spatial distribution across epidermal layers	Targeted activity in superficial SC where xerosis and hyperkeratosis are most pronounced, with improved tolerability vs low pH AHA formulations	Sah et al., 1998; Fluhr and Elias, 2002
Normalization of desquamation (corneodesmolysis)	Lactic acid promotes controlled degradation of corneodesmosomes and modulates protease activity involved in desquamation	Restoration of orderly corneocyte shedding; reduced corneocyte cohesion	Reduction in flaking, scaling, and hyperkeratosis; smoother skin surface	Harding et al., 2000; Smith, 1996
Support of barrier function	Lactate supports hydration, lipid organization, and enzyme activity within an optimal acidic pH environment	Improved barrier integrity; enhanced lipid organization; reduced TEWL	Improved skin resilience; reduced irritation and sensitivity in xerotic skin	Rawlings et al., 1996; Fluhr and Elias, 2002
Epidermal renewal and structural effects	Lactic acid stimulates epidermal turnover and may enhance epidermal thickness	Improved epidermal architecture and surface uniformity	Smoother skin texture and improved appearance in xerotic and hyperkeratotic conditions	Lavker et al., 1992
Formulation-dependent effects (pH and concentration)	Activity depends on formulation pH (typically ~4.4–5.5) and concentration, influencing balance between efficacy and tolerability	Controlled release of active lactic acid with minimized irritation	Improved tolerability and adherence; suitability for long-term use in chronic xerosis	Sah et al., 1998; Thueson et al., 1998

Ammonium lactate is used across a range of concentrations depending on clinical need. Lower concentrations (eg, 5–12%) are typically used to improve skin moisture levels and maintain barrier performance in mild xerosis, whereas higher concentrations (eg, 12–15%) are employed in more severe xerotic or hyperkeratotic conditions due to their enhanced desquamating effects. Higher concentrations increase the availability of active lactic acid within the SC, enhancing corneodesmolytic activity but also elevating the potential for irritation, highlighting the importance of formulation design. Higher concentrations of ammonium lactate are associated with enhanced moisturization and desquamation due to increased availability of active lactic acid, while maintaining good tolerability when appropriately formulated.[7,10] Clinical studies have demonstrated improvements in skin moisture and desquamation with ammonium lactate formulations.[12,14] Topical application of alpha-hydroxy acids, including lactic acid, has been shown to influence stratum corneum pH and acidify the skin surface.[2] In this context, formulations designed within a physiologic pH range may support epidermal homeostasis while minimizing irritation. In addition to pH and concentration, the formulation vehicle plays an important role in influencing the delivery and skin effects of lactic acid. Emollient-based vehicles can enhance skin hydration, improve patient acceptability, and support barrier function.[3] Together, these formulation factors contribute to the clinical performance of ammonium lactate across a range of xerotic skin conditions.

Clinical Relevance

Xerosis is a common feature of both dermatologic disease and environmental skin damage, affecting conditions such as atopic dermatitis, psoriasis, ichthyosis, and age-related or climate-induced dry skin.[15] Clinically, it presents with dryness, roughness, scaling, and, in populations with darker skin, visible ashiness. These features reflect key pathophysiologic processes, including reduced water content, impaired desquamation, and barrier dysfunction. Depletion of natural moisturizing factor (NMF) components, including lactate, contributes to reduced moisture levels within the stratum corneum and is associated with scaling and barrier instability.[5] Ammonium lactate addresses these core mechanisms through biomimetic delivery of L-lactic acid within the stratum corneum. Its humectant properties improve water retention at the skin surface while its corneodesmolytic activity normalizes desquamation and reduces scaling. In parallel, its effects on lipid processing and epidermal turnover contribute to improved barrier performance. In contrast to occlusive agents such as petrolatum, which primarily reduce transepidermal water loss, ammonium lactate targets multiple underlying components of xerotic skin pathology. Compared with other alpha-hydroxy acids, its buffered, physiologic pH allows more controlled availability of L-lactic acid, supporting efficacy while ensuring tolerability. Together, these actions provide benefits beyond simple hydration, holistically addressing the underlying causes of xerotic skin, particularly in patients with chronic or hyperkeratotic xerosis, where single-mechanism moisturizers may be insufficient.

