



## Ocular Burns: An Updated Review for Ophthalmologists, Nursing, Pharmacists, and Healthcare Workers.

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### Abstract:

**Background:** Ocular burns, whether thermal or chemical, represent a significant ophthalmic emergency with the potential for severe and lasting damage to vision and quality of life. Chemical burns, in particular, can cause progressive tissue damage, leading to complications such as corneal scarring, limbal stem cell deficiency, and permanent vision loss. The global incidence of ocular burns remains poorly understood, with alkali burns being more common than acid burns. Immediate and effective intervention is critical to minimizing long-term morbidity.

**Aim:** This review aims to provide an updated overview of the etiology, pathophysiology, epidemiology, and management of ocular burns for ophthalmologists, nurses, pharmacists, and healthcare workers such as security workers, health information, and medical records. It emphasizes the importance of timely intervention, multidisciplinary care, and patient education to improve outcomes.

**Methods:** The review synthesizes current literature on ocular burns, focusing on classification systems, diagnostic approaches, and evidence-based treatment strategies. It highlights the roles of various healthcare professionals in managing acute and chronic phases of ocular burns, including emergency decontamination, pharmacological interventions, and surgical rehabilitation.

**Results:** Early and aggressive irrigation is the cornerstone of acute management, with lactated Ringer's solution being the preferred irrigant. Topical corticosteroids, antibiotics, and cycloplegics are used to control inflammation and prevent infection. Severe cases may require surgical interventions such as amniotic membrane transplantation or limbal stem cell grafting. Prognosis depends on the extent of limbal ischemia and conjunctival involvement, with classification systems like Roper-Hall and Dua guiding treatment decisions.

**Conclusion:** Ocular burns require a multidisciplinary approach to optimize outcomes. Immediate decontamination, tailored pharmacological therapy, and timely surgical interventions are essential. Patient education and preventive measures, particularly in workplace settings, are crucial to reducing the incidence of ocular burns.

**Keywords:** Ocular burns, chemical burns, limbal ischemia, amniotic membrane transplantation, multidisciplinary care, patient education.

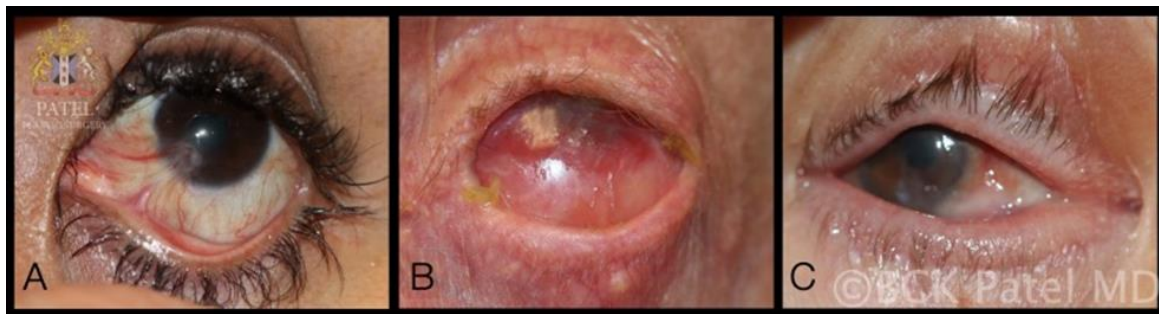
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## Introduction:

Acute ocular burns represent a significant ophthalmic emergency, requiring immediate medical attention due to their potential for severe and lasting damage. The extent of injury is determined by several critical factors, including the type of causative agent, the duration of exposure, the surface area of the eye affected, and the specific ocular tissues involved. Moderate to severe burns involving the eye and its surrounding structures, known as the ocular adnexa, often result in substantial morbidity and can lead to long-term consequences that profoundly affect both vision and quality of life. Among the most common sequelae of severe ocular burns are acute and chronic pain, scarring that may cause disfigurement, loss of normal function in the protective adnexa, and permanent vision impairment [1]. The permanent loss of vision, in particular, carries significant implications beyond the immediate physical damage. It is associated with an elevated risk of subsequent injuries, as well as the development of psychological conditions such as depression. Additionally, individuals with permanent vision loss are more likely to experience chronic health issues and face broader biopsychosocial challenges, including reduced independence and social functioning [2][3][4][5]. These outcomes underscore the importance of timely and effective intervention in cases of acute ocular burns to minimize both the immediate and long-term impacts. Furthermore, the multifaceted consequences of severe ocular burns highlight the need for comprehensive management strategies that address not only the physical damage but also the psychological and social well-being of affected individuals. Early diagnosis, appropriate treatment, and ongoing support are essential to improving outcomes and enhancing the quality of life for patients suffering from such injuries.



