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New advances in the medication of common conjunctivitis

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ABSTRACT

Background: *The conjunctiva serves as a frontline mucosal and immunologic barrier, rendering it highly susceptible to infectious, allergic, and immune-mediated insults. Conjunctivitis remains the most common ocular surface disease globally, yet its clinical management is often challenged by diagnostic ambiguity, empirical treatments, and evolving pathogen resistance.*
Objective: *This review synthesizes recent advancements in the pharmacological management of conjunctivitis, with a focus on aligning therapeutic strategies to distinct etiologic subtypes: bacterial, viral, and allergic.*
Methods: *Evidence from randomized controlled trials, real-world clinical studies, and translational research published between 2010 and 2024 was critically reviewed. First-line pharmacotherapies and emerging treatment modalities were evaluated based on efficacy, safety, accessibility, and mechanism of action.*
Results: *Conventional topical therapies such as antibiotics, antihistamines, and corticosteroids remain central to treatment. However, biologics, immunomodulators, and antiseptic-antiviral combinations have expanded the therapeutic landscape, particularly in refractory or high-severity cases. Innovations in drug delivery systems and immune-targeted agents show promise but require further validation.*
Conclusion: *Optimal conjunctivitis management demands precision diagnosis, stratified treatment selection, and vigilance against overtreatment. Integrating traditional medicine within evidence-based frameworks and ensuring equitable access to novel therapies especially in resource-limited settings represent critical frontiers for future research and policy reform.*

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1. Introduction

Conjunctivitis, the most widespread ocular surface disorder worldwide, manifests as an inflammatory response of the conjunctival tissue, typically triggered by compromised host immunity or heightened pathogen virulence. While frequently encountered in routine clinical practice, its diagnosis and management remain fraught with complexity. A major impediment lies in the absence of universally accepted diagnostic frameworks and treatment protocols, often compelling clinicians to rely on subjective judgment, thereby engendering inconsistent therapeutic outcomes.

In recent years, the field of ophthalmology has experienced a paradigm shift, driven by advancements in diagnostic modalities, pharmacological innovation, and improved understanding of ocular immunopathology. A growing corpus of multicenter trials and translational studies has begun to inform more nuanced, evidence-based strategies tailored to the diverse etiologies of conjunctivitis.

This review seeks to provide a comprehensive and clinically relevant synthesis of current therapeutic approaches to infectious, allergic, and immune-mediated conjunctivitis. We explore first-line agents and novel therapeutics ranging from biologics to immunomodulators and propose practical treatment algorithms to standardize care while identifying areas that warrant further investigation.

2. Epidemiology of Common Conjunctivitis

Conjunctivitis encompasses a diverse group of ocular surface disorders, among which bacterial, viral, and allergic subtypes are the most clinically prevalent and epidemiologically significant. The global incidence of conjunctivitis demonstrates considerable geographical variation, shaped by climate, population density, and regional pathogen profiles. Each subtype exhibits distinct transmission dynamics and seasonal patterns, necessitating tailored public health strategies.

Bacterial conjunctivitis remains a prominent cause of outpatient visits, particularly in pediatric populations. Its rapid spread via direct contact especially in high-density settings such as schools and long-term care institutions amplifies its epidemic potential. Meanwhile, viral conjunctivitis, predominantly caused by adenoviruses, represents the most frequently encountered infectious form. It often presents unilaterally before progressing to bilateral involvement and is associated with high transmissibility, prolonged shedding, and limited antiviral treatment options.

Allergic conjunctivitis, encompassing seasonal (SAC), perennial (PAC), and vernal keratoconjunctivitis (VKC) subtypes, affects an estimated 30–40% of the global population. SAC and PAC are especially prevalent in temperate and urbanized regions, with East Asian studies reporting prevalence rates of 15–20%. In contrast, North American data reveal a diagnostic discrepancy: although approximately 40% of individuals report exposure to allergens, fewer than 10% seek ophthalmological consultation, indicating substantial underdiagnosis or self-management.

Clinical outcomes vary widely depending on early recognition and treatment. Randomized controlled trials have revealed notable differences in treatment efficacy: for instance, antibiotic therapy in bacterial conjunctivitis demonstrated clinical cure rates of 26% in general cohorts and up to 53% in modified intention-to-treat populations. These findings highlight the importance of stratified clinical approaches and underscore the ongoing need for epidemiologically informed treatment protocols.