Clinical studies have demonstrated improvements in dryness, scaling, and skin texture with ammonium lactate formulations, including in ichthyosis and severe xerosis, where outcomes were superior to vehicle and petrolatum-based emollients in controlled comparisons.[16-18] Similar benefits have been reported in both atopic and non-atopic dry skin populations, with improvements in clinical signs and, in some studies, non-invasive measures of skin condition.[19,20] Clinical use should be guided by disease severity and phenotype. Lower concentrations of ammonium lactate (5–12%) are typically appropriate for mild xerosis and maintenance therapy, where improvement in skin moisture levels and barrier support are the primary objectives. Higher concentrations (12–15%) are more suitable for moderate to severe xerosis and hyperkeratotic conditions, where enhanced desquamation is required. This concentration-dependent approach allows treatment to be tailored to clinical need while maintaining tolerability.

In inflammatory dermatoses such as psoriasis, ammonium lactate is used as an adjunctive therapy, supporting improvements in scaling and overall skin condition and contributing to maintenance regimens alongside anti-inflammatory treatments.[21] Its relevance is particularly notable in skin of color, where xerosis may present as visible ashiness, and in conditions such as acanthosis nigricans, where it has been reported to contribute to improvements in skin texture through its desquamating (corneodesmolytic) and humectant effects.[22]

Safety

Ammonium lactate has a long history of safe use in dermatologic practice and is generally well tolerated across diverse patient populations. The most commonly reported adverse effects are localized stinging, burning, or irritation, particularly when applied to compromised or inflamed skin. These reactions are typically concentration-dependent and are more likely to occur in patients with impaired barrier function.[10] Topical absorption of ammonium lactate is limited, with studies indicating minimal systemic exposure following application, supporting its suitability for long-term use.[7] Evidence from formulation and clinical studies indicates that irritation potential increases at higher concentrations and lower pH.[7,10] Accordingly, ammonium lactate formulations are typically buffered within a physiologic pH range (approximately 4.5–5.5) to maintain tolerability. This favorable safety profile reflects the biomimetic nature of ammonium lactate, in which the availability of L-lactic acid is self-regulated by the local skin pH environment.

Positioning Within Moisturization Strategies

Conventional moisturizers are typically categorized as occlusive, humectant, or emollient agents, each targeting a specific aspect of skin moisture balance.[3,8] Occlusives reduce transepidermal water loss, while humectants attract water into the stratum corneum. However, these approaches do not directly restore endogenous components of the skin barrier to the same extent.

In contrast, ammonium lactate represents a biomimetic approach that provides a physiological component of the natural moisturizing factor while simultaneously supporting desquamation and barrier homeostasis. This dual mechanism positions ammonium lactate between traditional moisturizers and active dermatologic treatments, providing both symptomatic relief and improvement of underlying barrier abnormalities.

This distinction is particularly relevant in patients with chronic xerosis, where long-term improvement of barrier function is required rather than short-term hydration alone.

CONCLUSIONS

A more nuanced understanding of the mechanism of action of ammonium lactate is now informing its role in clinical dermatology. The use of ammonium lactate in skincare offers a biomimetic approach to skin barrier regeneration by delivering L-lactic acid in a pH-dependent manner aligned with physiological skin processes. Its mechanisms of action include hydration, regulation of desquamation, and barrier support, addressing key drivers of xerotic skin pathology.

The pH-balanced nature of ammonium lactate formulations enables effective delivery while maintaining tolerability. Its broad clinical utility across dermatologic conditions, including mild-to-moderate xerosis, hyperkeratotic disorders such as ichthyosis, and xerosis associated with inflammatory dermatoses such as atopic dermatitis and psoriasis, supports its use as a first-line or adjunctive therapy, depending on disease severity and clinical presentation. Its relevance is also notable in patients with skin of color, in whom xerosis may present as visible ashiness and contribute to patient burden, and where improvements in hydration and desquamation may provide both functional and cosmetic benefits. These findings emphasize the importance of approaches that align with the physiological processes of the skin. By delivering L-lactic acid in a pH-dependent, targeted manner, ammonium lactate represents a distinct therapeutic category that bridges the gap between conventional moisturizers and active dermatologic treatments.

Its ability to address multiple aspects of barrier dysfunction: moisture balance, desquamation, and pH regulation, supports its role as an important component of xerosis management across a wide range of patient populations.