**Figure 1: Punctal stenosis caused by a chemical burn with conjunctival and lid margin mucocutaneous junction scarring.**

## Etiology:

Burns affecting the eye and ocular adnexa can be broadly classified into two primary categories: thermal and chemical. These categories differ significantly in their mechanisms of injury and the progression of damage immediately following exposure. Thermal burns result from exposure to heat energy, and the tissue damage typically ceases once the heat source is removed or loses its thermal energy. For instance, individuals escaping a house fire or sustaining flash burns from explosions or fireworks often experience thermal injuries. The blink reflex and the protective function of the ocular adnexa, particularly the eyelids, often result in the skin of the eyelids bearing the brunt of the damage in thermal injuries. Direct thermal burns to the ocular surface, such as those caused by hot water, hot cooking oil, curling irons, or flames from explosions or fires, usually result in superficial injuries due to the brief duration of contact. These types of burns can generally be managed similarly to other superficial corneal injuries, with a focus on supportive care and monitoring for complications [6]. In contrast, chemical burns to the eye demand more urgent and aggressive management. Unlike thermal burns, the tissue damage from chemical burns can persist and worsen as long as the chemical agent remains in contact with the ocular structures. This ongoing damage can penetrate deeper layers of the eye, necessitating immediate intervention to remove the offending agent

and halt further injury. Chemical burns often result from exposure to common household substances such as drain cleaners, oven cleaners, laundry or dish detergents, bleach, and ammonia. Industrial exposures to chemicals like fertilizers, acids, lye, lime, and cement also pose significant risks. Additionally, fireworks and explosions can cause both thermal and chemical injuries, complicating the clinical picture. In cases of blast injuries, there is an increased likelihood of full-thickness or penetrating injuries, as well as the potential for intraocular foreign bodies, which require thorough evaluation and management [7]. The distinction between thermal and chemical burns is critical for guiding appropriate treatment strategies. While thermal burns often result in superficial damage that can be managed expectantly, chemical burns necessitate prompt and aggressive intervention to prevent progressive injury and long-term complications. Understanding the etiology and mechanisms of these injuries is essential for optimizing patient outcomes and minimizing the risk of permanent visual impairment or other adverse sequelae.

### **Epidemiology:**

The global incidence of ocular burns remains poorly understood due to a lack of comprehensive data. Despite efforts to utilize existing datasets, significant gaps persist in understanding the worldwide prevalence and impact of ocular burns. The World Health Organization's Blindness Data Bank provides valuable information on penetrating eye injuries and eye injuries leading to blindness; however, it does not specifically address ocular chemical burns, leaving a critical void in the epidemiological understanding of this condition [8]. In the United States, insights into the scope of ocular burns have been partially derived from two key databases: the American Academy of Ophthalmology's IRIS® Registry (Intelligent Research in Sight) and The Nationwide Emergency Department Sample, which is part of the Healthcare Cost and Utilization Project. These databases have shed light on the prevalence and characteristics of ocular burns as a significant public health concern in the U.S. [9]. Ocular chemical burns account for approximately 11.5% to 22.1% of all eye injuries [10]. In 1999, around 280,000 work-related eye injuries were treated in U.S. emergency departments, with chemical burns being the second most common type of injury after ocular foreign bodies. Workers aged 20 to 34 were identified as the demographic at highest risk for sustaining such injuries [11]. Between 2010 and 2013, emergency departments in the U.S. treated 144,419 cases of chemical ocular burns, with a median patient age of 32 years. Notably, the highest rates of injury were observed among children aged 1 to 2 years, with 28.61 and 23.49 injuries per 100,000 population, respectively. However, these figures are primarily extrapolated from case series and have been criticized for their reliance on incomplete data, underscoring the need for more robust epidemiological studies to better understand the true burden of ocular chemical burns [12].

In terms of the types of chemical burns, alkali injuries appear to be more common than acid injuries, with one database reporting alkali burns at 53.6% compared to acid burns at 46.4% [1]. Some sources suggest that alkali burns occur nearly twice as frequently as acid burns. Ammonia-containing compounds are the most frequent cause of alkali burns, while sulfuric acid is the leading cause of acid burns [13]. These findings highlight the importance of understanding the specific agents involved in ocular chemical burns, as this knowledge can inform prevention strategies and guide clinical management. The lack of comprehensive global data on ocular burns, particularly chemical burns, represents a significant challenge in addressing this public health issue. Enhanced surveillance, standardized reporting, and targeted epidemiological research are essential to better understand the incidence, risk factors, and outcomes of ocular burns. Such efforts would not only improve prevention and treatment strategies but also help reduce the long-term visual and psychosocial consequences associated with these injuries.

### **Pathophysiology:**

The extent of acute tissue damage caused by ocular burns is influenced by several factors, including the chemical and physical properties of the causative agent, such as its pH, concentration, volume, temperature, and the force of impact, as well as its interaction with ocular tissues. Alkaline agents, which are lipophilic, possess a greater capacity to penetrate deeply into ocular structures compared to acidic agents. Alkaline burns induce liquefactive necrosis, a process in which the superficial tissues liquefy, allowing the chemical to infiltrate deeper layers and damage critical intraocular components such as the trabecular meshwork,

lens, and ciliary body. In contrast, acidic agents typically cause coagulation necrosis, which involves the denaturation of proteins in superficial tissues, thereby limiting their penetration. However, hydrofluoric acid is an exception to this pattern, as it can penetrate deeply and cause significant damage to anterior chamber structures. Despite these differences in mechanisms, both acidic and alkaline agents have the potential to cause severe and lasting damage to ocular tissues [14].

