American College of Occupational and Environmental Medicine

Eye Disorders

Effective Date: April 1, 2017

Contributors

Editor-in-Chief:
Kurt T. Hegmann, MD, MPH, FACOEM, FACP

Evidence-based Practice Eye Panel Chair:
Bernard R. Blais, MD, FAAO, FACOEM, FACS

Evidence-based Practice Eye Panel Members:
Panel members represent expertise in ophthalmology, optometry, occupational medicine, medical toxicology (preventive medicine), and law. Identities are blinded for external peer-review.

Methodology Committee Consultant:
Kurt T. Hegmann, MD, MPH, FACOEM, FACP

Research Conducted By:
Kurt T. Hegmann, MD, MPH, FACOEM, FACP
Jeremy J. Biggs, MD MSPH
Kristine Hegmann, MSPH, CIC
Matthew A. Hughes, MD, MPH
Matthew S. Thiese, PhD, MSPH
Ulrike Ott, PhD, MSPH
Atim C. Effiong, MPH
Brenden Ronna
Leslie Cepeda Echeverria
Dillon Fix
Austen James Knudson
Jeremiah Lafayette Dortch
Zachary Cooper Arnold
Alzina Koric
Ninoska De Jesus
Katherine Anne Schwei
Louise Juliet

Specialty Society and Society Representative Listing:
ACOEM acknowledges the following organizations and their representatives who served as reviewers of the "Eye Disorders Guideline." Their contributions are greatly appreciated. By listing the following individuals or organizations, it does not infer that these individuals or organizations support or endorse the eye treatment guidelines developed by ACOEM. An additional organization wished to remain anonymous.

American Association of Occupational Health Nurses

Kim Olszewski, DNP, CRNP, COHN-S/CM, FAAOHN

American College of Emergency Physicians
Charles J. Gerardo, MD, MHS
Richard D. Shih, MD

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	NSAID Drops for Thermal Ocular Burns	Recommended, Insufficient Evidence (I)
	NSAID Drops for Welder's Flash	Recommended, Insufficient Evidence (I)
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Test/Procedure/Treatment	Details	Recommendation
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	Peripheral Vision Screening for Select Postoperative Examinations	Recommended, Evidence (I)
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Overview

The Eye Disorders treatment guideline is designed to provide health care providers with evidence-based guidance on the treatment of working-age adults with potentially work-related eye disorders, whether acute, subacute, chronic, or postoperative. While the primary patient population target is working-age adults, the principles may apply more broadly.

This treatment guideline discusses the initial assessment and diagnosis of patients with eye injuries and disorders that are potentially work-related, identification of red flags that may suggest the presence of a serious underlying medical condition, initial management, diagnostic considerations and special studies to identify clinical pathology, work-relatedness, modified duty and activity, and return to work, as well as further management considerations including delayed recovery. Algorithms for patient management are also included and schematize how to generally manage eye disorders. This guideline does not address certain eye disorder categories such as congenital disorders or malignancies. It also does not address specific intraoperative procedures. For those patients with allergies who also have work-related asthma, the Occupational/Work-Related Asthma Guideline may be of assistance. This includes recommendations on exposure management of sensitizer-induced asthma, irritant-induced asthma, and criteria for removal from exposure.

The objectives of this guideline include baseline evaluations, diagnostic tests and imaging, return to work, medications, patching, injections, and operative procedures. Comparative effectiveness is addressed where available. To be more inclusive, this guideline includes some disorders that may not be considered work-related by certain jurisdictions. It excludes disorders that are considered to be entirely nonoccupational. It is recognized that there are differences in workers' compensation systems [1] and regional differences in treatment approaches.[2-4]

The Evidence-based Practice Eye Panel and the Research Team have complete editorial independence from the American College of Occupational and Environmental Medicine and Reed Group, neither of which influenced the guidelines. The literature is routinely monitored and searched at least annually for evidence that would overturn this guidance. The guideline is planned to be comprehensively updated at least every five years, or more frequently should evidence require it.

A detailed methodology document used for guideline development including evidence selection, scoring, incorporation of cost considerations,[5, 6] and formulation of recommendations is available online as a full-length document[7] and has also been summarized elsewhere.[8, 9]

The health questions for acute, subacute, chronic, and postoperative eye disorders addressed by this guideline include:

1. What diagnostic studies have been used for pre/placement examinations? Screening examinations?
2. What evidence supports the initial assessment and diagnostic approach?
3. What red flags signify serious underlying condition(s)?
4. What diagnostic approaches and special studies identify clinical pathology?
5. What initial treatment approaches have evidence of efficacy?
6. What is the evidence of work-relatedness for various diagnoses?
7. When is patching appropriate?
8. What modified duty limitations are effective and recommended?
9. When is return to work status recommended?
10. When initial treatment options fail, what evidence supports other interventions?
11. When and for what conditions are injections and other invasive procedures recommended?
12. When and for what conditions is surgery recommended?
13. Which surgeries are recommended for which conditions?

All evidence in the prior eye disorders guideline garnered from four databases (Cochrane, PubMed, CINAHL, and Scopus) was included in this guideline. Additionally, new comprehensive searches for evidence were performed in those databases up through 2016 to help assure complete capture. There was no limit on year of publication. Search terms are listed with each table of evidence. Guidance was developed with sufficient detail to facilitate the assessment of compliance[5] and auditing/ monitoring.[6] Alternative options to manage conditions are provided.

Because few studies solely evaluate patients with work-related eye disorders, studies that include different populations were used to develop the recommendations. In addition, most studies that focus on pharmaceuticals, appliances, and specific devices are industry sponsored. In certain areas, this may have made little difference as the comparisons were between the medication and placebo and the results may be stark. However, in other studies, the comparison groups may have been suboptimally treated and produced a bias in favor of the medication or device. In addition, industry-sponsored studies have been shown to frequently have better results and lower complication rates than studies conducted by independent investigators.

This guideline has undergone extensive external peer review. This guideline includes all criteria for the AGREE[6], IOM criteria[5] AMSTAR [10], [11] [12] and GRADE II [13] criteria. In accordance with the IOM's Trustworthy Guidelines, detailed records are kept, including responses to external peer reviewers.[5]

Definitions

The classifications of *acute* (<1 month), *subacute* (1 to 3 months), and *chronic* (>3 months) are used in this guideline where appropriate and are based on commonly accepted durations.

Rationales for recommendations may refer to costs, which are defined as *low* (<$100), *moderate* ($100-$500), and *high* (>$500).

Impact

Based on population-based data, it is estimated that 3.5-7.7% of the general US population does not have binocular visual correction of at least 20/50, with considerable differences based on race/ethnicity (Lee 00). The Centers for Disease Control and Prevention estimated that 3% of adults over 40 years are either blind, have visual fields less than 20 degrees, and/or have visual impairment (20/40 or less) [14]. Approximately

16% of adults over age 40 have cataract(s), 3% are blind (20/200 or less), and 2% have glaucoma [14]. Adequacy of visual acuity is a major criterion for many jobs, and visual impairments have been associated with increased risks of injuries [15]. Color deficiencies are common but highly variable, affecting approximately 8% of the male population with European ancestry [16]. Color perception is a requisite criterion for numerous occupations; specific requirements vary widely depending on job requirements. The workplace is a common source of ocular injury [17-20] and emergency department surveillance data indicate males in their third decade of life have the highest incidence rates (64.8% *cf* females) [21]. Eye injury claims at the largest US workers compensation insurer constituted 5% of all workers compensation claims [22]. Some permanent eye disability cases are also occupationally related. For example, disabling ocular injuries (8.5%) are reportedly the second most common injury in construction workers after low back pain (14.8%) [23].

The average cost of an occupationally-related eye injury has been estimated at $1,463 (OSHA), although this is likely an underestimate due to inadequate inclusion of indirect costs to employers for rehiring and retraining replacement workers, the loss of productivity, reduced quality work, administrative costs, and losses to the patient and patient's family (including productivity at home).

Risk and Causation

The etiology of most ocular injuries is noncontroversial. The eye is well innervated with nociceptors (pain sensation). The mechanism of injury and onset of symptoms is thus acute, noticeable, and readily discernible. Ocular diseases are naturally more challenging, with many factors producing ocular diseases such as pterygia and cataracts (see Work-Relatedness Guideline).

Acute Trauma

Determining the work-relatedness of ocular injuries (e.g., foreign bodies, rust rings, corneal lacerations, abrasions, contusions, hyphemas, burns) is not difficult because the mechanism of injury and acuity of symptom onset generally begets a straightforward determination of work-relatedness [22, 24-46]. Chemical injuries are common [47-60].

The construction industry has many reported risks for ocular injuries [47, 61-66]. Manufacturing is also a common industry with reportedly elevated risks [47, 50, 67, 68].

Welding-related tasks constituted an estimated 8.2% of all workers' compensation claims at the largest US workers' compensation insurer, with actual welding as the most common cause of occupational eye injury (38.5%), followed by grinding (17.5%), multiple tasks (3.8%), standing/walking/observing (3.4%), cleaning/brushing (3.3%), manual material handling (2.6%), and numerous other activities [22]. Employment in that study was most commonly in manufacturing (60.7%), construction (13.7%), services (12.1%), and wholesale/retail trade (5.9%).

Eyewear is believed to be strongly protective for eye injuries, although quality studies are sparse (likely largely due to the ease of implementation of eyewear programs) [26, 68-77]. Barriers to eyewear usage and/or injury reportedly include younger age [78], lack of comfort/fit [79], fogging [79], scratching of the eyewear [79], being rushed [80], fatigue [80], faulty equipment [80], foreign workforces [56, 81-84], and lack of safety training [78, 79, 85]. A case-crossover trial found unfamiliar work to be a considerable risk for ocular injury [80]. An ecological study found an inverse relationship between unemployment conditions and risks of report of ocular injury [86].

Enucleation is a sequellae of severe work-related eye injuries [24, 87]. A university-based case series reported occupational causes in 13.5% of cases and motor vehicle crashes in 13.5% of cases [24]. Open globe injuries are similarly reported to commonly arise from occupational injuries [27, 32, 40, 56, 63, 75, 88-95].