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ORIGINAL ARTICLE

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Ammonium Lactate in Clinical Practice: Optimizing Treatment of Xerotic and Hyperkeratotic Skin Conditions

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ABSTRACT

Ammonium lactate is a well-established, time-tested dermatologic therapy with a substantial body of clinical evidence supporting its use in xerotic and hyperkeratotic skin conditions. Although its use in routine practice has evolved over time, interest in ammonium lactate has been renewed by advances in the understanding of lactate biology and its role in skin physiology.
Xerosis is characterized by reduced water content, impaired corneocyte turnover, and structural disruption of the stratum corneum, leading to scaling, roughness, and discomfort.

As a pH-balanced source of L-lactic acid, ammonium lactate exerts biomimetic effects, aligning with physiologic skin processes. This pH-dependent delivery allows effective lactic acid activity at clinically relevant concentrations while maintaining a favorable tolerability profile. Emerging insights into the role of lactate as both a natural moisturizing factor component and a regulator of epidermal function provide a more contemporary framework for understanding its clinical activity.

Through combined humectant and desquamating activity, ammonium lactate boosts moisture balance, surface smoothness, and overall skin quality. Clinical evidence supports its use in conditions including ichthyosis, atopic dermatitis, psoriasis, keratosis pilaris, acanthosis nigricans, as well as visible "ashiness", a distinct clinical feature associated with xerosis in skin of color.

Treatment outcomes are influenced by concentration, formulation, and disease severity, endorsing a tailored therapeutic approach. This review provides a clinically focused framework for the use of ammonium lactate, positioning it as a versatile and physiologically aligned treatment option within contemporary dermatologic practice.

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INTRODUCTION

Xerotic and hyperkeratotic skin conditions represent a substantial proportion of dermatologic consultations and are associated with both physical discomfort and psychosocial burden. These conditions encompass a wide spectrum of disorders, including atopic dermatitis, psoriasis, ichthyosis vulgaris, keratosis pilaris, and age-related xerosis.[1,2]

Keratinizing disorders are characterized by impaired epidermal turnover and reduced stratum corneum hydration, resulting in scaling and roughness. These changes are associated with reduced natural moisturizing factor (NMF) activity and impaired water-binding capacity.[3,4] Altered desquamation contributes to retention of corneocytes and visible scaling.[5]

Standard emollients improve symptoms of dryness but often provide only transient benefit in chronic xerotic conditions.[6] In contrast, ammonium lactate, a pH-balanced source of L-lactic acid, acts through both humectant and corneodesmolytic mechanisms, supporting moisture regulation while promoting epidermal renewal.

While the mechanistic basis of ammonium lactate has been explored in detail elsewhere, the present review focuses on its clinical application across a range of dermatologic conditions, with emphasis on treatment selection, patient outcomes, and real-world use.

This therapy provides a biomimetic, single-ingredient approach to the management of xerotic skin that is consistent with physiological processes such as moisture regulation and epidermal renewal (Figure 1).

Ammonium lactate is widely accessible across both prescription and over-the-counter settings in various formulations. It may be used as part of routine dermatologic care, both as an initial intervention and as part of longer-term treatment strategies.

Ammonium Lactate's Mechanism of Action in Xerotic Skin

The clinical relevance of ammonium lactate lies in its ability to support hydration and normalize corneocyte turnover within the stratum corneum (Figure 1). As a humectant, it enhances water retention, improving skin flexibility and reducing roughness. In parallel, its corneodesmolytic activity promotes desquamation, reducing scale and smoothing the skin surface. It may also support aspects of lipid

organization within the stratum corneum.[5,7] These effects are influenced by the local pH environment, which regulates the availability of L-lactic acid and supports clinical efficacy while maintaining tolerability compared with lower-pH formulations of free lactic acid.[8-10]

Clinical Benefits of Ammonium Lactate

The clinical utility of ammonium lactate in xerotic and hyperkeratotic skin conditions is supported by a substantial body of evidence and long-standing use in dermatologic practice. While improvements in dryness, scaling, and skin texture are consistently reported, its benefits extend beyond symptomatic relief. Its effects are most evident in conditions where disrupted corneocyte turnover and impaired hydration contribute to visible skin changes and patient discomfort.