The pathophysiology and progression of ocular burns can be categorized into distinct clinical phases. One proposed classification divides the disease course into four phases: immediate, acute (0 to 7 days), early reparative (7 to 21 days), and late reparative (beyond 21 days) [15]. Alternatively, for simplicity, some clinicians classify the management of chemical ocular injuries into three phases: immediate, acute (less than 6 weeks), and chronic (beyond 6 weeks) [14]. Following the initial injury, the focus of management shifts to minimizing inflammation and promoting re-epithelialization of the ocular surface. Several factors can impede the healing process, including limbal and conjunctival ischemia, persistent inflammation, exposure of the ocular surface due to adnexal burns, and elevated intraocular pressure. These complications must be carefully managed to facilitate recovery. For instance, limbal ischemia can compromise the stem cell population essential for corneal regeneration, while persistent inflammation can lead to scarring and further tissue damage. Elevated intraocular pressure, often resulting from damage to the trabecular meshwork, can exacerbate injury and delay healing. Effective therapeutic and surgical interventions tailored to the underlying pathophysiology are critical during these phases and will be discussed in detail in the treatment and management section. Understanding the pathophysiology of ocular burns is essential for guiding appropriate clinical interventions. By addressing the specific mechanisms of tissue damage and the factors that hinder healing, clinicians can develop targeted strategies to mitigate the long-term consequences of these injuries and improve patient outcomes.



**Figure 2: Digital slit lamp image of the patient with ocular chemical burn with lime depicting matted lashes, diffuse conjunctival congestion, blanching, stromal edema and inferior limbal stem cell deficiency.**

### **History and Physical:**

The initial evaluation of a patient with ocular burns, whether in the prehospital or hospital setting, must prioritize addressing any immediate life-threatening conditions while ensuring the safety of healthcare providers. The primary focus should be on assessing and stabilizing the patient's airway, breathing, and circulation (ABCs). Once the ABCs have been evaluated and no immediate interventions are required, the clinical team can proceed with a more detailed assessment of the injury. If the patient is conscious and has a normal mental status, attention can shift to evaluating the extent of exposure to the chemical agent(s). While continuing decontamination procedures, it is essential to gather specific information about the nature of the chemical exposure, including the type of agent involved, the duration of exposure, and the circumstances surrounding the incident. Concurrently, the care team can collect additional patient-specific

details, such as medical history, current medications, allergies, surgical history, and the time of the last meal, as ocular irrigation is initiated. Following stabilization and the commencement of irrigation, further investigation into the properties of the chemical agent(s) can be conducted using resources such as Safety Data Sheets (SDS) and consultation with The Poison Control Center, which provide critical information for the acute management of chemical exposures.

After thorough irrigation of the eyes and associated structures, the pH of the ocular surface should be measured using litmus paper to ensure it has returned to a neutral range (7.0 to 7.2). Once neutralization is confirmed, the clinical team can proceed with a detailed assessment of the extent of ocular surface and adnexal involvement. Visual acuity should be evaluated at this stage, if possible. However, significant pain due to exposure of superficial ocular nerves may cause blepharospasm, limiting the patient's ability to cooperate. In such cases, the application of a topical ocular anesthetic may be necessary to facilitate a comprehensive examination. Biomicroscopy (slit lamp evaluation) is a critical component of the assessment, with particular attention paid to the extent of limbal and conjunctival/episcleral ischemia, corneal clarity, and the total surface area affected. To accurately assess the surface area involvement, the eye should be stained with an agent such as sodium fluorescein, which highlights areas of epithelial damage. The severity and extent of tissue involvement have significant prognostic value and guide subsequent management decisions [14]. During the slit lamp examination, the clinician should carefully evaluate signs of ocular perforation, such as a shallow anterior chamber or extrusion of intraocular contents. If there is no evidence of a ruptured globe, intraocular pressure (IOP) can be safely measured. Elevated IOP may indicate damage to the trabecular meshwork or other intraocular structures, necessitating further intervention. The findings from the history and physical examination, combined with the results of diagnostic tests, provide a comprehensive understanding of the injury's severity and guide the development of an individualized treatment plan. This systematic approach ensures that both immediate and long-term complications are addressed effectively, optimizing patient outcomes.

#### **Evaluation:**

In most cases of ocular burns, imaging studies are not routinely required for diagnosis or management. However, if the mechanism of injury suggests the possibility of an intraocular foreign body—such as in blast injuries or explosions—computed tomography (CT) imaging of the orbits may be warranted. CT imaging is particularly useful for detecting metallic or radiopaque foreign bodies and assessing the extent of orbital or ocular damage. The decision to pursue further imaging should be guided by the patient's history, physical examination findings, and clinical suspicion of associated injuries. For example, in cases of severe trauma or suspected globe rupture, imaging may help rule out additional complications, such as orbital fractures or intracranial involvement. The primary focus of evaluation in ocular burns remains the clinical assessment, including slit lamp examination and measurement of intraocular pressure (if no globe rupture is suspected). Staining the ocular surface with sodium fluorescein is essential to evaluate the extent of epithelial damage and identify areas of corneal or conjunctival involvement. Additionally, assessing limbal ischemia, corneal clarity, and conjunctival/episcleral damage provides valuable prognostic information. While imaging is not typically a first-line tool for ocular burns, it plays a critical role in specific scenarios where the mechanism of injury or clinical findings suggest more complex or penetrating trauma. A thorough and systematic evaluation ensures that all potential complications are identified and addressed promptly, optimizing patient outcomes.