3. Treatment

Effective management of conjunctivitis necessitates a systematic, etiology-driven approach that integrates clinical assessment, targeted pharmacotherapy, and ongoing disease monitoring. Given the heterogeneity of conjunctivitis subtypes bacterial, viral, allergic, and immune-mediated a unified treatment strategy must be adaptable, evidence-based, and responsive to evolving clinical presentations.

Figure 1 illustrates a diagnostic and therapeutic decision tree designed to streamline initial patient evaluation.

The algorithm begins with the characterization of ocular discharge: purulent secretions suggest bacterial etiology, while serous or watery discharge warrants further differentiation based on conjunctival hyperemia and patient allergy history. This framework facilitates rapid classification and enables prompt initiation of subtype-specific therapy.

A concise summary of pharmacologic regimens, including first-line agents and adjunctive options is presented in Table 1.

This overview provides clinicians with a practical guide to mechanism-based treatment selection, encompassing antibiotic, antiviral, antihistaminic, immunomodulatory, and corticosteroid therapies.

Current treatment paradigms prioritize etiologic eradication, anti-inflammatory control, and antimicrobial stewardship. Approximately 85% of mild-to-moderate conjunctivitis cases respond favorably to topical therapy. However, severe presentations such as WHO grade ≥3 ocular inflammation may require systemic intervention. In cases of undetermined etiology, empirical broad-spectrum topical treatment, paired with confirmatory laboratory testing, is recommended. Once microbiological data are available, therapy should be refined to target the identified pathogen.

Ultimately, clinical success depends not only on symptom resolution but also on preventing complications such as chronic inflammation, corneal involvement, or vision-threatening sequelae. A personalized and dynamic treatment strategy guided by evidence and adjusted according to disease progression is essential for achieving optimal outcomes in conjunctivitis management.

4. Bacterial Conjunctivitis

4.1. Topical Therapy

Although acute bacterial conjunctivitis is often self-limiting, the associated symptoms ocular discomfort, discharge, and impaired vision significantly impact patients' quality of life. Topical antibiotic therapy, when appropriately administered, can reduce symptom duration and transmission risk. Clinical studies indicate that up to 25% of bacterial conjunctivitis cases involve polymicrobial infections, justifying the need for empirical broad-spectrum coverage during initial treatment [1].

First-line topical agents include fluoroquinolones (e.g., moxifloxacin, besifloxacin), aminoglycosides (e.g., tobramycin), and macrolides (e.g., azithromycin). These demonstrate comparable clinical efficacy, though individual pharmacokinetics and tolerability profiles vary. Caution is warranted, as antibiotics may induce adverse effects such as headache, dysgeusia, or microbial resistance.

For mild, uncomplicated presentations, delayed antibiotic initiation (typically 48–72 hours post-diagnosis) may reduce unnecessary exposure while preserving therapeutic efficacy. Combination therapy such as 0.6% povidone-iodine with 0.1% dexamethasone has not shown superior outcomes compared to monotherapy and may increase the risk of adverse effects [2].

In neonatal prophylaxis, current guidelines increasingly discourage routine erythromycin ointment use due to limited efficacy. Instead, prenatal screening and treatment for maternal sexually transmitted infections (STIs) remain the gold standard [3]. For confirmed neonatal infections, erythromycin (0.5%) remains first-line, while agents such as 1% azithromycin are under investigation but not yet validated for routine use.

Besifloxacin, with superior corneal penetration and broad-spectrum efficacy, has demonstrated high microbial clearance rates in pediatric populations [4]. In chronic or recurrent bacterial conjunctivitis (lasting >4 weeks), empirical therapy must consider underlying conditions such as giant fornix syndrome[5] and may require corticosteroid adjuncts, albeit with monitoring for ocular hypertension and cataract risk [6].

Traditional and Herbal Interventions

Complementary therapies rooted in traditional medicine are increasingly explored for ocular surface infections. *Buddleja officinalis* Maxim, long used in East Asian medicine, demonstrates anti-inflammatory and antimicrobial effects in conjunctivitis models [7]. Other botanicals, including *Syringa* and *Ribes* species, as well as *Corydalis saxicola* Bunting ("Yan-huang-lian"), exhibit potential ocular benefits [8-10]. While promising, these agents require further standardization and validation via randomized controlled trials before formal clinical integration.