Genodermatoses (Ichthyosis)

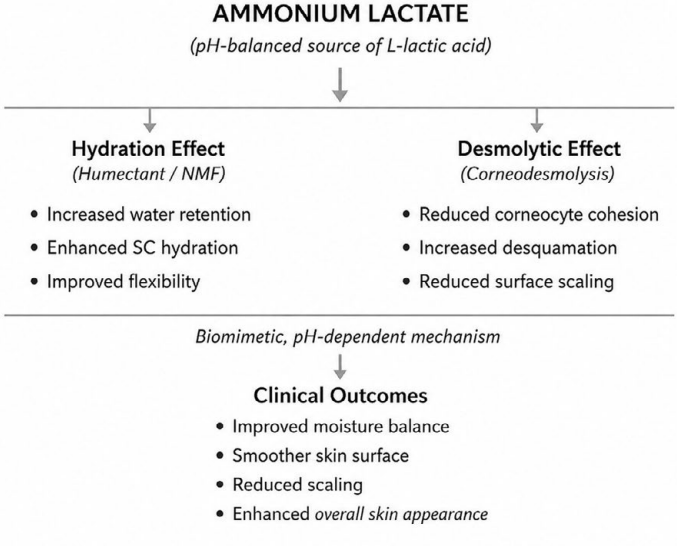
In genodermatoses such as ichthyosis, where retention hyperkeratosis and impaired corneocyte shedding are central features, ammonium lactate has demonstrated consistent benefit across controlled and comparative studies. Evidence supporting its use includes prospective trials evaluating 12% ammonium lactate formulations applied twice daily over approximately 4 weeks, with regular clinical assessment. In one controlled study, ammonium lactate lotion produced clinically meaningful reductions in scale thickness and improvements in skin smoothness compared with both vehicle and petrolatum-based emollients, demonstrating superiority over simple occlusive therapy.[11]

These characteristics make ammonium lactate well suited for long-term management of ichthyosis and other epidermal differentiation disorders, where sustained control of scaling is required. Its tolerability supports chronic use, with gradual introduction appropriate in patients with severe barrier impairment.

Inflammatory Conditions

In inflammatory dermatoses such as atopic dermatitis and psoriasis, the role of ammonium lactate is more nuanced and is best understood in the context of adjunctive and maintenance therapy rather than primary disease control. In these conditions, xerosis and abnormal epidermal turnover contribute significantly to disease burden, making supportive therapies an important component of management.

FIGURE 1. Dual mechanism of action of ammonium lactate in xerotic skin.



In atopic dermatitis, ammonium lactate is primarily used during the maintenance phase to restore moisture balance and support barrier function between flares. Studies in patients with atopic and non-atopic dry skin have demonstrated improvements in hydration, smoothness, and skin condition with regular use.[12] Although use during acute flares may be limited by stinging in some patients with compromised barrier function, incorporation into longer-term management may help maintain baseline skin quality. It may be particularly advantageous in lichenified areas, such as, heels, knees and elbows, where persistent dryness and scaling contribute to skin thickening.

In patients with psoriasis, ammonium lactate is best positioned as an adjunctive therapy. Its ability to reduce scale and improve plaque texture may enhance the effectiveness of topical treatments. This is particularly relevant in plaque psoriasis, where hyperkeratosis and increased epidermal thickness can limit drug penetration.[13,14] This has been demonstrated in randomized, double-blind, placebo-controlled studies, including a trial involving 55 patients with mild-to-moderate psoriasis, in which the combination of ammonium lactate with topical corticosteroids resulted in improved treatment outcomes and maintenance of response compared with corticosteroid therapy alone.[15] By improving plaque scaling and surface uniformity, ammonium lactate may support steroid-sparing strategies by enhancing treatment response and potentially reducing the duration or intensity of topical corticosteroid use.[13,15]

The value of ammonium lactate in inflammatory dermatoses lies in improving skin condition and supporting overall treatment response.