#### **Treatment / Management:**

The management of chemical ocular burns begins with immediate and thorough decontamination of the ocular surface and surrounding adnexa. Simultaneous decontamination of other affected body areas, particularly the oropharynx, is essential to prevent inhalational injuries. Contaminated clothing should be removed and discarded, and care must be taken to avoid exposing healthcare providers to harmful substances during the decontamination process. In the prehospital setting, if commercially prepared sterile irrigating or amphoteric solutions are available, they can be used for initial ocular lavage. However, tap water is often the only accessible option and, despite its hypotonicity relative to the cornea, which may

exacerbate corneal edema, it remains a suitable emergency irrigating solution due to its immediate availability [16]. The timing of decontamination is critical, and treatment should never be delayed, regardless of the irrigating solution used [14]. Upon arrival at the hospital, continuous ocular irrigation must be initiated until the pH of the ocular surface is neutralized to a range of 7.0 to 7.2. The volume of irrigation required varies depending on the severity of the injury, with mild burns typically needing around 2 liters and severe burns potentially requiring up to 10 liters. Irrigation should continue for at least 30 minutes, though severe injuries may necessitate 2 to 4 hours of continuous lavage. Alkali burns generally require more extensive irrigation than acid burns due to their deeper penetration. Lactated Ringer's solution is commonly used in hospital settings due to its availability and compatibility with ocular tissues, although other solutions such as 0.9% sodium chloride (normal saline) or balanced salt solutions are also effective. Topical anesthesia can enhance patient comfort and compliance during prolonged irrigation procedures.

Once irrigation is complete and the ocular surface pH is neutralized, any residual particulate matter must be meticulously removed to prevent ongoing inflammation. Special attention should be given to the superior fornix, which can be thoroughly examined using single or double eyelid eversion. In cases of lime injuries, particularly in children or uncooperative adults, an examination under anesthesia may be necessary to ensure complete removal of particulate matter and adequate evaluation of the ocular surface [17]. For severe eyelid burns, escharotomy may be required to facilitate eyelid closure and prevent exposure-related complications such as corneal drying and infection. Effective management of chemical ocular burns requires a systematic approach that prioritizes immediate decontamination, thorough irrigation, and meticulous removal of particulate matter. These steps, combined with appropriate follow-up care, are essential to minimize long-term complications and optimize visual outcomes.

### **Management During the Acute and Early Reparative Phases:**

The management of ocular burns during the acute phase (days 0 to 7) and early reparative phase (days 8 to 21) focuses on suppressing inflammation, promoting re-epithelialization of the ocular surface, and preventing complications. The severity of the injury determines the frequency of patient evaluations and the intensity of treatment. For mild injuries, treatment may involve the use of topical antibiotic ointments and preservative-free artificial tears to maintain ocular surface lubrication and prevent infection. However, more severe injuries require close monitoring for complications such as ocular surface exposure due to adnexal scarring, corneal or stromal thinning, and elevated intraocular pressure (IOP). Topical corticosteroids are a cornerstone of therapy during the acute phase, as they effectively reduce inflammation, which is a major barrier to healing. However, their use must be carefully monitored to avoid complications such as increased IOP or delayed epithelial healing. Topical cycloplegic agents, such as atropine or cyclopentolate, are often added to the regimen to alleviate pain caused by ciliary spasm and to reduce the risk of synechiae formation. Systemic pain medications may also be necessary to manage discomfort during the acute phase. Preservative-free artificial tears are used throughout all stages of healing to maintain ocular surface hydration and support epithelial recovery.

Systemic medications, such as tetracyclines (e.g., doxycycline 20 to 50 mg PO twice daily) and vitamin C (1,000 mg PO daily), are often prescribed to promote wound healing. Tetracyclines have anti-inflammatory and collagenase-inhibiting properties, while vitamin C supports collagen synthesis and tissue repair. For infection prophylaxis, preservative-free topical antibiotics are preferred. Aminoglycosides, such as gentamicin and tobramycin, should be avoided due to their toxicity to the corneal epithelium. Erythromycin ophthalmic ointment is a well-tolerated and widely available alternative for initial infection prophylaxis. Elevated IOP is a common complication in ocular burns and can impair corneal healing during the acute and early reparative phases. Medications to lower IOP, such as topical beta-blockers, alpha-agonists, or carbonic anhydrase inhibitors, may be required. Chronically elevated IOP can lead to optic nerve damage and glaucomatous vision loss, making aggressive management essential. For more severe burns, specialized therapies may be necessary. Topical biologics, such as autologous serum drops or platelet-rich plasma, can promote epithelial healing and provide essential growth factors. Bandage contact lenses are useful for managing corneal epithelial defects and alleviating pain from exposed corneal nerves. However, when using

bandage contact lenses, antibiotic prophylaxis against *Pseudomonas* is critical to prevent infection. In cases of severe burns, early amniotic membrane transplantation (AMT) is recommended, ideally within the first week, to promote healing and reduce inflammation. Tenonplasty may also be considered in cases of severe scleral melting or ischemia to support re-epithelialization [13][19].

### **Management During the Late Reparative Phase:**

The late reparative phase (beyond 21 days) focuses on controlling residual inflammation, rehabilitating the ocular surface, and reconstructing damaged structures. Conjunctival limbal autograft (CLAU) may be performed to restore limbal stem cells, which are essential for maintaining a healthy corneal epithelium. This procedure provides a foundation for subsequent keratoplasty, which is performed to improve visual function by replacing scarred corneal tissue. The type of keratoplasty—such as penetrating keratoplasty (PK) or deep anterior lamellar keratoplasty (DALK)—depends on the depth and extent of corneal scarring. In cases of persistent ocular surface exposure, symblepharon release and forniceal reconstruction may be necessary to restore normal eyelid function and protect the cornea. Lid reconstruction may also be required for cosmetic or functional reasons. These surgical interventions aim to improve both visual outcomes and the patient's quality of life [13][14]. In summary, the management of ocular burns requires a tailored, multidisciplinary approach that evolves with the phase of injury. Early interventions focus on reducing inflammation, promoting epithelial healing, and preventing complications, while later stages emphasize rehabilitation and surgical reconstruction to restore visual function and ocular surface integrity.