4.2. Systemic Therapy

Systemic antibiotic therapy is reserved for severe or hyperacute bacterial conjunctivitis, particularly cases caused by *Neisseria gonorrhoeae* or *Haemophilus influenzae*, which can progress rapidly to corneal ulceration, orbital cellulitis, or even permanent visual impairment [11].

For adult patients without corneal involvement, intramuscular ceftriaxone or penicillin G is recommended, with spectinomycin as an alternative for those with β-lactam allergies. When the cornea is affected, dual therapy ceftriaxone plus doxycycline or azithromycin should be initiated promptly, ideally within 48 hours [12].

Meningococcal conjunctivitis poses a unique systemic threat, as up to 29% of cases may evolve into invasive meningococcal disease within 48 hours [13]. Intravenous penicillin G or ciprofloxacin (for β-lactam-sensitive patients) is the treatment of choice, accompanied by public health notification and contact prophylaxis.

In pediatric or institutional outbreaks linked to *Haemophilus influenzae*, systemic cephalosporins or rifampin may be co-administered with topical therapy. Adjunct corticosteroids when judiciously applied have been shown to reduce symptom burden without compromising microbial clearance [14]. Surgical debridement may be necessary for refractory cases with pseudomembrane formation or orbital involvement [15].

5. Viral Conjunctivitis

Viral conjunctivitis is the most prevalent form of infectious conjunctivitis worldwide, with adenovirus accounting for the majority of cases. The condition typically manifests unilaterally before progressing to bilateral involvement and is associated with high transmissibility, environmental persistence, and limited antiviral treatment options. Most patients seek medical attention within one week of symptom onset, though many attempt self-treatment with over-the-counter agents prior to clinical consultation [1].

5.1. Empirical and Supportive Management

Current management is largely empirical, focusing on supportive care such as artificial tears, cold compresses, and meticulous hygiene to alleviate discomfort and reduce transmission. Ocular irrigation with saline or antiseptic agents (e.g., 5% povidone-iodine) is commonly employed in the absence of targeted antiviral options [2].

Despite limited regulatory approval, topical povidone-iodine (PVP-I) solutions demonstrate broad-spectrum antiviral activity and are frequently used off-label to manage adenoviral keratoconjunctivitis (EKC) [3]. Combination therapy with dexamethasone enhances symptomatic relief and reduces viral load, though long-term safety and recurrence rates require further validation [4-5].

Prophylactic antibiotic use, although prevalent, is not recommended unless secondary bacterial infection is suspected. Topical corticosteroids may be cautiously applied in cases complicated by pseudomembrane formation or subepithelial infiltrates, with careful monitoring to prevent rebound inflammation or intraocular pressure elevation [6].

5.2. Antiviral Therapies and Herpetic Conjunctivitis

The only FDA-approved topical antiviral for conjunctivitis is 0.15% ganciclovir gel, primarily indicated for herpes simplex virus (HSV)–associated conjunctivitis. However, no approved antivirals currently exist for adenoviral EKC, leaving clinicians reliant on symptomatic strategies and antiseptics.

Herpetic conjunctivitis presents unique therapeutic challenges. HSV-related cases generally respond to ganciclovir or acyclovir, whereas varicella zoster virus (VZV) requires higher dosing due to reduced drug sensitivity. Systemic antivirals (e.g., acyclovir, valacyclovir) are indicated for moderate-to-severe cases, particularly when epithelial keratitis or periorbital involvement is evident.

In complicated presentations such as stromal keratitis or persistent inflammation adjunctive corticosteroid-tacrolimus combinations have shown efficacy in restoring visual function and preventing recurrence. These regimens should be tapered gradually to minimize the risk of flare-ups [7].

6. Allergic Conjunctivitis

Allergic conjunctivitis is a highly prevalent immunologically mediated ocular surface disorder, significantly impairing patient quality of life. It encompasses a clinical spectrum that includes seasonal allergic conjunctivitis (SAC), perennial allergic conjunctivitis (PAC), vernal keratoconjunctivitis (VKC), and atopic keratoconjunctivitis (AKC). Among these, SAC accounts for the majority of cases, often triggered by airborne allergens such as pollen, with PAC resulting from year-round exposures like dust mites and animal dander [1].

While visual prognosis is generally favorable, untreated or chronic cases particularly VKC and AKC can lead to corneal involvement, giant papillae, and vision-threatening complications [2]. Accurate subtype differentiation and early therapeutic intervention are thus essential for symptom control and long-term ocular surface preservation.