Hyperkeratotic Conditions (Keratosis Pilaris and Acanthosis Nigricans)

In keratosis pilaris and acanthosis nigricans, altered corneocyte turnover and follicular or epidermal plugging contribute to the characteristic rough texture and thickened skin surface, making therapies that normalize epidermal shedding particularly relevant.[5,16]

The evidence for keratosis pilaris is more limited than in xerosis or ichthyosis and is often derived from smaller studies or combination approaches. For example, in a comparative study evaluating the addition of intense pulsed light (IPL) to topical ammonium lactate 14%, treatment outcomes were improved compared with ammonium lactate alone, although the study population was small (10 patients, 50 treatment sites), highlighting both the potential benefit and the limitations of the available evidence.[17]

In acanthosis nigricans, ammonium lactate provides meaningful cosmetic benefit. Clinical reports have demonstrated enhanced skin smoothness, reduction in thickness, and improvement in overall skin appearance when ammonium lactate is used as part of topical treatment regimens.[18] Although evidence for direct effects on hyperpigmentation is limited, reduction in surface hyperkeratosis and textural irregularity may contribute to visible cosmetic improvement. Although it does not address underlying metabolic or endocrine drivers, its ability to improve visible skin changes supports its role as an adjunctive therapy, particularly in patients where texture and appearance are key concerns.

TABLE 1.

Clinical Use of Ammonium Lactate by Concentration		
Concentration	**Effects**	**Clinical Applications**
5–10%	Water balance, surface smoothing	Everyday xerosis, ashy skin, xerosis-prone skin, maintenance therapy
12–15%	Water balance + enhanced desquamation	Moderate-to-severe xerosis, psoriasis, ichthyosis, keratosis pilaris
Adjunctive therapy	Barrier support and treatment optimization	With corticosteroids, post-treatment maintenance, combination therapy

Treatment should be tailored to severity and patient expectations. In milder presentations, it may be sufficient as monotherapy, whereas more resistant cases may require combination approaches. These considerations reflect the broader principle that ammonium lactate is most effective when used to normalize epidermal turnover within a comprehensive treatment strategy.[8,19]

Localized Xerosis (Foot Xerosis)

Localized xerosis, particularly of the feet, represents a common and clinically relevant presentation in dermatologic practice. In contrast to more generalized dry skin, foot xerosis is often associated with mechanical stress, friction, fissuring, and reduced barrier resilience, all of which can amplify discomfort and impair quality of life. These features make treatment goals somewhat different.

In this setting, ammonium lactate has demonstrated benefits through its combined effects on moisture retention and epidermal renewal. Studies in patients with xerosis have shown that ammonium lactate enhances skin smoothness, reduces scaling, and supports overall skin condition, with comparative studies supporting its utility in more localized moderate-to-severe presentations as well.[20,21] This makes ammonium lactate particularly useful in patients with dry or mildly fissured plantar skin where both hydration and desquamation are required.

Ammonium lactate is effective in mild-to-moderate foot xerosis and may be used as part of a stepwise or combination approach in more severe disease. In comparative studies of foot xerosis, higher-concentration urea-based products may produce more rapid improvement in more severe or fissured disease, particularly where marked hyperkeratosis is present.[20] This broader positioning is supported by systematic review data, which identify ammonium lactate as one of the better-studied active moisturizing agents in this indication, although urea remains the most extensively investigated comparator.[22] Ammonium lactate occupies an important intermediate position: more active than simple emollients, but generally better tolerated and more suitable for maintenance use than more aggressive desquamating therapies.

Combination Therapy and Adjunctive Use

In routine clinical practice, ammonium lactate is frequently incorporated into combination regimens. By reducing scale and improving stratum corneum hydration, it may enhance the penetration and effectiveness of concomitant topical therapies. Several studies have reported improved outcomes when ammonium lactate is used alongside topical corticosteroids, supporting its role as an adjunct in inflammatory dermatoses.[15]

In keratosis pilaris and other disorders of keratinization, primary management typically includes topical keratolytics and emollients aimed at reducing follicular plugging and improving skin texture. As a keratolytic with humectant properties, ammonium lactate functions as a supportive therapy, addressing both hydration and corneocyte turnover. In milder disease, these effects may be sufficient to achieve improvement without escalation, while in more persistent cases, combination approaches may provide additional benefit, including when used alongside device-based therapies such as IPL.[17]

Environmental and Everyday Xerosis

Environmentally induced xerosis represents one of the most common presentations encountered in dermatologic practice, particularly in older individuals and in patients exposed to low humidity, frequent washing, or irritant environments.[1,2] Epidemiological studies incorporating multivariate regression analyses have identified age, environmental exposure, and skin care practices as independent predictors of xerosis, highlighting its multifactorial and persistent nature. As a result, treatment strategies must address both immediate symptoms and longer-term maintenance of skin condition.