### **Differential Diagnosis:**

A red, painful eye can result from various conditions, requiring careful differentiation to ensure appropriate management. Several serious conditions must be considered, including intraocular foreign body, ruptured globe, corneal or scleral laceration, corneal abrasion, infectious keratoconjunctivitis, uveitis, and superficial ocular foreign body. A detailed history and thorough physical examination are critical in distinguishing between these causes. An intraocular foreign body typically presents with acute pain, photophobia, and blurred vision, often with a history of high-velocity trauma. A ruptured globe, a severe ophthalmic emergency, may exhibit signs such as decreased visual acuity, irregular pupil shape, and extrusion of ocular contents. Corneal and scleral lacerations also present with pain and reduced vision but may show a clear entry wound with or without foreign material embedded in the cornea or sclera. Corneal abrasions, common in contact lens wearers and trauma cases, result in sharp pain, photophobia, and tearing, with fluorescein staining revealing epithelial defects. Infectious keratoconjunctivitis, often caused by viral or bacterial pathogens, leads to conjunctival hyperemia, discharge, and, in bacterial cases, mucopurulent exudate. Uveitis, associated with systemic inflammatory diseases, presents with pain, photophobia, and a perilimbal flush. Superficial ocular foreign bodies cause localized irritation, foreign body sensation, and excessive tearing. Chemical ocular injury, a distinct category, requires immediate differentiation. A thorough history regarding exposure to chemicals, the time of injury, and the type of agent involved is essential. Physical findings may include conjunctival blanching, corneal opacification, and persistent pain. Immediate irrigation is crucial in these cases. Accurate differentiation among these conditions is essential for effective management. Timely intervention can prevent complications and preserve vision.

### **Prognosis:**

The prognosis of ocular burns is closely tied to the severity of the injury, which can be assessed using two established classification systems: the Roper-Hall and Dua classification systems. These tools help clinicians evaluate the extent of damage and predict outcomes based on early clinical findings. The Roper-Hall classification, introduced in 1965, grades ocular burns from I to IV based on two key factors: corneal clarity and the degree of limbal ischemia. Grade I injuries, characterized by clear corneas and no limbal ischemia, have the best prognosis, while Grade IV injuries, marked by opaque corneas and extensive limbal ischemia, carry the poorest prognosis. The Dua classification, published in 2001, uses a more detailed approach, grading injuries from I to VI based on the number of limbal clock hours involved and the percentage of conjunctival involvement. Similar to the Roper-Hall system, higher grades in the Dua classification indicate more severe injuries and worse prognoses [14].



While these classification systems were developed decades apart, they remain valuable tools for assessing injury severity and guiding treatment decisions. However, it is important to note that advancements in medical and surgical management have improved outcomes for patients with ocular burns since these systems were introduced. Despite these improvements, certain clinical features remain strongly associated with poor prognoses. A hazy or opaque cornea, extensive limbal ischemia, and significant conjunctival involvement are all indicators of a more guarded prognosis. Limbal ischemia, in particular, is a critical factor, as it reflects damage to the limbal stem cells, which are essential for maintaining a healthy corneal epithelium. The extent of limbal ischemia may not be immediately apparent during the initial examination, as blanching of limbal vessels can be subtle. Frequent reassessments using staining techniques, such as sodium fluorescein, are often necessary to accurately evaluate the degree of ischemia [13]. Severe limbal ischemia increases the risk of conjunctivalization of the cornea, a condition in which the corneal surface becomes covered by conjunctival-like tissue. This process leads to corneal opacification, vascularization, and impaired vision. Conjunctivalization is a significant complication that underscores the importance of early and aggressive management to preserve limbal stem cell function and prevent long-term visual impairment [20]. In summary, the prognosis of ocular burns depends on the severity of the injury, particularly the extent of limbal ischemia and conjunctival involvement. While classification systems like Roper-Hall and Dua provide a framework for assessing prognosis, ongoing advancements in treatment continue to improve outcomes for patients with ocular burns. Early and accurate assessment, combined with timely intervention, remains critical to optimizing visual recovery and minimizing complications.

### **Complications:**

Complications of ocular injuries and infections can lead to significant morbidity, including permanent vision loss. Infectious keratitis, a severe corneal infection, is a primary concern following trauma, contact lens misuse, or ocular surface disease. It can lead to corneal ulceration, scarring, and vision impairment if not promptly treated with appropriate antimicrobial therapy. Glaucoma, another serious complication, can develop due to increased intraocular pressure following ocular trauma, uveitis, or chemical burns. Secondary glaucoma from inflammation or steroid use may result in irreversible optic nerve damage. Corneal or stromal melting and perforation occur in severe infections, inflammatory conditions, or chemical burns. Progressive tissue degradation can lead to corneal thinning and rupture, necessitating urgent surgical intervention, such as corneal transplantation or tectonic grafting. Permanent vision loss may result from direct damage to ocular structures, scarring, or complications like glaucoma and retinal detachment. Chronic inflammation and pain, common in uveitis or persistent corneal injury, can severely affect quality of life and require long-term management with anti-inflammatory medications. Sympathetic ophthalmia, a rare but serious bilateral granulomatous uveitis, may develop after penetrating ocular trauma or surgery. If untreated, it can lead to blindness in both eyes. Hypotony, or low intraocular pressure, may arise from ciliary body dysfunction, globe rupture, or chronic inflammation, leading to phthisis bulbi, a shrunken, non-functional eye. Cataracts can form due to ocular trauma, prolonged inflammation, or corticosteroid use. In advanced cases, surgical removal may be necessary to restore vision. Early recognition and intervention are essential to minimize complications and preserve ocular function [21].