Management strategies for allergic conjunctivitis are tailored to disease severity and chronicity, typically beginning with dual-action topical agents and escalating to corticosteroids or immunomodulators in refractory cases [3].

6.1. Antihistamines and Vasoconstrictors

Topical H1-antihistamines are the cornerstone of first-line therapy, offering rapid relief from pruritus and redness. Among these, olopatadine and epinastine exhibit favorable tolerability and efficacy profiles [4]. Epinastine's low systemic absorption renders it particularly suitable for pediatric use, and its novel 0.5% eyelid cream formulation has shown promise in preventing seasonal flare-ups [5].

Alcaftadine offers long-lasting anti-pruritic effects and is effective in preventing allergen re-exposure–induced symptoms [6]. For preservative-sensitive patients, azelastine is preferred due to its tolerability and dual anti-inflammatory action [7].

Systemic antihistamines may provide adjunctive benefit but are not recommended as monotherapy for ocular symptoms. They may exacerbate dry eye in susceptible individuals and are associated with systemic side effects such as sedation and QT prolongation [8].

In milder cases, artificial tears combined with topical antihistamines may suffice. When conjunctival hyperemia persists, vasoconstrictor agents can be added, though prolonged use should be avoided due to rebound hyperemia and tachyphylaxis [9].

6.2. Mast Cell Stabilizers

Mast cell stabilizers, such as cromolyn sodium and lodoxamide, function by preventing mast cell degranulation, thereby reducing histamine-mediated symptoms. These agents are most effective when initiated prophylactically ideally 2–4 weeks before allergen exposure and are rarely used as monotherapy due to their delayed onset of action [10].

Adherence remains a challenge in clinical practice, as patients often expect rapid symptom relief, leading to premature discontinuation. As such, mast cell stabilizers are frequently combined with antihistamines in dual-action formulations to enhance both immediate and long-term symptom control.

6.3. Nonsteroidal Anti-inflammatory Drugs (NSAIDs)

Topical NSAIDs (e.g., ketorolac, nepafenac) provide short-term anti-inflammatory relief and are occasionally employed in allergic conjunctivitis. However, they are generally less effective than antihistamine-mast cell stabilizer combinations and are not recommended for first-line use [11].

Importantly, NSAIDs carry a risk of corneal complications, including ulceration and melting particularly in patients with compromised ocular surfaces or concomitant dry eye [12]. Consequently, their use should be reserved for select cases under close ophthalmologic supervision.

6.4. Immunomodulators and Immunotherapy

In moderate-to-severe or steroid-refractory allergic conjunctivitis, immunomodulators play a pivotal therapeutic role. Agents such as cyclosporine A and tacrolimus have emerged as effective steroid-sparing treatments, particularly in VKC and AKC, by selectively inhibiting T-cell activation and eosinophilic inflammation [13]. These drugs exhibit excellent ocular bioavailability and are associated with high remission rates, though local irritation may limit adherence [14].

Emerging delivery platforms such as liposomal carriers, hydrophilic nanoparticles, and cyclodextrin complexes aim to enhance drug stability and reduce dosing frequency [15]. Current evidence supports initiating these agents only under specialist supervision, particularly in pediatric or chronic cases.

Immunotherapy offers a disease-modifying approach, particularly for patients with concomitant allergic rhinitis or asthma. Subcutaneous (SCIT) and sublingual immunotherapy (SLIT) modalities have demonstrated efficacy in alleviating ocular symptoms and reducing antihistamine dependency [16]. SLIT is associated with higher patient compliance and comparable clinical benefit, although optimal dosing protocols remain under investigation [17].

Lirentelimab, an anti-Siglec-8 monoclonal antibody, is under development for eosinophilic ocular disease. By promoting eosinophil apoptosis and mast cell inhibition, it has shown promise in early-phase trials for chronic allergic conjunctivitis, including VKC and PAC [18].

6.5. Glucocorticoids and Others

Corticosteroids remain indispensable in the management of severe or refractory allergic conjunctivitis, especially in cases involving limbal stem cell dysfunction, shield ulcers, or giant papillae. Short-term regimens using agents like loteprednol etabonate the only FDA-approved steroid for SAC are favored due to their lower propensity to raise intraocular pressure or induce cataract [19].

However, long-term use demands strict monitoring due to well-documented adverse effects including ocular hypertension, posterior subcapsular cataracts, and secondary infections. For patients requiring extended control, transitioning to selective glucocorticoid receptor agonists (SEGRAs) such as ZK 209614 may offer inflammation suppression without steroid-associated complications [20].