Welder's Flash (Photokeratitis)

Acute, unprotected ultraviolet radiation exposures (UV-A, UV-B) are known to burn the cornea and conjunctiva [96-101]. Welding is the most commonly reported exposure. Other reported examples include ultraviolet lamps for poultry abattoir disinfection [102], germicidal medical lamps [103], and damaged protective covers on mercury vapor lamps [104].

Pterygia

The worldwide prevalence of pterygia is estimated at 10%. Men have an approximately 7% higher risk for pterygia compared with women [105, 106]. For individuals in their 40s to 60s, the risk for pterygia approximately doubles [105]. Cigarette smoking is estimated to *reduce* risk of pterygia by 18% [107]. Conjunctival tumors are more common among farmers compared with controls [108]. Outdoor activity has been associated with 76% higher risk of pterygia [105, 109-116]. There is a 3.6-fold higher risk of pterygia among those living at latitudes of 0°-10° compared with those at 40°-50° [105]. Other reported risks include alcohol [117], low educational status [117-119], high systolic blood pressure [120], dry eyes [117, 119], not using sunglasses [117, 119], not using a hat [117, 119], light complexion [110], and dark complexion [112]. Use of sunglasses has been estimated to reduce risk up to 5.6-fold [110].

Retinal Laser-Induced Damage

Lasers are highly variable in their intensity and ability to damage tissue [121-123]. Reports include associated retinal and other ocular damage [124-133] among military [134-136] and commercial pilots [137, 138].

Cataracts

A cataract is a lens opacity that obscures vision. Cataracts are typically subdivided according to their anatomic location (i.e., nuclear, cortical, posterior subcapsular) and severity (size and intensity) of visual impairments by various classification systems [139-148]. The different anatomic locations may occur simultaneously in one patient. Elderly individuals are most susceptible to nuclear cataracts, whereas younger patients are more susceptible to posterior subcapsular cataracts.

Age is a robust risk factor for cataracts [149-162], with National Health Interview Survey data suggesting that individuals older than 75 years have a 10-fold greater risk compared with young adults [163]. Low educational status is a risk for cataracts [163]. Genetic factors are reported risks [164-167].

Age-related and cortical cataracts have been associated with increased carbohydrate intake and glycemic index [168]. Microvascular retinal changes associated with hypertension reportedly predict the risk of nuclear cataracts [169], as does hypertensive status [170]. Diabetes mellitus increases cataract risk by approximately 67-80% [149, 163, 170-173]. Oral hypoglycemic agents and insulin have been associated with 2-fold and 3.4-fold increased risks, respectively, which appear to be markers for diabetes rather than additional independent risks [166]. Use of glucocorticosteroids also increases risk [166, 174].

Smoking and alcohol have both reportedly increased risk of cataracts [177]. Obesity has been found to increase the risk of age-related cataracts, particularly posterior subcapsular cataracts [166, 175]. Lipids have been associated with increased risk [171]. Statins have been found to reduce the risk of nuclear cataracts by 29% [171] and cataract extractions by 34% [176]. Kidney disease is a reported risk for cataracts [160].

Aspirin and thiazide diuretic use have been associated with reduced risk of cataracts [166]. Dietary lutein and zeaxanthin have been found to reduce the risk of cataracts [178]. Dietary but not supplemental vitamin E has been associated with a reduced risk of age-related cataracts [179, 180], although reductions of 9-60% in cataract risk associated with multivitamin use have been reported [181, 182]. Glutathione S-transferases polymorphisms have been associated with cataracts [183]. Cataracts have been associated with subsequent age-related maculopathy [150], as well as elevated mortality [170, 184, 185].

Ultraviolet (UV) radiation, especially UVB, has been associated with cataracts [186-189]. This risk may be limited to cortical cataracts [190-192]. Steelworkers and other open hearth workers exposed to heat on the job may have an increased risk of cataracts [193-195]. Airline pilots and astronauts are reportedly at increased risk [196, 197]. A large cohort study suggested that all three types of cataracts were interestingly less common in rural residents than urban or suburban residents [198].

Cataracts may be associated with acute exposures to radiation of 2 Grays [199, 200]. Chronic cumulative exposures above 1 Gray are associated with cortical but not nuclear cataracts [201]. Healthcare workers exposed to ionizing radiation are also reportedly at increased risk of cataracts [202-205]. Work with trinitrotoluene has been associated with cataracts [206].

Post-traumatic cataracts occur, although there is no classification system for these more heterogeneous cataracts. The outcomes are more varied, largely because of the diversity and severity of causes [207-209]. Prospective cohort data suggest that a recalled history of ocular injury was associated with increased risk of posterior subcapsular and cortical cataracts [210].

General Approach and Basic Principles

The principal recommendations for assessing and treating patients with eye symptoms are as follows:

- The initial assessment focuses on detecting indicators of potentially serious injury or disease, termed *red flags*, which require urgent assessment and treatment as indicated.
- The foci for the treatment of patients with eye symptoms include optimal medical care, monitoring for complications, facilitating the healing process, assisting stay at work or early return to work in a modified or full-duty capacity, and surgical intervention(s) when indicated.
- Patients recovering from eye problems may usually stay at work or consider early return to modified work as their condition permits.
- Occupational factors should be addressed when the disorder is believed to be caused by work.
- Prevention measures should be addressed when the injury or disorder has a means of ready prevention.
- Nonphysical factors (e.g., psychosocial, workplace, or socioeconomic problems) should be addressed in an effort to resolve delayed recovery (see Cornerstones of Disability Prevention and Management).

This guideline addresses the following eye injuries and disorders that may be encountered by health care providers.

Blunt Trauma: Ocular contusions are caused by blunt trauma to the eye or periorbital structures that may cause contusion of the globe and/or periorbita. Although there may be no symptoms, most patients have local pain, visual loss, diplopia, or a red eye. The clinician may observe any of the following: eyelid ecchymosis, corneal edema, subconjunctival hemorrhage, hyphema, reduced visual acuity, abnormal visual fields, lens dislocation, lens subluxation, retinal tears, retinal edema, retinal detachment, and/or restricted ocular motion (e.g., if extraocular muscles are trapped in a blowout fracture).

Retrobulbar Hemorrhage: A retrobulbar hemorrhage may increase the pressure on the globe such that the intraocular pressure may become greater than the perfusion pressure of the eye, leading to total ischemia of the retina. A relaxing incision at the lateral canthus must be completed within 10 minutes of the rise in IOP or the eye may be irreversibly damaged secondary to the high IOP.

Orbital Floor Fractures: Orbital floor fractures are susceptible to causing diplopia, which may or may not resolve without surgery [183, 211-215]. The initial treatment foci are on understanding the mechanisms of diplopia and enophthalmos in orbital floor fractures, the best way to evaluate a patient, and the best way to restore maximal function and appearance [215].

Diplopia caused by orbital floor blowout fractures is one of the major complications of orbital injuries. However, diplopia may also resolve without surgery. When ongoing vertical movement of the eye is impaired, surgery is indicated and is performed after complete resolution of orbital hemorrhage and edema. The maximal time before the first surgical procedure is often considered to be 2 weeks [216], and waiting is particularly indicated when there has been some improvement in diplopia over the first week.

Better prognoses for non-surgical management include lack of diplopia, lack of entrapment of muscle, lack of enophthalmos, and lack of marked hypo-ophthalmos. Nonresolving oculocardiac reflex, the ''white-eyed'' blowout fracture, and early enophthalmos or hypoglobus are indications for immediate surgical repair. Surgery within 2 weeks is recommended in cases of symptomatic diplopia with positive forced ductions and evidence of orbital soft tissue entrapment on computed tomographic (CT) scan or large orbital floor fractures that may cause latent enophthalmos or hypo-ophthalmos [183, 211-215].

Hyphema: Traumatic hyphema involves an acute, most often blunt, injury sufficient to produce blood behind the cornea in the aqueous humor. Complications of traumatic hyphema include increased intraocular pressure, peripheral anterior synechiae, optic atrophy, corneal blood staining, secondary hemorrhage, and accommodative impairment. The reported incidence of secondary anterior chamber hemorrhage, i.e., rebleeding, in the setting of traumatic hyphema ranges from 0 to 38%. The risk of secondary hemorrhage may be higher among Black/African Americans than among whites. Secondary hemorrhage is generally thought to convey a worse visual prognosis, although the outcome may depend more directly on the size of the hyphema and the severity of associated ocular injuries. Some issues involved in managing a patient with hyphema are using various medications (e.g., cycloplegics, systemic or topical steroids, antifibrinolytic agents, analgesics, and antiglaucoma medications), the patient's activity level, use of a patch and shield, outpatient versus inpatient management, and medical versus surgical management. Special considerations are widely accepted in managing children, patients with hemoglobinopathies (e.g., hemoglobin S), and patients with hemophilia). It is important to identify and treat ocular injuries that often accompany traumatic hyphema. Consider the following general recommendations:

1. Advise routine use of topical cycloplegics and corticosteroids, consider systemic antifibrinolytic agents or corticosteroids, and use a rigid shield.
2. Recommend activity restriction (quiet ambulation). If compliance (with medication use or activity restrictions), follow-up, or increased risk for complications (e.g., history of sickle cell disease or hemophilia) is a concern, inpatient management may be needed.
3. Indications for surgical intervention include the presence of corneal blood staining or dangerously increased IOP despite maximum tolerated medical therapy, among others.

Thermal Burns of the Eye: Thermal burns of the eye are caused by exposure to hot gases, liquids, or solids. Unless there is local contact only with the eye, the periocular structures are typically also involved. Damage may range from superficial burns of the lids and surrounding structures to superficial destruction of the cornea, conjunctiva, or sclera, to greater destruction including exposure of the globe. If damage exceeds superficial burns of the lids and surrounding structures, prompt intervention by a specialist is imperative.

Electromagnetic Radiation Injury to the Eye: Patients with electromagnetic radiation injuries to the eye may have no initial symptoms. Severe cases may show a marked decrease in central visual acuity, but there may be severe delayed consequences. Depending on the exact electromagnetic spectrum, the symptoms or signs may be localized to the anterior segment, lens, retina, and choroid. These types of injuries may cause scarring of the cornea or retina or cataracts. Visual field disorders also may result from damage to the retina or choroid. Burns from the blue end of the visible spectrum and ultraviolet A are discussed under nonionizing radiation exposure.