### **Consultation:**

Consultation with ophthalmology is essential in all cases of acute chemical burns to the eye or ocular adnexa. Immediate evaluation by an ophthalmologist ensures proper assessment of corneal damage, intraocular pressure, and the extent of limbal ischemia. Ophthalmologic management includes aggressive irrigation, topical medications, and possible surgical intervention such as amniotic membrane grafting or limbal stem cell transplantation for severe injuries. Plastic surgery consultation may be required for extensive periocular or facial burns that involve eyelid function. Eyelid contracture or cicatricial changes can lead to exposure keratopathy and require surgical correction to preserve vision and ocular surface integrity. Ear, nose, and throat (ENT) specialists may need to evaluate cases where chemical exposure has affected the nasal passages, sinuses, or airway. Inhalation injuries from chemical burns, especially in industrial accidents, can cause significant respiratory complications requiring specialized management. Oral and maxillofacial surgery (OMFS) consultation is necessary when chemical burns extend to the oral



cavity, affecting the lips, mucosa, or teeth. Severe burns may lead to tissue necrosis, requiring debridement or reconstructive procedures. A multidisciplinary approach is essential for comprehensive management. Early involvement of appropriate specialists can help minimize long-term complications and improve functional and aesthetic outcomes [21].

### **Patient Education:**

Patient education is crucial in preventing chemical eye injuries both at home and in the workplace. In the home, parents and caregivers must store hazardous chemicals, such as cleaning agents and industrial solvents, in secure, childproof locations. Proper labeling and safe storage can reduce accidental exposure. Healthcare providers should emphasize the importance of supervising young children and using safety locks on cabinets containing harmful substances. In the workplace, employees must use appropriate personal protective equipment (PPE), including safety goggles, face shields, and gloves when handling chemicals. Employers should ensure that all workers receive training on the specific chemicals they use, including their potential hazards and first-aid measures in case of exposure. Clear labeling of hazardous substances and adherence to safety protocols are essential in minimizing risk. Workplaces dealing with hazardous chemicals must have readily accessible onsite decontamination stations, such as emergency eyewash stations and safety showers. Workers should be trained on their locations and proper usage to ensure rapid response in an emergency. Regular drills and periodic hazardous materials training should reinforce decontamination procedures and chemical safety protocols. For both home and workplace settings, individuals should be aware of first-aid measures, including immediate and prolonged eye irrigation in case of chemical exposure. Prompt medical evaluation following exposure is necessary to assess ocular damage and prevent complications. Educating the public and workers on chemical safety and emergency response can significantly reduce the incidence and severity of chemical eye injuries [21].

### **Other Issues:**

The most critical issue in managing chemical eye injuries is ensuring immediate and thorough irrigation. Inadequate irrigation allows the chemical to continue damaging ocular tissues, leading to worse outcomes. The primary goal is to normalize the ocular pH as quickly as possible, typically using copious amounts of isotonic saline or lactated Ringer's solution. Delayed or insufficient irrigation increases the risk of corneal damage, stromal necrosis, and vision loss. Failure to remove particulate matter, especially from the superior fornix, is another major pitfall. Residual chemicals trapped in the conjunctival sac can cause ongoing inflammation, delayed healing, and further corneal injury. Careful eversion of the eyelids and manual removal of any debris using a moistened cotton swab or forceps is essential. Using a commercially available irrigation lens, such as a Morgan lens, allows for continuous, hands-free irrigation and ensures even distribution of the fluid across the ocular surface. If an irrigation lens is unavailable, a healthcare provider must manually perform continuous irrigation while monitoring the patient. Adequate irrigation should continue for at least 15-30 minutes or until the ocular pH normalizes, with repeated pH checks using litmus paper. Topical anesthesia is necessary for effective irrigation and examination. Without proper pain control, the patient may resist treatment, leading to incomplete decontamination. Proparacaine or tetracaine drops should be used before irrigation to reduce discomfort and facilitate thorough cleansing of the eye. Early and aggressive management significantly improves outcomes by reducing chemical exposure time and preventing long-term complications [21].