Ammonium lactate is well suited to this setting, and evidence from randomized and comparative studies in patients with xerosis has demonstrated consistent benefits in skin hydration, smoothness, and skin condition following regular use of 12% ammonium lactate formulations. In a randomized, double-blind, contralateral study involving patients with moderate-to-severe xerosis, clinically meaningful improvement was observed over a treatment period of approximately 3 weeks, with continued benefit during ongoing use.[23] Additional controlled studies have similarly demonstrated superiority over emollient comparators in improving skin texture and reducing scaling.[11,24]

Improvement with ammonium lactate is often progressive, with continued benefit during ongoing use. This pattern is consistent with its ability to influence desquamation and skin barrier structure, in addition to providing direct moisturization.[8,19] It may contribute to a functional reservoir of lactate within the stratum corneum, supporting sustained water-binding capacity and ongoing regulation of epidermal processes.[3,7] Although not directly quantified in clinical studies, this may help explain the durability of response observed with continued use.

Skin of Color

By improving hydration and smoothing the superficial epidermis, ammonium lactate reduces visible scaling and helps to ensure a more uniform skin surface. These effects are particularly relevant in patients with skin of color, where xerosis often presents as lightening

or "ashiness" due to increased reflection of light from surface scale in darker phototypes.[25] Clinically, improvements in skin smoothness may have a substantial impact on patient satisfaction. While not directly targeting pigmentation pathways, these changes in hydration may enhance perceived skin appearance and quality.

Clinical Applications and Biomimetic Properties Based on Concentration

The clinical effects of ammonium lactate can be understood within a biomimetic framework, in which concentration-dependent activity aligns with physiological processes in the stratum corneum. Rather than acting as a simple topical agent, it modulates both hydration and epidermal turnover, with effects influenced by concentration, formulation, and the local skin environment. Increasing concentrations are associated with greater effects on desquamation and epidermal renewal, reflecting the balance between its humectant and corneodesmolytic properties.[8,19]

Lower concentrations of ammonium lactate (typically 5–10%) primarily exert hydrating and smoothing effects. At these concentrations, lactate functions predominantly as a humectant, enhancing water uptake and retention within the skin barrier and improving skin flexibility. Several studies in patients with xerosis, including age-related and environmentally induced dry skin, have demonstrated improved moisture balance and skin texture with 12% ammonium lactate compared with vehicle or emollient controls.[23,24] Similar benefits have been observed in patients with atopic and non-atopic dry skin, where enhancements in moisture levels and surface smoothness were reported.[12] These properties make lower concentrations particularly suitable for maintenance therapy, everyday xerosis, and conditions such as ashy skin in patients with skin of color. Repeated application may also support the formation of a functional reservoir of lactate within the stratum corneum, contributing to sustained water-binding capacity and ongoing improvement in skin condition.

In contrast, higher concentrations (12–15%) provide both hydrating and more pronounced corneodesmolytic effects. At these levels, increased availability of L-lactic acid enhances corneodesmolysis and promotes normalization of corneocyte turnover, leading to more rapid reduction in scaling and hyperkeratosis.[8,19] Clinical evidence supports the use of these concentrations in conditions characterized by significant hyperkeratosis, including ichthyosis and psoriasis. In patients with ichthyosis, 12% ammonium lactate has been shown to reduce scale thickness and improve skin smoothness compared with vehicle and petrolatum-based treatments.[11] Comparative studies in psoriasis have demonstrated reduced scaling and improved skin condition when ammonium lactate is used as part of combination therapy.[26]

Higher concentrations are associated with enhanced corneodesmolytic activity, which in some patients, particularly those with compromised barrier function, may be accompanied by mild, transient cutaneous sensitivity. Overall, however, ammonium lactate formulations are well tolerated, reflecting their pH-balanced composition, which helps regulate the availability of active L-lactic acid within the skin. This relationship highlights the importance of aligning treatment selection with individual patient needs and disease severity.[8,9]

Concentration selection should reflect both the severity of xerosis and the phase of treatment. Lower concentrations are generally appropriate for long-term maintenance and prevention of recurrence, whereas higher concentrations may be used during active treatment phases to achieve more rapid reduction in scaling. In some cases, stepwise escalation or combination therapy may be employed to optimize outcomes while maintaining tolerability. This combination of efficacy and tolerability supports the use of ammonium lactate across a range of treatment intensities, often enabling effective management without escalation to more intensive therapeutic options in many cases.