Chemical Burns: Toxic substances often begin to cause damage immediately upon contact with ultrasensitive eye tissues. Damage is related to the substance's properties, concentration, duration of exposure and speed of irrigation. Aside from general tissue damage, acids and alkalis can change the pH in the eye itself. From this detrimental change, severe eye damage, including blindness, may result. A history of significant chemical exposure is an emergency, and examination should be delayed until after the eye is flushed to dilute the chemical (see Overview). It is imperative that emergency flushing begin immediately. To ensure the best chances for a minimal amount of eye damage, correct emergency equipment, proper placement, and knowledge of its use are necessary. The requirements governing medical services and first aid are covered in OSHA 1910.151(a)(b), whereas ANSI Z-358.1, Emergency Eyewash and Shower Equipment, provides guidance. At the site, water is the initial dilution agent to flush the eye or body. Subsequently, an isotonic saline or balanced Ringer's solution is preferred and should be used, if available (otherwise, use sterile intravenous fluids), until a tear pH of about 7 is obtained after ceasing irrigation for

approximately 10 minutes. Proper flushing usually takes at least 15 minutes, but can take as long as 24 hours.

Irrigation technique. ANSI Z-358.1, Emergency Eyewash and Shower Equipment, identifies guidance for having the facilities to dilute a chemical within 10 seconds of undergoing an industrial eye chemical hazard. Once at the site of an industrial injury, emergency medical personnel or first responders may resolve pain and blepharospasm by applying a topical ophthalmic anesthetic (proparacaine hydrochloride). If needed, the interpalpebral fissure may be widened by means of a lid retractor (e.g., Demarres). The eye should be irrigated directly with isotonic saline, Ringer's lactate or other ocular solutions. A contact lens should be removed to facilitate irrigation of the eyeball. The irrigation is not completed until the upper lid is double everted so that all cul-de-sacs (recesses) of the conjunctiva are thoroughly irrigated and visualized. Irrigation should continue until the conjunctival secretions show a consistent pH of approximately 7 after ceasing irrigation for 10 minutes.

Contact lenses. In the event of a contact lens, remove contact lenses as soon as practical. Do not delay irrigation while waiting for contact lens removal because the lens may come out with the irrigation or can be removed when irrigation is complete. Contact lenses adhere to the cornea and sometimes the paralimbal conjunctiva, depending on the type, and they have been shown to protect the cornea and/or conjunctiva beneath the lens. However, they do not fulfill the requirements of PPE. If a contact lens has not been washed out during the irrigation, it(they) may be removed following completion of irrigation.

Alkali burns. Alkali burns of the eye typically cause pain initially and may have disastrous consequences if not treated immediately. Alkali exposure can cause corneal ulceration or conjunctival, scleral, and/or anterior segment degeneration that is manifested as a blanched or "marbleized" appearance. The cornea may become opacified. The diagnosis is usually based on a history of exposure to alkaline chemicals, but occasionally testing the pH of tears or residual liquid is required. Immediate and copious irrigation should be performed. Irrigation in most cases should be continued until the patient is seen by the ophthalmologist on an emergency referral basis. The primary exception is a very minor amount of mildly alkaline material that may be addressable without ophthalmological evaluation. A casual examination of the eye may reveal that the globe is white because there is severe ischemia of the conjunctiva or episcleral vessels, a finding that would be noted during a slit-lamp examination.

Acid burns. Acid burns of the eye, caused by acid splashes or vapors, may have immediate effects of corneal erosion, corneal necrosis, and decreased visual acuity unless irrigation is accomplished immediately. In patients with acid burns, the eye appears inflamed immediately, unlike alkali burns, where the eye typically appears white due to necrosis of the superficial ocular vessels. Delayed effects are unusual in patients with acid burns, although hydrofluoric (HF) acid burns are the exception.

Hydrofluoric acid burns. Hydrofluoric acid causes delayed tissue destruction out of proportion to the apparent exposure. With an HF acid concentration of less than 20%, the onset of symptoms may be delayed up to 24 hours. With high concentrations, symptoms may begin relatively quickly. The patient's main complaint is severe eye pain out of proportion to the apparent exposure. HF acid penetrates tissue remarkably well and causes deep as well as superficial necrosis. HF acid exposure must be treated immediately with copious irrigation with water or isotonic saline solution for 5 minutes and then by calcium gluconate 1% solution or Ringer's lactate solution providing Ca2+ and Mg+ atoms to the cell replacing the Ca^{++} and Mg^{++} atoms that were incorporated into insoluble calcium and magnesium fluoride molecules. Immediate referral to an ophthalmologist after emergency care is recommended while calcium gluconate is irrigated into the eye.

Corneal Ulceration: Corneal ulcers are considered an ophthalmologic emergency. They may result in permanent visual impairment. They may be bacterial, viral, fungal, or parasitic in origin and may occur following corneal lacerations, abrasions, and intrusion of foreign bodies. They may result from poorly fitted or inadequately cleaned contact lenses. Patients with corneal ulcers present with complaints of changes in visual acuity, photophobia and/or eye pain, tearing, and a sensation that a foreign body is in the eye. The presence of corneal ulcers can be determined by direct visualization, but magnified viewing with fluorescein staining is needed to completely rule out their presence.

Open Globe Eye Injury: Direct trauma to the eye from high-velocity objects can cause laceration or perforation of the globe. The trauma can be perforating or penetrating. Patients with damage to the integrity of the globe can present with decreased visual acuity, local pain, and bleeding. The cardinal sign is

distortion of the globe with loss of tension or IOP; the pupil is not round, but rather is distorted and/or nonreactive. In addition, ecchymosis or other signs of damage to periorbital structures are usually evident. The clinician may observe subconjunctival hemorrhage, distortion of the iris or pupil, or herniation of the iris through the cornea. There also may be retinal damage. The injured eye should be protected with a metallic or plastic shield. Transfer by stretcher is recommended.

Initial Care

The principal recommendations for initial assessment and approach to the treatment of patients with eye injuries and disorders are as follows:

- Initial assessment should focus on detecting indications of potentially serious ocular pathology, termed red flags, and determining an accurate diagnosis. For these purposes, red flags are defined as a sign or symptom of a potentially serious condition indicating that further definitive care, support, consultation and/or specialized treatment may be necessary.
- In the absence of red flags, eye disorders may be safely and effectively treated in experienced primary care settings. Conservative treatment should generally proceed for 48 to 72 hours for superficial foreign bodies, corneal abrasions, conjunctivitis, and ultraviolet radiation burns. Normally, eye tissues heal rapidly. If eye damage is not well on the way to resolution within 48 to 72 hours, additional care and/or referral is indicated particularly if the provider is inexperienced with more complex care. Nonspecific eye disorders are often monitored for considerably longer periods of time while evaluations, ergonomic and other adjustments are made. The foci are on providing the most effective treatment(s), monitoring for complications, facilitating the healing process, and determining fitness for return to work in a modified- or full-duty capacity.
- Corneal discomfort can be relieved with a topically applied ophthalmic nonsteroidal anti-inflammatory drug (NSAID) or an oral analgesic. Intramuscular or intravenous opioids are rarely needed, typically for some severe ocular/face injuries. Topical anesthetics are generally avoided other than diagnosis or brief treatment because they may obscure worsening pathology and thus inadvertently cause further injury.
- Visual acuity should be assessed and documented carefully at each examination prior to other examinations or treatment, except for cases of chemical burns where immediate copious irrigation should be administered without delay.
- Patients recovering from acute eye injury or infection should be encouraged to return to modified work as their condition permits.

Nonphysical factors, such as psychosocial, workplace, or socioeconomic problems, should be addressed in an effort to resolve delayed recovery.

Initial Assessment

Presenting Symptoms

The patient will typically present with either: (i) an acute injury or event or (ii) an ocular disease. Acute injury or events generally have fairly simple mechanisms of injury that often beget a straightforward treatment approach (e.g., immediate irrigation for a chemical splash). If immediate treatment is not required, then a careful history and physical examination will commence to identify the most likely diagnosis of the patient's symptoms and signs.

History

Information obtained from a careful history and examination directs the approach to management. This section is separated into history elements for acute, ocular injury and for ocular diseases. However, it is recognized that there are many cases where both sets of questions are needed.

Elements of the History of Ocular Injury

While a detailed, accurate history is essential in all injuries, it is especially important to obtain a detailed history of an ocular injury because incorrect or misleading information may lead to blindness. Such information may be obtained from a variety of sources, including the patient, the first responder(s), and others involved in or associated with the accident. Information for acute trauma should include the four Ws:

1. Where: Location of the accident
2. When: Time and date
3. Who: Other individuals involved
4. What: A detailed description of the accident circumstances, including force and load. If chemical exposure was involved, seek available Safety Data Sheet (SDS) information. Critical data include:
    i. What chemical (SDS information‡)
    ii. Type of chemical (alkali, acid, solvent)
    iii. Type of exposure (liquids, solids, fumes)
    iv. Dose of exposure
    v. pH of the material
    vi. Concentration of the material
    vii. Solubility of the material
    viii. Contact time
5. Emergency medical care provided by first responder(s), with information from:
    i. Product manufacturer
    ii. Availability of chemical data
    iii. Safety Data Sheets
    iv. Regional poison control center
    v. Internet

Elements of the History of Ocular Diseases

Asking open-ended questions generally allows the clinician to assess the primary focus for the visit, diagnose the condition more accurately, and identify a preferred treatment approach.

1. What are your symptoms?
    a. Are you experiencing pain? Sensitivity to light? Blurry vision? Loss of vision? Headache?
    b. Is your problem located primarily in the eye or near the eye? Do you have pain or other symptoms elsewhere? Nose? Sinus? Throat? Ear? Head?
    c. Are your symptoms constant? Intermittent?
    d. What makes the problem worse or better?
2. How do these symptoms limit you?
    a. How long can you look at something?
    b. Can you see clearly?
3. When did your current limitations begin?
    a. How long has your vision been limited? More than a day or two?
    b. Have your symptoms changed? How?
4. Have you had similar episodes previously?
5. Have you had any previous testing or treatment? With whom?
6. What do you think caused the problem?
7. What are your specific job duties? How long do you spend performing each duty?
8. Do you have other medical problems? Diabetes? High blood pressure? Glaucoma?
9. What do you hope to accomplish during this visit?