### **The Role of Nurses in the Management of Ocular Burns:**

Nurses play a pivotal role in the multidisciplinary care of patients with ocular burns, contributing to both acute management and long-term rehabilitation. Their responsibilities span across various stages of care, including initial assessment, emergency intervention, patient education, and ongoing support. In the acute phase, nurses are often the first healthcare providers to encounter patients with ocular burns, making their role in initial assessment and stabilization critical. They must quickly evaluate the patient's overall condition, prioritize life-threatening issues, and initiate immediate decontamination procedures. This includes thorough irrigation of the affected eye(s) to neutralize the pH and remove harmful chemical agents. Nurses must ensure that irrigation is performed efficiently and safely, minimizing the risk of further injury

or contamination to the patient or healthcare team. During the acute and early reparative phases, nurses are responsible for administering prescribed medications, such as topical antibiotics, corticosteroids, and cycloplegic agents, while monitoring adverse effects. They also play a key role in assessing pain levels and providing appropriate pain management, which may include administering systemic analgesics or assisting with the application of topical anesthetics. Nurses must closely monitor patients for complications such as elevated intraocular pressure (IOP), corneal thinning, or signs of infection, promptly reporting any concerns to the ophthalmologist. Their ability to recognize early warning signs of complications is essential for preventing long-term visual impairment. Patient education is another critical aspect of nursing care in ocular burns. Nurses educate patients and their families about the importance of adhering to prescribed treatments, such as the proper application of eye drops or ointments, and the need for frequent follow-up visits. They also provide guidance on protective measures to prevent further injury, such as wearing eye protection in hazardous environments. In cases of severe burns, nurses may assist in coordinating specialized treatments, such as amniotic membrane transplantation or referral to a corneal specialist. Beyond the acute phase, nurses support patients through the rehabilitation process, addressing both physical and emotional challenges. They help patients adapt to vision loss or changes in visual function, providing resources for low-vision aids or counseling services. By offering compassionate, patient-centered care, nurses significantly contribute to improving outcomes and enhancing the quality of life for individuals with ocular burns.

### **Role of Pharmacists:**

Pharmacists play a crucial role in the management of ocular burns by providing immediate guidance on first-aid measures, ensuring the availability of appropriate medications, and contributing to long-term patient care. Their expertise in pharmacotherapy allows them to support both emergency and follow-up treatment, minimizing complications and optimizing outcomes. In the acute phase, pharmacists educate patients and healthcare providers on the importance of immediate and thorough irrigation with sterile isotonic solutions such as normal saline or lactated Ringer's. They ensure that emergency departments and workplaces have adequate supplies of these irrigation solutions and specialized devices, such as Morgan lenses, to facilitate continuous flushing. Pharmacists also advise on the use of topical anesthetics, such as proparacaine, to alleviate pain and facilitate effective decontamination. Following initial stabilization, pharmacists assist in selecting appropriate medications for pain relief, infection prevention, and inflammation control. They recommend antibiotic eye drops, such as fluoroquinolones, to reduce the risk of secondary infections, particularly in cases of epithelial disruption. For inflammation management, they guide the use of topical corticosteroids while monitoring adverse effects, such as delayed wound healing or increased intraocular pressure. Additionally, pharmacists counsel patients on the proper use of preservative-free artificial tears to prevent ocular surface dryness and promote healing. In cases of severe ocular burns, pharmacists collaborate with ophthalmologists to manage complications such as corneal melting, secondary glaucoma, and uveitis. They ensure the appropriate use of systemic medications, including oral acetazolamide for intraocular pressure control and immunosuppressive agents in cases of severe inflammation. Furthermore, pharmacists play a role in patient education, emphasizing adherence to prescribed medications, proper eye drop administration techniques, and the importance of follow-up care. Beyond individual patient management, pharmacists contribute to public health initiatives by promoting workplace safety measures, ensuring access to personal protective equipment (PPE), and advocating for regular hazardous materials training. Their role extends to research on novel pharmacological treatments for chemical eye injuries, contributing to advancements in ocular burn management. Through their involvement in emergency care, pharmacotherapy, patient education, and public health, pharmacists play a vital role in improving outcomes for individuals affected by ocular burns.

### **Role of Healthcare informatics, Medical Records, Healthcare Security Workers:**

#### **Healthcare Informatics:**

Healthcare informatics plays a crucial role in managing ocular burns by improving data collection, analysis, and decision-making. Electronic health records (EHRs) ensure that patient data, including ocular injury

history, treatment protocols, and medication administration, are accurately documented and easily accessible. Clinical decision support systems (CDSS) assist healthcare providers in selecting evidence-based treatments, ensuring timely interventions. Telemedicine enables remote consultations with ophthalmologists, allowing prompt assessment and management of chemical burns, particularly in areas with limited specialist availability. Data analytics help identify trends in ocular burn cases, supporting preventive strategies and resource allocation.

### **Medical Records:**

Accurate medical records are essential for the effective management of ocular burns. Documentation of initial injury severity, treatment provided, and patient progress ensures continuity of care. Medical records facilitate communication between emergency teams, ophthalmologists, pharmacists, and rehabilitation specialists, reducing treatment delays and errors. They also play a key role in medicolegal cases by providing a detailed account of injury management and patient outcomes. Standardized documentation improves research efforts on ocular burns, contributing to advancements in treatment protocols and preventive measures.

### **Healthcare Security Workers:**

Healthcare security workers contribute to ocular burn management by ensuring the safety of hospital environments, enforcing chemical handling protocols, and responding to emergencies. In industrial or laboratory settings, they play a role in enforcing hazardous material regulations, ensuring that emergency eyewash stations and personal protective equipment (PPE) are available and functional. During chemical exposure incidents, security personnel assist in directing patients to appropriate medical care, managing crowd control, and coordinating with emergency response teams. Their role in workplace safety training helps prevent accidental chemical exposures, reducing the incidence of ocular burns. By integrating healthcare informatics, accurate medical records, and security measures, healthcare systems enhance the prevention, management, and treatment of ocular burns, improving patient outcomes and workplace safety.