In recalcitrant cases, 0.1% tacrolimus ointment applied periocularly has shown efficacy in reducing palpebral inflammation and preserving corneal integrity [21]. Adjunctive use of rebamipide, an epithelial barrier stabilizer, and CRTH2 antagonists targeting eosinophilic pathways, is currently under investigation [22].

7. Conclusion

Conjunctivitis, though often regarded as a self-limiting ocular condition, presents a multidimensional challenge that extends beyond symptomatic relief. Clinicians today must navigate a complex therapeutic landscape marked by microbial resistance, immunologic diversity, and patient adherence barriers. As such, the contemporary approach to conjunctivitis must evolve from isolated symptomatic management toward an integrated therapeutic continuum encompassing prevention, precision treatment, and relapse mitigation.

Advances in ocular pharmacology particularly the development of biologics, topical immunomodulators, and targeted delivery systems have significantly broadened the therapeutic arsenal. However, these innovations must be balanced with real-world considerations, including cost, accessibility, regional drug availability, and adverse event surveillance. Importantly, symptomatic resolution should not be misconstrued as clinical cure, especially in chronic or immune-mediated cases where subclinical inflammation may persist.

Future research must adopt a hierarchical and strategic orientation:

1. Molecular elucidation of chronic and recurrent conjunctivitis pathogenesis;
2. Validation of novel therapeutics through multicenter, randomized controlled trials;
3. Integration of traditional medicine within evidence-based frameworks, particularly in high-burden settings such as East Asia.

In the context of China, enhancing diagnostic standardization, ensuring equitable access to innovative treatments in secondary and rural healthcare settings, and conducting rigorous clinical appraisal of traditional Chinese ophthalmic formulations should form key pillars of future translational agendas.

This review synthesizes developments from 2010 to 2024, offering a consolidated, evidence-driven reference for ophthalmic practitioners, researchers, and public health policymakers. By aligning therapeutic strategies with clinical complexity and patient-centered outcomes, we move toward a more intelligent, adaptive, and globally resonant model of conjunctivitis care.

8. Method of Literature Search

A comprehensive literature search was conducted to identify relevant studies on the pharmacological management of conjunctivitis. We systematically reviewed publications in English or with English abstracts from the following electronic databases: PubMed/MEDLINE, Embase, Scopus, The Cochrane Library, and LILACS (from 2003 to November 2, 2025). Chinese databases including CNKI and Wanfang Data were also queried using equivalent search terms.

The search strategy combined terms related to conjunctivitis subtypes bacterial conjunctivitis, viral conjunctivitis, allergic conjunctivitis, seasonal allergic conjunctivitis (SAC), perennial allergic conjunctivitis (PAC), and vernal keratoconjunctivitis (VKC) with pharmacotherapy-related keywords such as medication, treatment, antibiotics, antivirals, antihistamines, mast cell stabilizers, immunomodulators, and corticosteroids.

Boolean operators were used to optimize retrieval:

1. Disease-specific terms were linked with “OR”
2. Treatment-related terms were linked with “OR”
3. The two groups were then combined using “AND”

The final search logic was: (Disease Concept Terms) AND (Treatment Concept Terms)

All article types were considered, including randomized controlled trials, prospective and retrospective cohort studies, case reports, and narrative and systematic reviews. Reference lists of key articles were manually screened to identify additional eligible studies. Non-English full texts without English abstracts were excluded.

Author Contribution

Zhiyun Xiao contributed to the conceptualization of the study and the development of the research framework. She conducted the comprehensive literature review, organized the analytical narrative, and was responsible for writing the original draft of the manuscript. She also participated in the refinement of the research questions and the alignment of the manuscript’s structure with the study’s objectives.

Nana Meng was primarily responsible for data curation, including the acquisition, organization, and verification of clinical and observational data. She prepared all tables and figures, ensured the accuracy of presented data, and assisted in revising the visual materials to reflect the study’s methodological and clinical insights.

Min Zhou provided supervision throughout the research process, offering methodological guidance and ensuring scientific rigor. He performed critical manuscript review and substantive editing, refining the logic, improving the clarity of the arguments, and ensuring compliance with ethical and academic standards. He also reviewed the final statistical interpretations and their consistency with the conclusions.