The onset of a red eye, duration of the redness, and clinical course should be noted to help to distinguish the causative agents (see Table 1, below). The patient's chief complaint often identifies or suggests the cause of the red eye. For example, itching may signify allergies. A scratchy or burning sensation suggests lid,

conjunctival, or corneal disorders, including foreign bodies, in-turning eyelashes, and dry eyes. Localized lid pain or tenderness is a common presenting complaint of a stye or an acute chalazion of the lid.
Deep, non-localizing, intense, aching pain may reflect disorders such as iritis, or acute glaucoma, as well as sinusitis, cluster headache, or ocular migraine. Photophobia suggests problems arising from the anterior segment of the eye, such as corneal abrasions, iritis, and acute glaucoma. A halo effect around lights is a sign of corneal edema commonly seen in acute glaucoma. Individuals who have corneal edema associated with contact lens wear may also experience halo vision.

Table 1. Symptoms of Red Eye

Symptom	Acute Glaucoma	Acute Iridocyclitis	Keratitis	Bacterial Conjunctivitis	Viral Conjunctivitis	Allergic Conjunctivitis
Blurred vision	3	1-2	3	0	0	0
Pain	2-3	2	2	0	0	0
Photophobia	1	3	3	0	0	0
Colored halos	2	0	0	0	0	0
Exudation	0	0	0-3	3	2	1
Itching	0	0	0	0	0	2-3

Note: The range of severity of the symptom is indicated by 0 (absent) to 3 (severe).
Modified from Bradford CA, ed. Basic Ophthalmology. 7th ed. San Francisco, Calif: American Academy of Ophthalmology; 1999.

Red Flags

For potentially occupationally-related eye injuries, the mechanism of injury usually provides the most important information regarding the potential for a "red flag" (see Table 2, below). Potentially serious eye conditions are listed below. Depending on the provider's training and experience in dealing with the particular disorder, early consultation with an eye specialist may be needed.
In general, sudden onset of loss of vision, loss of visual acuity, photophobia, flashing lights, painful eye, and trauma are all red flags. Other red flags include systemic symptoms such as loss of function of the face, a hand, or a leg; speech alterations; accompanying new headache; and scalp tenderness.

Table 2. Red Flags for Potentially Serious Eye Conditions Requiring Immediate Ophthalmologic Examination

Disorder	Medical History	Physical Examination
Ocular injury, open globe	• Trauma due to high-velocity foreign-body injury • Visual loss • Bleeding • Local pain	• Visible foreign body in globe; deformity of globe • Loss of globe pressure • Distorted pupil and/or iris • Subconjunctival hemorrhage
Ocular injury, closed globe	• Direct blow • Visual loss • Diplopia	• Eyelid ecchymosis • Subconjunctival hemorrhage • Vitreous hemorrhage • Lens dislocation • Retinal edema and/or tear • Decreased visual acuity • Hyphema • Retrobulbar hemorrhage • Extraocular motion deviation

Disorder	Medical History	Physical Examination
Thermal burns	• Exposure of eyes to hot material/extreme heat • Superficial eye pain • Photophobia	• Burns of lids and/or surrounding structures • Damage to cornea, conjunctiva, and/or sclera • Decreased visual acuity
Radiation injury	• Exposure of eyes to ultraviolet, laser, or bright light • Delayed severe superficial eye pain (4-6 hours) • Tearing • Photophobia	• Blepharospasm • Tearing • Corneal punctate staining and/or sloughing of epithelium • Retinal damage
Chemical burns	• Alkali, acid, solvent splash • Painless visual loss	• Corneal erosion • Conjunctival chemosis • Necrosis of anterior segment of tissues and vessels • Decreased visual acuity • Circumcorneal vascular ischemia • Necrosis of cornea and/or conjunctiva • Glaucoma
Hydrofluoric (HF) acid burns	• HF acid splash • Delayed damage	• Necrosis of cornea and/or conjunctiva • Decreased visual acuity
Corneal ulcer	• Abrasion or infection • Superficial pain • Foreign-body sensation • Photophobia • Visual loss	• Corneal infiltrates and ulcers • Decreased visual acuity • Ulceration on slit-lamp exam and fluorescein staining

Examination

The eye examination differs somewhat based on whether the presenting problem is an acute, discrete injury or an occupational disease (including red eye not due to trauma).
A comprehensive examination is preferred in patients with ocular diseases. A more abbreviated and focused examination is typically initially performed for obvious, acute injuries. At a minimum, a visual acuity assessment is performed prior to any treatment. The main exception is with chemical injuries, where immediate irrigation is mandated.

Ocular Examination for Eye Injury

For chemical exposures, this examination occurs after decontamination or while it is in progress, if that is feasible. Otherwise, initial ocular (visual) screening is extremely useful as the initial test of choice.
The examination of the injured eye should include the following:

1. Visual acuity (each eye separately) with best correction or pinhole
2. Inspection of the ocular structure (If an open globe is suspected, no pressure should be exerted on the globe.)
3. Position of the eyes and eye movements (six cardinal positions) if the globe is intact
4. Examination of the pupils for size and reaction to light
5. Gross visual fields by confrontation
6. Ophthalmoscopy
7. Intraocular pressure (IOP) determination if the globe is intact
8. Injury to lid(s) or other adnexal structures

It is important for make immediate referrals to the closest specialist when eye injuries exceed the treating provider's capability. Make the patient comfortable (with intravenous analgesics, if necessary) and protect

the eye from further injury by applying a rigid Fox shield or equivalent. Depending on the type of injury, transport the patient on a stretcher.

How to Examine for Ocular Disease, including Red Eye

Visual complaints from diseases, including red eye, are initially evaluated with a visual acuity chart, a penlight (slit lamp preferred), a tonometer, a sterile fluorescein dye strip, topical anesthetic drops, and an ophthalmoscope. Many clinics use a vision screening device screener, a noncontact "puff" tonometer, and a slit lamp or biomicroscope. A systematic approach to the examination is recommended, beginning by examining the face, orbital area, and lids and ending with a close view of the eyeball. The preferred method for examining the eyeball is with a slit-lamp biomicroscope and the ophthalmoscope.

The American Academy of Ophthalmology specifies nine diagnostic steps to use when evaluating a patient with a red eye (Bradford):

1. Determine whether visual acuity is normal or decreased using a Snellen chart or (preferred) ETDRS chart at 20 feet or 6 meters, or the 1 meter ETDRS chart if required.
2. Inspect the pattern of redness present and determine whether it is due to subconjunctival hemorrhage, conjunctival hyperemia, ciliary flush, or a combination of these.
3. Ascertain the presence of conjunctival discharge and categorize it as to amount (profuse or scant) and character (purulent, mucopurulent, serous, or hemorrhagic).
4. Identify opacities of the cornea, including large keratitic precipitates, or irregularities of the corneal surface, such as corneal edema, corneal leukoma (a white opacity caused by scar tissue), and irregular corneal reflection. Conduct the examination using a slit lamp biomicroscope, or at least penlight and transilluminator. Biomicroscopy is the practice standard.
5. Search for disruption of the full thickness of the corneal epithelium by staining the cornea with fluorescein. Search for a lack of corneal epithelium vitality by staining with rose bengal.
6. Use a slit lamp (biomicroscope) to estimate the depth of the anterior chamber as normal or shallow and to detect any microscopic blood or white blood cells, which would indicate either hyphema or hypopyon, respectively. (A hypopyon is indicated by the presence of protein and white blood cells in the anterior chamber [e.g., when a corneal ulcer is present] and a hyphema is indicated by protein and red blood cells in the anterior chamber. These typically "layer" out in the inferior cornea.)
7. Detect irregularity of the pupils and determine whether one pupil is larger than the other. Observe the reactivity of the pupils to light to determine whether one pupil is more sluggish than the other or is nonreactive.
8. Determine whether the intraocular pressure is high, normal, or low by performing tonometry. This is especially important if acute angle closure glaucoma is suspected. (Tonometry is contraindicated when external infection or lack of globe integrity is obvious.)
9. Detect the presence of proptosis, lid malfunction, or any limitations of eye movement.

Methods of Testing

Visual Acuity: Quantitative Bilateral Tests. Acuity is measured at infinity (as a minimum) and near and intermediate distances (based on job description) and is performed with and without corrective devices (e.g., glasses or contact lenses) and without removing other corrective devices (e.g., intraocular lenses).

Slit-Lamp Biomicroscopy. Slit-lamp examination is the standard method of examining the eye. The slit lamp uses intense illumination and magnification. The general findings noted in a slit-lamp examination (biomicroscope) and their clinicopathologic correlations appear at the end of this Guideline under "Additional Resources."

How to Interpret the Findings of Red Eye. The associated signs and symptoms (see Table 1. Symptoms of Red Eye and Table 3. Signs of Red Eye) of various disorders overlap to some extent. Although many conditions may cause a red eye, several signs and symptoms signal greater concerns. The presence of one or more of these signals (i.e., a red flag) alerts the physician that the patient may have a disorder requiring definitive care that often includes referral if the examiner has insufficient experience with that particular condition. See Table 4. Differential Diagnosis – Red Eye.

Table 3. Signs of Red Eye

Symptom	Referral Advisable if Present	Acute Glaucoma	Acute Iridocyclitis	Keratitis	Bacterial Conjunctivitis	Viral Conjunctivitis	Allergic Conjunctivitis
Ciliary Flush	Yes	1	2	3	0	0	0
Conjunctival Hyperemia	No	2	2	2	3	2	1
Corneal Opacification	Yes	3	0	1-3	0	0-1	0
Corneal Epithelial Disruption	Yes	0	0	1-3	0	0-1	0
Pupillary Abnormalities	Yes	Mid-dilated, nonreactive	Small; may be irregular	Normal or small	0	0	0
Shallow Anterior Chamber Depth	Yes	3	0	0	0	0	0
Elevated Intra-Ocular Pressure	Yes	3	-2 to +1	0	0	0	0
Proptosis	Yes	0	0	0	0		0
Discharge	No	0	0	Sometimes	2-3	2	1
Preauricular Lymph Node Enlargement	No	0	0	0	0	1	0

Note: The range of severity of the symptom is indicated by 0 (absent) to 3 (severe).
Modified from Bradford CA, ed. Basic Ophthalmology. 7th ed. San Francisco, Calif: American Academy of Ophthalmology; 1999.