### **Conclusion:**

Ocular burns, particularly chemical injuries, pose a significant threat to vision and overall quality of life. The severity of these injuries depends on factors such as the type of chemical, duration of exposure, and extent of ocular tissue involvement. Alkali burns, due to their deep penetration and liquefactive necrosis, are often more devastating than acid burns, which typically cause coagulation necrosis. Immediate and thorough irrigation is the most critical step in managing chemical ocular burns, as it halts further tissue damage and neutralizes the pH of the ocular surface. Lactated Ringer's solution is widely recommended for irrigation due to its compatibility with ocular tissues. The management of ocular burns is multifaceted, involving acute, reparative, and chronic phases. In the acute phase, the focus is on decontamination, inflammation control, and prevention of complications such as infection and elevated intraocular pressure. Topical corticosteroids, antibiotics, and cycloplegics are commonly used, while systemic medications like vitamin C and tetracyclines support tissue repair. Severe cases may require advanced interventions such as amniotic membrane transplantation or limbal stem cell grafting to promote healing and restore ocular surface integrity. Prognosis is closely tied to the extent of limbal ischemia and conjunctival involvement, with classification systems like Roper-Hall and Dua providing valuable guidance. Early recognition of severe injuries and timely intervention are crucial to improving outcomes. However, despite advancements in treatment, ocular burns can still lead to permanent vision loss, underscoring the importance of preventive measures. Patient education plays a pivotal role in reducing the incidence of ocular burns, particularly in workplace and home settings. Proper storage of hazardous chemicals, use of personal protective equipment, and access to emergency eyewash stations are essential preventive strategies. Healthcare professionals, including nurses and pharmacists, are integral to both acute management and long-term rehabilitation, ensuring that patients receive comprehensive care. In conclusion, ocular burns demand a multidisciplinary approach that combines immediate decontamination, evidence-based pharmacological therapy, and surgical interventions when necessary. By prioritizing early intervention, patient education, and preventive measures, healthcare providers can mitigate the devastating consequences of ocular burns.

and improve patient outcomes. Continued research and advancements in treatment protocols will further enhance the management of this challenging condition.

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## الملخص

**الخلفية:** تمثل الحروق العينية، سواء كانت حرارية أو كيميائية، حالة طارئة خطيرة في طب العيون مع احتمالية حدوث أضرار دائمة في الرؤية ونوعية الحياة. تؤدي الحروق الكيميائية، بشكل خاص، إلى تلف الأنسجة التدريجي، مما قد ينتج عنه مضاعفات مثل تندب القرنية، نقص الخلايا الجذعية الحوفية، وفقدان دائم للبصر. لا تزال معدلات الإصابة بالحروق العينية عالميًا غير مفهومة بشكل كافٍ، مع كون الحروق القلوية أكثر شيوعًا من الحروق الحمضية. يعد التدخل الفوري والفعال ضروريًا للحد من المضاعفات طويلة الأمد.

**الهدف:** تهدف هذه المراجعة إلى تقديم نظرة محدثة حول أسباب الحروق العينية، وآلياتها المرضية، وانتشارها، وأساليب إدارتها، موجة لأطباء العيون والممرضين والصيادلة والعاملين في الرعاية الصحية مثل الامن الصحي والعاملين في السجلات والإدارة الصحية. تؤكد المراجعة على أهمية التدخل السريع، الرعاية متعددة التخصصات، وثقافة المرضى لتحسين النتائج العلاجية.

**الأساليب:** تعتمد هذه المراجعة على تحليل الأدبيات الحديثة المتعلقة بالحروق العينية، مع التركيز على أنظمة التصنيف، وطرق التشخيص، والاستراتيجيات العلاجية المستندة إلى الأدلة. كما تسلط الضوء على دور مختلف المتخصصين في الرعاية الصحية في التعامل مع المراحل الحادة والمزمنة للحروق العينية، بما يشمل إزالة التلوث الطارئة، التدخلات الدوائية، والتأهيل الجراحي.

**النتائج:** تعد الري المبكر والمكثف بالحلل الفسيولوجية، مثل محلول رينجر الالكتاتني، الركيزة الأساسية في العلاج الحاد. تُستخدم الكورتيكوستيرويدات الموضعية، والمضادات الحيوية، وموسعات الحدقة للسيطرة على الالتهاب ومنع العدوى. قد تتطلب الحالات الشديدة تدخلات جراحية مثل زراعة الغشاء الأمنيوسي أو زراعة الخلايا الجذعية الحوفية. يعتمد التشخيص على مدى نقص تروية الجوف ومدى تأثير المتحمة، حيث تساعد أنظمة التصنيف مثل رويبر-هال ودوا في توجيه القرارات العلاجية.

**الاستنتاج:** تتطلب الحروق العينية نهجًا متعدد التخصصات لتحقيق أفضل النتائج. يعد التطهير الفوري، والعلاج الدوائي المخصص، والتدخلات الجراحية في الوقت المناسب ضروريًا. كما أن تثقيف المرضى واتخاذ تدابير وقائية، خاصة في بيئات العمل، أمران أساسيان للحد من معدلات الإصابة بالحروق العينية.

**الكلمات المفتاحية:** الحروق العينية، الحروق الكيميائية، نقص تروية الجوف، زراعة الغشاء الأمنيوسي، الرعاية متعددة التخصصات، تثقيف المرضى.