Chunhe Shi, as the corresponding author, oversaw the entire research workflow and ensured coordination among contributors. He conducted clinical validation, confirming that the study’s interpretations align with established ophthalmological evidence and clinical practice. He was responsible for final approval of the manuscript, verifying its accuracy, completeness, and readiness for submission, and assumed primary responsibility for responding to editorial queries and post-submission revisions.

All authors have reviewed the final version of the manuscript and agree to be accountable for all aspects of the work.

Compliance with Ethical Standards

This article is a narrative review based on previously published literature and does not involve any new studies with human participants or animals performed by any of the authors. Therefore, ethical approval and informed consent were not required.

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Competing Interest declaration

The author declare that, to their knowledge, they have no financial, personal, or professional relationships that could be construed as a potential competing interest regarding the work described in this manuscript.

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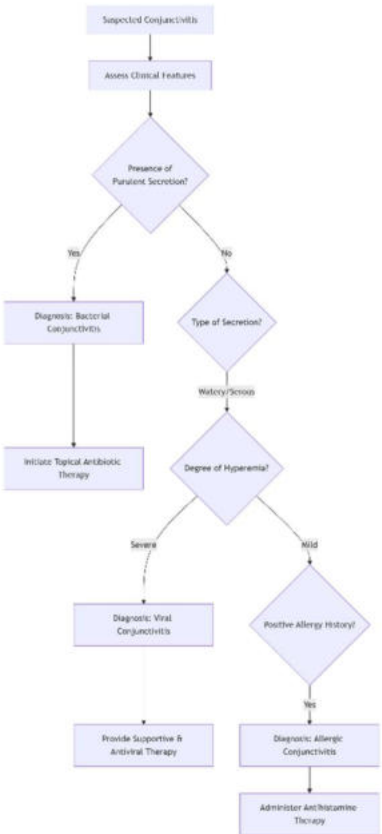
Appendices



As illustrated in Figure 1, the decision tree guides clinicians through a structured diagnostic algorithm beginning with the nature of ocular discharge. By stratifying cases into bacterial, viral, or allergic conjunctivitis based on secretion type and allergy history, the flowchart facilitates timely and precise treatment initiation, minimizing misdiagnosis and overtreatment.

Fig. 1. Diagnostic and therapeutic decision tree for conjunctivitis subtyping and treatment initiation based on ocular discharge and allergy history.

Table 1. Pharmacologic management strategies for bacterial, viral, and allergic conjunctivitis, categorized by therapeutic class, mechanism of action, and clinical considerations.

Conjunctivitis Subtype	First-Line / Common Therapies	Mechanism of Action	Key Considerations
Bacterial	• **Topical antibiotics:** Fluoroquinolones (e.g., moxifloxacin, besifloxacin), aminoglycosides (e.g., tobramycin) • **Systemic antibiotics** (for severe/hyperacute cases)	Eradication of causative bacteria	• Empirical broad-spectrum coverage is initially recommended. • Consider delayed prescription for mild cases to support antimicrobial stewardship. • Hyperacute cases (e.g., gonococcal) require immediate systemic therapy.
Viral	• **Supportive care:** Artificial tears, cold compresses • **Antiseptics:** Povidone-iodine (PVI) • **NSAIDs** (for inflammation)	Symptom relief and reduction of viral load	• No FDA-approved antivirals for EKC; PVI is commonly used off-label. • Antibiotics are not indicated unless secondary bacterial infection is suspected.
Allergic			
- Mild/Moderate	• **Dual-action antihistamines/mast cell stabilizers** (e.g., olopatadine, alcaftadine, epinastine)	Rapid relief of itching and redness; prevention of mast cell degranulation	First-line choice for most patients due to dual efficacy and convenience.
- Moderate/Severe	• **Topical corticosteroids** (short-term)	Potent suppression of immune and inflammatory response	• Use short-term for acute exacerbations due to risks of glaucoma and cataracts. • Immunomodulators are steroid-sparing agents for chronic, refractory cases.
- Refractory/Chronic	• **Immunomodulators:** Cyclosporine, tacrolimus • **Biologics** (e.g., anti-Siglec-8: Lirentelimab; investigational)	Targeted inhibition of specific immune pathways (e.g., eosinophils, mast cells)	Emerging therapies, many still under investigation; reserved for severe, treatment-resistant forms.

Table 1 summarizes the primary pharmacologic options across conjunctivitis subtypes, highlighting each agent's mechanism of action, clinical indications, and safety considerations. This framework supports rational drug selection aligned with both etiology and disease severity.