Table 4. Differential Diagnosis – Red Eye

Illness	Details	Severity and Incidence
Acute angle-closure glaucoma	A form of glaucoma due to sudden and complete occlusion of the anterior chamber angle by iris tissue.	Uncommon, serious (The more common chronic open-angle glaucoma causes no redness of the eye.)
Iritis or iridocyclitis	An inflammation of the iris alone or of the iris and ciliary body; often manifested by ciliary flush.	Serious
Herpes simplex keratitis	An inflammation of the cornea caused by the herpes simplex virus.	Common, potentially serious; can lead to corneal ulceration
Conjunctivitis	Hyperemia of the conjunctival blood vessels; may be bacterial, viral, allergic, or irritative.	Common, often not serious
Episcleritis	An inflammation (often sectorial) of the episclera (the vascular layer between the conjunctiva and the sclera), without discharge; possibly allergic, occasionally painful	Uncommon, not serious

Modified from Berson FG. Basic Ophthalmology for Medical Students and Primary Care Residents. 6th ed. San Francisco, Calif: American Academy of Ophthalmology; 1993.
¥ Fluorescein, applied primarily as a 2% alkaline solution and with impregnated paper strips, is used to examine the integrity of the conjunctival and corneal epithelia. Defects in the corneal epithelium will appear green in ordinary light and bright yellow when a cobalt blue filter is used in the light path. Similar lesions of the conjunctiva appear bright

orange or yellow in ordinary illumination. Fluorescein also has been used in the fitting of rigid contact lenses, although it cannot be used for soft lenses, which absorb the dye. Prepared sterile ophthalmic strips are used diagnostically for staining the anterior segment of the eye when: 1) delineating a corneal injury, herpetic ulcer, or foreign body; 2) determining the site of an intraocular injury; 3) fitting contact lenses; 4) making the fluorescein test to ascertain postoperative closure of a sclerocorneal (also referred to as corneoscleral) wound in delayed anterior chamber re-formation; and 5) making the lacrimal drainage test. Avoid using fluorescein while the patient is wearing soft contact lenses because the lenses may become stained. Whenever fluorescein is used, flush the eyes with sterile normal saline solution and wait at least 1 hour before replacing the lenses. Rose Bengal Ophthalmic Strips are particularly useful for demonstrating abnormal conjunctival or corneal epithelium; devitalized cells stain bright red, whereas normal cells show no change; the abnormal epithelial cells present in dry eye disorders are effectively revealed by this stain).
± A slit lamp features an oblique (condensed) illumination and a magnifying system. With refinements, this system is used in current slit lamps. All detail is seen by the viewer by reflected light. Substances that do not reflect light are not visible; they are termed optically empty, such as normal tears and the aqueous humor. Structures that transmit light, but can be seen in the beam, are termed reluctant, such as the cornea, lens, and vitreous. Structures that do not transmit light are opaque. The examiner must use special techniques for illumination and focusing that enhance the examination. The methods include: 1) diffuse illumination; 2) direct or focal illumination (the most useful and important type of slit-lamp illumination, whereby tissues such as the cornea are seen as an optical section or a block of tissue known as a parallelepiped); 3) retro-illumination, where the area is being illuminated by reflected rays (e.g., a corneal foreign body or corneal ulcer); and 4) indirect illumination.

Diagnostic Approach

If the patient does not have red flags for serious conditions, the clinician may then determine which other eye disorder is present. The criteria presented in Figure 1 follow the clinical thought process from the mechanism of illness or injury to unique symptoms and signs of a particular disorder and finally to test results, if any tests were needed to guide treatment at this stage.

Several symptoms and signs are common to a number of eye injuries or disorders (see Table 1. Symptoms of Red Eye and Table 3. Signs of Red Eye). Therefore, accurate diagnosis depends on linking the mechanism of injury or pathogenesis, symptoms, signs, and findings of the eye examination with findings on magnification and, if necessary, with fluorescein staining of the eye. In the following lists, an asterisk (*) after a symptom or sign indicates a red flag.

Special Studies and Diagnostic and Treatment Considerations

Special studies are not generally indicated during the first 2 to 3 days of treatment, except for in red flag conditions. Most patients with eye problems improve quickly once any red flag issues are ruled out. The clinical history and physical findings generally are adequate to diagnose the problem and provide treatment. If the patient's limitations due to eye symptoms, other than nonspecific symptoms, do not improve in 3 to 5 days, reassessment is recommended. After again reviewing the patient's limitations, history, and physical findings, the clinician may consider referral for further diagnostic studies and discuss these options with the patient. For patients with limitations after 3 to 5 days and unexplained physical findings, such as localized pain or visual disturbance, referral may be indicated to clarify the diagnosis and assist recovery.

Selection of Special Studies

Radiography of the globe may be indicated if the patient's history indicates the possibility of injury by a penetrating high-speed radiopaque foreign body. Ultrasonography can be used to locate non- and radiopaque foreign bodies. Computed tomographic (CT) scan of the orbit may be indicated in cases of significant blunt trauma and associated fractures at the time of initial evaluation and treatment. Magnetic resonance imaging (MRI) is never indicated when there may be a possibility of a metallic foreign body. Table 5 compares (generally) the abilities of different techniques to identify physiologic insult and define anatomic injury.

Table 5. Ability of Various Techniques to Identify and Define Ocular Pathology

Technique	Identify Physiologic Insult	Identify Anatomic Defect
History	+ + +	+
Physical examination, including visual acuity testing and fundoscopy	+ + + +	+ + + +
Fluorescein staining	0	+ + + +
Slit-lamp examination	0	+ + + +
Tonometry	+ + +	0
Imaging studies		
Plain-film radiography	0	+a
Ultrasonography	0	+ + + +b
CT scan	0	+ + + +a
MRI	0	+ + + +c

Note: Specificity and repetitiveness from 0 (absent) to (maximum).
[a]For evaluating suspected periorbital and other depressed fractures.
[b]For evaluating suspected retinal detachment, chamber dimensions, and intraocular foreign bodies.
[c]For evaluating foreign body and intracranial pathology.

If the patient does not have red flags for serious conditions, the clinician may then determine which other eye disorder is present. The criteria presented in Table 5 follow the clinical thought process from the mechanism of illness or injury to unique symptoms and signs of a particular disorder and finally to test results, if any tests were needed to guide treatment at this stage.
The clinician must be aware that several symptoms and signs are common to a number of eye injuries or disorders (see Table 1. Symptoms of Red Eye and Table 3. Signs of Red Eye). Therefore, accurate diagnosis depends on linking the mechanism of injury or pathogenesis, symptoms, signs, and findings of the eye examination with findings on magnification and, if necessary, with fluorescein staining of the eye.

Diagnostic Criteria

In the following lists, an asterisk (*) after a symptom or sign indicates a red flag.

Symptoms of Red Eye (see Table 1. Symptoms of Red Eye)

- **Blurred Vision.** Blurred vision often indicates serious ocular disease. Blurred vision that improves with blinking suggests a discharge or mucus on the ocular surface.
- **Severe pain.*** Pain may indicate keratitis, ulcer, iridocyclitis, or acute glaucoma. Patients with conjunctivitis may complain of a scratchiness or mild irritation, but do not have severe pain.
- **Photophobia.*** Photophobia is an abnormal sensitivity to light that accompanies iritis. It may occur either alone or secondary to corneal inflammation. Patients with conjunctivitis have normal light sensitivity.
- **Colored halos.*** Rainbow-like fringes or colored halos seen around a point of light are usually a symptom of corneal edema, often resulting from an abrupt rise in intraocular pressure. Therefore, colored halos are a danger symptom suggesting acute glaucoma as the cause of a red eye.
- **Exudation.** Exudation, also called mattering, is a typical result of conjunctival or eyelid inflammation and does not occur with iridocyclitis or glaucoma. Patients often complain that their lids are “stuck together” on awakening. Corneal ulcer is a serious condition that may or may not be accompanied by exudate. Mucoid discharge generally is related to allergic conditions. Watery discharge may occur with viral conditions, and a purulent discharge is related to bacterial conditions.
- **Itching.** Although a nonspecific symptom, itching most commonly indicates an allergic conjunctivitis.