Formulation Considerations

In addition to concentration, formulation characteristics further influence clinical outcomes, particularly pH and vehicle composition. As a pH-dependent system, the availability of L-lactic acid within the stratum corneum is governed by the formulation environment and the skin surface microenvironment. Formulations within a physiologic pH range (approximately 4.5–5.5) are generally associated with improved tolerability while maintaining efficacy.

Differences in formulation may also influence penetration, skin feel, and patient adherence, all of which contribute to real-world treatment outcomes. As a result, not all ammonium lactate–based products are clinically equivalent, and selection of an appropriate formulation should be considered alongside concentration and disease severity when optimizing therapy.

Safety and Tolerability

Ammonium lactate has a well-established safety profile with generally mild, transient adverse effects. The most commonly reported adverse effects are localized stinging, burning, or irritation, particularly when applied to compromised or inflamed skin. Irritation may also be more noticeable in thinner or intertriginous skin sites, including the face, neck folds, and axillae, where gradual introduction, lower concentrations, and lower-frequency application may improve tolerability. These reactions are typically concentration-dependent and are more likely to occur in patients with impaired barrier function, such as those with active dermatitis or fissured skin.[8,27] Importantly, these symptoms are usually self-limiting and tend to diminish with continued use as the barrier integrity improves. The pH-balanced nature of these formulations contributes to this favorable tolerability profile by moderating the availability of active lactic acid within the skin.

Studies evaluating ammonium lactate in xerosis have consistently reported good tolerability. In randomized studies comparing ammonium lactate with vehicle or other emollients, discontinuation due to adverse events has been uncommon, and patient-reported tolerability has generally been favorable.[21,23,24]

Topical absorption of ammonium lactate is limited, with studies indicating minimal systemic exposure following application, supporting its indication for chronic use in adult populations.[9,28] Regulatory safety assessments have further confirmed that ammonium lactate and related compounds are safe for topical use within established concentration and pH ranges.[27] Published safety data in pediatric populations remain more limited, and use in younger patients should be guided by clinical judgment and product-specific labeling.

Tolerability can be optimized through appropriate patient selection and use. Initiating treatment with lower concentrations or reduced frequency may minimize the risk for irritation in sensitive skin. Patient education

regarding the possibility of transient stinging is also important in supporting adherence and preventing premature discontinuation.

Overall, the safety and tolerability profile of ammonium lactate justify its use across a broad range of dermatologic indications, including in long-term management strategies for chronic xerotic conditions.

CONCLUSIONS

Ammonium lactate plays an important role in the management of xerotic and hyperkeratotic skin conditions. Beyond simple moisturization, it supports fundamental determinants of skin function, including hydration and epidermal renewal.

Clinical evidence consistently demonstrates improvements in scaling, texture, and overall skin quality. It is particularly effective in xerotic conditions characterized by retention hyperkeratosis, while in inflammatory dermatoses it is best integrated within a broader therapeutic strategy.

These benefits reflect its ability to normalize key stratum corneum processes, including water balance and desquamation. This represents a physiologically aligned mode of action, in which therapeutic effects are achieved through modulation of normal physiological processes rather than disruption, which is in line with current approaches to skin barrier restoration. In practice, optimal outcomes depend on appropriate patient selection according to disease severity, treatment phase, and individual characteristics. Used in this way, ammonium lactate provides a practical option for both active treatment and the long-term management of xerosis.

Ammonium lactate, a pH-balanced source of L-lactic acid, exerts complementary effects within the stratum corneum through both humectant and corneodesmolytic mechanisms. The humectant effect enhances water retention and leads to better stratum corneum hydration, while corneodesmolysis reduces corneocyte cohesion and promotes desquamation. Together, these processes contribute to improved moisture balance, smoother skin surface, and reduction in visible scaling. These effects reflect a biomimetic, concentration-dependent mode of action aligned with physiological skin processes.

DISCLOSURES

Latanya Benjamin MD reports consulting/advisory relationships with Incyte, Kenvue, L'Oréal, CeraVe, Pelthos, Alphyn, ZenZema, Isdin, Organon, Arcutis, and Veradermics; and participation in speakers bureaus for Organon, Incyte, Sanofi, Regeneron, Kenvue, L'Oréal, Avène, and Arcutis.

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