Signs of Red Eye (see Table 3. Signs of Red Eye)

- **Reduced visual acuity.*** Reduced visual acuity suggests a serious ocular disease, such as an inflamed cornea, iridocyclitis, glaucoma, or vitreous hemorrhage. It never occurs in simple conjunctivitis unless the associated cornea is involved. Acceptable of passable visual acuity for driving and injuries without a known baseline is considered 20/40 or better in each eye separately and both eyes together.
- **Ciliary flush.*** Ciliary flush is an injection of the deep conjunctival and episcleral vessels surrounding the cornea. It is seen most easily in daylight and appears as a faint violaceous ring in which individual vessels cannot be seen by the unaided eye. These engorged vessels, whose origin is the ciliary body, are a manifestation of inflammation of the ciliary body and the anterior segment of the eyeball. Ciliary flush is a danger sign often seen in eyes with corneal inflammations, iridocyclitis, or acute glaucoma. Usually ciliary flush is not present in conjunctivitis.
- **Conjunctival hyperemia.** Conjunctival hyperemia is an engorgement of the larger and more superficial bulbar conjunctival vessels. A nonspecific sign, it may be seen in almost any of the conditions causing a red eye.
- **Corneal opacification.*** In a patient with a red eye, corneal opacities always denote disease. These opacities may be detected by direct illumination with a penlight, or they may be seen with a direct ophthalmoscope (with a plus lens in the viewing aperture) outlined against the red fundus reflex. Several types of corneal opacities may occur, including:
    - Keratic precipitates, or cellular deposits on the corneal endothelium, usually too small to be visible. Occasionally forming large clumps, these precipitates can result from iritis or chronic iridocyclitis.
    - A diffuse haze obscuring the pupil and iris markings. This may be characteristic of corneal edema. It is frequently seen in acute glaucoma.
    - Localized opacities. These may be due to keratitis or ulcer.
- **Corneal epithelial disruption.*** Disruption of the corneal epithelium, which occurs in corneal inflammations and trauma, can be detected in two ways. The first method uses fluorescein vital stain, which detects disruption of the epithelium.
    - The examiner should be positioned in such a way as to observe the reflection from the cornea of a single light source (e.g., window or penlight) as the patient moves his or her eye into various positions. Epithelial disruptions cause distortion and irregularity of the light reflected by the cornea. Apply fluorescein to the eye. Areas denuded of cells of the epithelium will stain a bright green with a blue filter.
    - The second method uses rose bengal vital stain, which detects degeneration or absence of one or more layers of the epithelium. The examiner should be positioned in the same manner as described above. Apply rose bengal vital stain. Diseased epithelium will stain a reddish purple color.
- **Pupillary abnormalities.*** The pupil in an eye with iridocyclitis typically is somewhat smaller than that of the other eye due to reflex spasm of the iris sphincter muscle. The pupil is also distorted occasionally by posterior synechiae, which are inflammatory adhesions between the lens and the iris. In acute glaucoma, the pupil is usually fixed, mid-dilated (about 5 to 6 mm), and slightly irregular. Conjunctivitis does not affect the pupil.
- **Shallow anterior chamber depth.*** In a red eye, a shallow anterior chamber (especially related to acute ocular pain, nausea, and sometimes vomiting) suggests the possibility of acute angle-closure glaucoma. Anterior chamber depth can be grossly estimated through side illumination with a penlight. The most exact technique and practice standard involves using a slit lamp with or without a diagnostic anterior segment contact lens. Intraocular pressure (IOP) is then measured.
- **Elevated IOP.*** IOP is unaffected by common causes of red eye other than iridocyclitis and glaucoma. In any red eye without obvious infection, IOP can be measured to rule out glaucoma as clinically indicated (routinely at the time of all eye screening examinations generally after age 40); however, under some circumstances, routine screening for IOP should be part of the examination.
- **Proptosis.*** Proptosis is a forward displacement of the globe. Proptosis of sudden onset suggests

serious trauma, orbital infection, or tumor. The most common cause of chronic proptosis is thyroid disease, especially Grave's disease, and is bilateral. Orbital mass lesions also result in proptosis and should be considered. Proptosis may be accompanied by conjunctival hyperemia or limitation of eye movement. Small amounts of proptosis are detected most easily by standing behind a seated patient and looking downward to compare the positions of the two corneas. Acute orbital proptosis secondary to trauma is an ophthalmologic emergency because it may cause severe pressure on the eyeball, which may lead to central retinal artery occlusion.

- **Preauricular nodes.** The type of ocular discharge may be an important clue to the cause of conjunctivitis. Preauricular node enlargement can be a prominent feature of common viral as well as some unusual varieties of chronic granulomatous conjunctivitis, known collectively as Parinaud's oculoglandular syndrome. Usually, such enlargement does not occur in acute bacterial conjunctivitis. The adenovirus is found most commonly, especially in epidemic keratoconjunctivitis, which generally is readily spread by direct contact with the secretions of affected individuals.

Management Approach

The principal recommendations for assessing and treating patients with eye complaints are as follows:

- Initial assessment should focus on detecting indications of potentially serious ocular pathology, termed red flags, and determining an accurate diagnosis. For these purposes, red flags are defined as a sign or symptom of a potentially serious condition indicating that further consultation, support, or specialized treatment may be necessary.
- In the absence of red flags, experienced healthcare providers can safely and effectively handle most work-related eye injuries. Conservative treatment can proceed for 48 to 72 hours for superficial foreign bodies, corneal abrasions, conjunctivitis, and ultraviolet radiation damage. Normally, eye tissues heal rapidly. If eye damage is not well on the way to resolution within 48 to 72 hours and the provider is not experienced with the condition, referral to a specialist is indicated.
- Ocular diseases and nonspecific eye complaints usually require longer treatment timelines.
- The treatment focus is on assuring optimal treatment, monitoring for complications, facilitating the healing process, and determining fitness for return to work in a modified- or full-duty capacity.

Follow-up Visits

The frequency of follow-up visits is determined by the diagnosis, stage and severity of the problem.
After successful treatment for simple corneal abrasions or minor foreign bodies, follow-up may be on a daily basis until the problem has resolved. As healing is rapid and minor abrasions do not generally require follow-up, it is also acceptable to schedule follow-up for such cases as needed. The larger, deeper and more extensive the injury, the more likely follow-up will need to be scheduled.
Photokeratitis (e.g., welder's flash) is generally readily treated and resolves in 1 or 2 days. It frequently requires no follow-up appointments or at most one appointment the next day.
For chemical burns, daily follow-up is generally required until the problem has resolved. For minor volumes of non-acidic, non-alkaline insults, it is acceptable to schedule follow-up as needed.
Thermal burns depend on the severity and involvement of other structures. Minor cases may require one follow-up appointment within a day or two. More severe cases may need follow-up every one to two days until the burns are resolved.
Blunt trauma injuries that include orbital blowout fractures without red flags for immediate surgery require follow-up approximately every 3 to 5 days to ascertain improvements and resolution of diplopia or other problems.
Traumatic hyphema requires close follow-up that is generally determined by IOP on presentation. The larger the extent of the hyphema and the higher the IOP, the more frequently the follow-up is needed.
Corneal ulcers require follow-up initially every 1 to 2 days until the epithelium has healed and then every 1 to 6 months depending on the severity and frequency of the episode when multiple.

Screening and Diagnostic Recommendations

Vision Screening

Vision screening is performed for a wide range of purposes. Categories of vision screenings include pre-placement, periodic surveillance, post-injury and postoperative [217, 218](AOA). It is also performed for motor vehicle driver licensure.

Vision Screening for Preplacement Examinations

Recommended.

Preplacement vision screening is recommended for jobs that require visual acuity.

Indications **–** Occupations that require visual acuity for performance. **Generally, most safety sensitive and safety critical jobs require corrected visual acuity of at least 20/40 in both eyes and each eye separately.**

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – High

Vision Screening for Periodic Surveillance Examinations

Recommended.

Periodic vision screening is recommended for jobs that require visual acuity.

Indications **–** Occupations that require visual acuity for performance. More frequent examinations are indicated for jobs with higher visual demands and/or higher risks and/or among those at higher risks for incident visual impairments. **Generally, most safety sensitive and safety critical jobs require corrected visual acuity of at east 20/40 in both eyes and each eye separately.**

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – High

Vision Screening for Post-injury Examinations

Recommended.

Vision screening is recommended for post-injury examinations.

Indications **–** All post-injury examinations, including subsequent follow-up examinations.

Strength of Evidence – **Recommended, Evidence (I)**

Level of Confidence – High

Vision Screening for Postoperative Examinations

Recommended.

Vision screening is recommended for postoperative examinations.

Indications **–** All postoperative examinations, including subsequent follow-up examinations.

Strength of Evidence – **Recommended, Evidence (I)**

Level of Confidence – High

Rationale for Recommendations

Vision screening is widely performed as a component of essentially all eye-related examinations, most commonly with either a Snellen chart or a vision screening device that is comparable to a Snellen chart. For preplacement examinations, there are data to suggest increased risk of motor vehicle crashes with reduced visual acuity that is usually worse with 20/40 corrected [219-222], thus indirect evidence that both preplacement examinations and surveillance examinations are likely successful. There are many protocols for screening, with the most frequent interval typically being either annual or biennial. For specific occupations, there is an absence of evidence of efficacy of visual screening, but strong belief it is successful. Occupation-specific visual acuity testing beyond Snellen tests is recommended for specific occupations. For

post-injury and postoperative examinations, vision screening is used to track the recovery, but there are naturally no studies without vision screening being performed to assess its comparable utility. Vision screening is not invasive, is without adverse effects, is low cost and is thus recommended for pre-placement, periodic surveillance, post-injury and postoperative examinations.

Color Vision Testing

Color vision screening is commonly performed as a component of preplacement and periodic examinations. It is sometimes performed prior to return to work for post-injury and postoperative patients, particularly for those in safety critical jobs.

Color vision is critical for countless occupations that require varying degrees of color detection. Color vision testing is also performed for motor vehicle driver licensure. Color detection is commonly segregated into several discrete categories including normal, deutranopia (difficulty detecting red/purple from green/purple), protanopia (difficulty detecting blue/green from red/green), tritanopia (difficulty detecting yellow/green from blue/green), and achromatopsia (absence of ability to detect colors) [223]. Although often categorized into these categories, there is an unappreciated and tremendous degree of heterogeneity within these groups. This heterogeneity has functional impacts such that some individuals within a given group can accurately perform a given occupation's tasks while others cannot [224, 225].

An added complication is that, there is a widespread misconception that color signals are of uniform color hue when they are not. This produces further difficulties with determining safety to perform a given job. There is yet another a common misperception that color detection is fixed for life, but multiple retinal intracranial diseases, metabolic disorders and pharmaceuticals all may result in serious, functional color vision impairments [226-231]. Such examples include diabetic retinopathy [230], multiple sclerosis, [232, 233], chloroquine, and amiodarone [234-236]. There also are some decrements in color vision discrimination ability with aging [237], mercury toxicity [238], and use of petroleum-based solvents [239]. As an example of the consequences of failure to detect color vision deficiencies, acquired color vision deficiencies have resulted in transportation injury fatalities [240-242]. Yet, color vision deficiency is also associated with advantages in discerning camouflaged objects, animals or humans [243, 244].

Color Vision Screening for Preplacement Examinations

Recommended.

Preplacement color vision screening is recommended for jobs that require color vision detection.

> *Indications* **–** Occupations that require color visual detection for accurate performance. Generally, most safety sensitive and safety critical jobs require some degree of color detection, although the discrimination requirements vary widely. These include almost all jobs requiring commercial operation of motorized equipment. Pseudochromatic plates are generally the most efficient way to screen a population and are thus recommended. Functional tests (e.g., on-the-job test) are of unclear validity and, if used, must test a wide array of circumstances (e.g., array of hues to be encountered, time of day/night, varying backgrounds) to have the potential to be valid.
> *Strength of Evidence* – **Recommended, Evidence (C)**
> *Level of Confidence* – High

Color Vision Screening for Periodic Surveillance Examinations

Recommended.

Periodic color vision screening is recommended for jobs that require color vision detection.

> *Indications* **–** Occupations that require color visual detection for accurate performance. Generally, most safety sensitive and safety critical jobs require some degree of color detection, although the discrimination requirements vary widely. These include almost all jobs requiring commercial

operation of motorized equipment. Pseudochromatic plates are generally the most efficient way to screen a population and are thus recommended. Functional tests (e.g., on-the-job test) are of unclear validity and, if used, must test a wide array of circumstances (e.g., array of hues to be encountered, time of day/night, varying backgrounds) to have the potential to be valid.
Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Color Vision Screening for Select Post-injury Examinations

Recommended.

Color vision screening is recommended for select post-injury examinations.

Indications **–** Post-injury examinations for safety critical jobs that also require color vision detection.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Moderate

Color Vision Screening for Select Postoperative Examinations

Recommended.

Color vision screening is recommended for postoperative examinations.

Indications **–** Postoperative examinations for safety critical jobs that also require color vision detection.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Moderate

Rationale for Recommendations
Color vision deficiency is well associated with increased failures on signal detection [224, 225]. Fatalities in the transportation sector have been attributed to operator color vision deficiencies [240-242]. Thus, this is a strong basis for screening for color vision deficiency. There is also a potential basis for screening in favor of those with color vision deficiency for jobs requiring superior camouflage or animal detection [243, 244]. There are many color vision screening tests used, including: Ishihara, Farnsworth Panel D-15, Farnsworth Munsell 100 Hue (FM-100), Roth 28-hue desaturated, L'Anthony's desaturated D-15/D-15DS, Medmont C100, Color Assessment and Diagnosis Test; Nagel anomaloscope, Bowman's Color Confusion Index, Cambridge Colour Test (CCT), Color Assessment and Diagnosis test (CAD), Vingrys test, King-Smith's test, SPP-2, Nagel anomaloscopre, Color Vision Testing Made Easy (CVMET); City University Colour Vision Test (CUT); Waggoner computerized color vision test (CCVT) Richmond Hardy-Rand-Rittler (HRR), American Optical Hardy-Rand-Rittler (AO-HRR), Malbrel's chromatometer and luminance perception; Lantern test [237] [245-249] [236, 238, 250-255] [256-266] Cole 06a,b,c [267-269] [270-273] [218, 274, 275]. Pseudoisochromatic plates are the most commonly administered tests used to screen for color deficiency, with Ishihara b eing the most widely used. Functional tests, such as the lantern test, a signal detection test, or on-the-job function tests are often used to attempt to ascertain sufficient discriminant abilities to perform a job after failure on pseudoisochromatic plate testing.

Functional tests have not been validated for determination of ability to both accurately perform the job tasks and prevent injuries/fatalities. Thus, they are generally of unclear ability to properly determine safe and accurate job performance. Carefully performed, functional testing that includes the array of circumstances likely to be encountered (e.g., array of hues to be encountered, time of day/night, season of year, varying backgrounds) may be sufficiently accurate for some jobs. The use of unvalidated functional tests is particularly concerning for safety critical jobs. Validated functional tests should be validated for both accuracy under a wide array of performance circumstances (e.g., array of hues to be encountered, time of

day/night, season of year, varying backgrounds), as well as for ability to perform without elevated accident crash or other critical outcome performance measure(s).
Color vision screening is recommended for pre-placement and periodic screening for all jobs that require color vision detection. For safety sensitive and safety critical jobs, greater frequency of periodic screening is recommended, generally either annually or biennially. For safety critical jobs, screening post-injury and postoperative is also recommended. For those with risks for acquired color vision deficiency, greater frequency of color vision screening may be considered.

Color vision screening is not invasive, is without adverse effects, is low cost and is thus recommended for pre-placement, periodic surveillance, as well as select post-injury and postoperative examinations.

Peripheral Vision Testing

Peripheral vision is particularly required to appreciate objects that are approaching the person or for situations where the person is moving and thus needing peripheral vision for accident avoidance. This is necessary for motor vehicle accident avoidance, avoidance of injury from a forklift driven by another worker, avoidance of injury from moving parts (e.g., suspended parts from an overhead crane), operation of overhead cranes, etc. Some safety sensitive and non-safety sensitive jobs require full visual fields to function.

Peripheral Vision Screening for Preplacement Examinations

Recommended.

Preplacement peripheral vision screening is recommended for jobs that require peripheral vision.

Indications **–** Occupations that require peripheral vision, generally including most safety sensitive and safety critical jobs. Optimum means for testing are unclear. Screening the temporal field of vision with simple equipment that can measure degrees of visual field is a reasonable option. Confirmatory testing with standard automated perimetry testing equipment is required for definitive determinations, particularly those with reductions in visual fields or glaucoma.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Moderate

Peripheral Vision Screening for Periodic Surveillance Examinations

Recommended.

Periodic peripheral vision screening is recommended for jobs that require peripheral vision.

Indications **–** Occupations that require peripheral vision, generally including most safety sensitive and safety critical jobs. Frequency is generally every year or biennially. Optimum means for testing are unclear. Screening the temporal field of vision with simple equipment that can measure degrees of visual field is a reasonable option. Confirmatory testing with standard automated perimetry testing equipment is required for definitive determinations, particularly those with reductions in visual fields or glaucoma.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Moderate

Peripheral Vision Screening for Select Post-injury Examinations

Recommended.

Peripheral vision screening is recommended for select post-injury examinations.

Indications **–** Post-injury examinations for jobs that also require peripheral vision. This is particularly needed where the injury may have reduced peripheral vision capabilities.
Strength of Evidence – **Recommended, Evidence (I)**

Level of Confidence – Low

Peripheral Vision Screening for Select Postoperative Examinations

Peripheral vision screening is recommended for select postoperative examinations.

Indications **–** Postoperative examinations for jobs that also require a peripheral vision. This is particularly needed where the injury may have reduced peripheral vision capabilities.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Low

Rationale for Recommendations
Peripheral vision is necessary for most safety sensitive and safety critical jobs and job tasks, although unsurpringly, there are no studies identified that address risks in those occupations. Cohort and longitudinal studies reported elevated crash risks among subjects with reduced useful field of view [276-278]. Other study designs have suggested visual field and/or useful field of vision [279, 280] are associated with crashes [279, 281-283]. Yet, multiple studies suggest no increased risk for peripheral vision [221, 276, 284, 285]. Driving simulator studies [286, 287] [288-290] and road tests [291, 292] suggest performance problems with one finding participants with bilateral central scotomas had higher risks of failing to detect pedestrians, slower and missed responses [287]. Another found performance impairments associated with peripheral vision impairments [288].
The degree of peripheral vision required varies among occupations. The most common screening tests used in primary care are manual kinetic testing (typically, "finger wiggle" moving from the lateral side forward) and confrontation fields. There are multiple tests that have been used mostly in comparative studies, including: Standard automated perimetry, Short-wavelength automated perimetry (SWAP), Frequency-doubling technology perimetry (FDT), High-pass resolution perimetry (HPRP), Scanning Laser Polarimetry (SLP, GDx VCC), Optical coherence tomography (OCT), pattern-electroretinography (PERG), Pattern Electrand Heidelberg Retina Tomography (HRT), Octopus tendency-oriented perimetry (TOP), and the Humphrey Swedish Interactive Threshold Algorithm (SITA)-fast (HSF), SITA 24-2 SAP, and Humphrey Matrix perimetry [293-309] [310-313] [314-330] [92, 320, 331-350]. There are no validated tests that demonstrate a given test is able to predict both inability to accomplish normal peripheral vision as well as to not successfully avoid crashes or accidents. Thus, the means to accomplish screening are unclear. Automated equipment is commonly used for confirmatory testing (or for monitoring glaucoma) and Wagner is most commonly used.
Peripheral vision screening is nevertheless recommended for pre-placement and periodic screening for jobs that require peripheral vision. This includes most safety sensitive and safety critical jobs. When injuries or surgeries potentially impair peripheral vision, peripheral vision screening of post-injury and postoperative patients is also recommended. For those in jobs requiring peripheral vision who also have risks for acquired or progressive loss of peripheral vision (e.g., glaucoma), greater frequency of peripheral vision screening is recommended.
Peripheral vision screening is not invasive, is without adverse effects, is low cost and is thus recommended for select pre-placement, periodic surveillance, as well as select post-injury and postoperative examinations.

Depth Perception

Depth perception is the ability of the eye to help ascertain three dimensions and be able to judge the distance of an object. Depth perception is also involved in ascertaining the length, width, and the height of an object. When the head is held steady and the body is not moving, both eyes are required to ascertain depth perception, known as stereopsis. While depth perception is commonly thought to require both eyes, this is not completely correct. When the head and/or body is moving (e.g., moving the head or traveling by vehicle), some depth perception is possible based on experiences, the relative changes in the size and position of objects. Still, people with stereopsis will use these clues much less frequently.

Overall, there were two review articles that partially included the condition of monocular vision as a risk factor for occupational injury. One review found that balance issues related to problems of depth perception and visual ambiguity caused by monocular vision increased the risk of falling off a roof for roofers [351]. The second review showed little evidence that visual impairment increased risks for occupational injury and no studies were found that directly assessed monocular vision as a risk factor for occupational injury [352]. Overall, the lack of evidence for monocular vision as a risk factor for occupational injury seems to be related to not properly defining eye pathology in current research [352].

Depth Perception Screening for Preplacement Examinations

Recommended.

Preplacement depth perception screening is selectively recommended for jobs that require depth perception.

Indications **–** Occupations that require a high degree of depth perception for accurate performance. Optimum means for testing are unclear. A functional test that either accomplishes the required job functions or one that mimics the required job task(s) may be best.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Low

Depth Perception Screening for Periodic Surveillance Examinations

Recommended.

Periodic depth perception screening is recommended for select jobs that require depth perception.

Indications **–** Occupations that require a high degree of depth perception for accurate performance. Optimum means for testing are unclear. A functional test that either accomplishes the required job functions or one that mimics the required job task(s) may be best.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Low

Depth Perception Screening for Select Post-Injury Examinations

Recommended.

Depth perception screening is recommended for select post-injury examinations.

Indications **–** Post-injury examinations for jobs that also require a high degree of depth perception.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Low

Depth Perception Screening for Select Postoperative Examinations

Recommended.

Depth perception screening is recommended for select postoperative examinations.

Indications **–** Postoperative examinations for jobs that also require a high depth perception.
Strength of Evidence – **Recommended, Evidence (I)**
Level of Confidence – Low

Rationale for Recommendations

Depth perception is necessary for select jobs and job tasks. The degree of depth perception required varies widely. There are multiple tests that have been used mostly in comparative studies, including: Polarized Stereoscopic Monitor, Distance Randot Stereotest, Titmus stereo test (static depth perception), Frisby stereotest, Randot circles and FNS, Wirt Fly Stereotest, TNO test, steroacuity, stereogram [353-360] Leske 06. There are no validated tests that demonstrate a given test is able to predict both inability to accomplish

normal depth perception as well as to not successfully perform job tasks. Thus, the means to accomplish the testing are unclear.

Depth perception screening is nevertheless recommended for select pre-placement and periodic screening for jobs that require a high degree of depth perception. For jobs that require a high degree of depth perception, depth perception screening of post-injury and postoperative patients is also recommended. For those in jobs requiring depth perception who also have risks for acquired or progressive loss of depth perception (e.g., keratoconus), greater frequency of depth perception screening may be considered.

Depth perception screening is not invasive, is without adverse effects, is low cost and is thus recommended for select pre-placement, periodic surveillance, as well as select post-injury and postoperative examinations.

Foreign Bodies, Rust Rings, and Corneal Abrasions

Related Terms

- Corneal Abrasion
- Corneal Injury
- Corneal Scratch
- Corneal Laceration (not same as an abrasion)
- Corneal Foreign Body
- Adherent Corneal Foreign Body
- Embedded Corneal Foreign Body
- Metallic Foreign Body
- Rust ring
- Ferrous ring

Overview

Foreign bodies and corneal abrasions are the most commonly reported occupational ophthalmological conditions [59, 83, 361]. In experienced hands, they are usually relatively simple to manage. However, complications such as infections and other adverse sequella occasionally occur.

Risk and Causation

Risk Factors

Risks differ widely across occupational groups. Both foreign bodies in the eye and corneal abrasions may occur in nearly any occupational workgroup. Yet, those at highest risk tend to be employed in construction and metalworking occupations, especially where high impact and/or grinding occur. ([362], [363-368]. Work-related injury was the most common cause, accounting for 70% - 72% of all eye injuries [83]). More than 90% of injuries at work were by workers who worked with grinding/buffing, welding, working in dusty atmospheres, and drilling/hammering [83]. Those exposed to windy environments are also particularly susceptible. Protective eye wear reduces, but does not eliminate risks [72, 83, 369, 370]. In some studies, most workers were not wearing eye protection even though it was available [83, 370].

Causation

Causation is rarely at issue as the onset of symptoms is generally quite acute. When the onset is acute, the event at hand determines the cause.

Prevalence/Incidence

Population-based incidence data are not available. Males between the ages of 20-40 were more likely to be seen with ocular trauma than were women [83, 370, 371]. In an Australian metropolitan area, corneal abrasions were among the top five ocular emergencies [361]. US data are spares and eports from Korea, Singapore and Nigeria found work was the most common causative factor for ocular traumatic emergencies [59, 83, 372]. Corneal abrasions are well known to occur in the peri-operative and intensive care settings due to lack of protective reflexes [373-377], but are beyond the scope of this guideline.

Work Relatedness

Work-relatedness is determined by whether the ocular event occurred out of, or in the course of employment. As these are acute events, such determinations of work-relatedness are rarely difficult or controversial.

Signs and Symptoms

Medical History

Symptoms of corneal abrasions, foreign bodies and rust rings both commonly include:

- A foreign body sensation.
- Acute onset of symptoms (usually)
- Pain. May be severe, especially if large foreign body or extensive abrasion(s).
- Tearing
- Redness
- Photophobia, especially if more severe
- Visual acuity usually preserved unless visual axis affected

Onset

- Symptom onset is sudden and timed with a known event such as metalworking. Abrasions often involve rubbing the eye, with or without a prior foreign body sensation.

Current treatments used

- Usually none, although may have included flushing of the eye.

Prior injuries and prior treatments

- Risk Factors
- Workers with corneal foreign bodies often have had the same in the past, as they tend to hold at-risk jobs (e.g., metalworking).

Red Flags

Red flags for potentially more serious injuries include [378, 379]:

- History of penetrating trauma or high impact metalworking without eye protection
- Suspected penetration of the globe
- Lacerated cornea
- Lacerated globe
- Ruptured globe
- Impaled globe
- Impaired extraocular eye movements
- Gradual onset of photophobia without an inciting event
- Systemic symptoms or diseases, especially rheumatological
- Purulence
- Abnormal visual acuity without objective foreign body and/or abrasion in the visual axis

Job Analysis and Prevention

The employer's roles include primary prevention as well as facilitating secondary and tertiary prevention. Primary prevention activities include engineering interventions such as machine guarding to prevent exposure to the generation of projectiles from hammering, grinding, drilling, and use of other high-speed machines [371].

Education is an important component of prevention [371]. Most often, in higher risk settings, eye protection is still required after consideration of engineering controls to prevent ocular injuries. Safety eye wear, includes glasses, goggles face shields and splash guards, and should be selected based on the exposure(s) to adequately prevent work-related eye injuries.

The employer's roles include eyewear provision, education and promotion of the use of appropriate eye safety wear [368]. Employer's roles also include facilitating appropriate medical care for eye injuries that

are incurred at the workplace. Employers sometimes also facilitate consultations when suboptimal clinical results occur.
One role of an employer is education of the susceptible workforce regarding ocular hazards [380, 381].

Education for Potential Eye Injuries

Recommended.

Education is recommendation for workers who have potential for eye injuries, e.g., from chemical splashes, impacting metal and/or wind-blown objects.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Indications:	All workers should be trained if they have potential for eye injuries, e.g., from chemical splashes, impacting metal and/or wind-blown objects.
Benefits:	Reduction in risk of injury
Harms:	Negligible
Frequency/Dose/Duration:	Pre-placement, periodic and post-injury
Indications for Discontinuation:	Lack of exposure
Rationale:	Behavioral and education training on injury prevention has been shown to be successful in a few studies, although it is combined with protective eye wear [73, 380, 381]. Training to prevent eye injuries is not invasive, has no adverse effects, is of negligible cost, has demonstrated efficacy and is thus recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits.

Protective Eyewear for Prevention of Eye Injuries

Recommended.

Behavioral and Psychological Interventions

Protective eyewear is recommended for prevention of eye injuries.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Indications:	Moderate and high risk occupations and at-risk workforces. The employer should educate the workers regarding the potential for ocular injury and the means of protection [71]. Especially in high-risk settings, it is recommended that this should then be followed by enforcement.
Benefits:	Proactive reductions in risks of injury
Harms:	Time to educate
Frequency/Dose/Duration:	Generally at baseline and at least annually in moderate and high risk settings.
Indications for Discontinuation:	At-risk exposure(s) have been engineered out

Rationale:	Protective eyewear promotion (PEP) has been shown to be effective for improving compliance, although not in some studies for reducing the rate of injuries [71, 381, 382], for which studies are likely underpowered. Other studies combining education and protective eyewear have shown reductions in injuries [380]. In one study, there was a 2.4-fold odds of wearing appropriate eyewear compared with controls. [382] Education is low cost, without adverse effects and likely effective and thus is recommended. This may require (re)inforcement for efficacy.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Educational interventions for the prevention of eye injuries, eye controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 4 articles in PubMed, 665 in Scopus, 1 in CINAHL, 1 in Cochrane Library and 2 in other sources. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 1 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic study met the inclusion criteria.

Safety Glasses in Most Employment Settings

Recommended.

Devices

Safety glasses suffice for most employment settings and are recommended for most low to moderate-risk exposure situations.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – High

Indications:	Workers at risk of penetrating trauma, hammering/pounding metal, chemical splashes or performing work that previously resulted in foreign bodies.
Benefits:	Injury Prevention
Harms:	Minor discomfort
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	Removal from at-risk task

Rationale: Safety glasses and/or safety eyewear have been shown to be effective for reductions in eye injuries [380]. Safety glasses are recommended for prevention of eye injuries and the specific type of protection is ideally selected to address the worker(s) specific job task(s). Safety glasses suffice for most employment settings. Where

there are high-risks of penetrating eye trauma or chemical splashes, safety goggles, face shields and/or splash guards are generally preferable.

Evidence: A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: eye, safety glasses, safety eyewear, safety goggles, eye protective devices, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 117 articles, and considered 3 for inclusion. In Scopus, we found and reviewed 2,782 articles, and considered zero for inclusion. In CINAHL, we found and reviewed 40 articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 10 articles, and considered zero for inclusion. We also considered for inclusion zero articles from other sources. Of the 3 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Safety Goggles, Face Shields and/or Splash Guards in High-Risk Jobs for Penetrating Eye Trauma or Chemical Splashes

Recommended.

Devices

Where there are high-risks of penetrating eye trauma or chemical splashes, safety goggles, face shields and/or splash guards are Recommended, Insufficient Evidence.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications: Workers at risk of penetrating trauma, hammering/pounding metal, chemical splashes or performing work that previously resulted in foreign bodies.

Benefits: Injury Prevention

Harms:

Frequency/Dose/Duration:

Indications for Discontinuation: Removal from at-risk task

Rationale: There are no quality studies. There are no quality comparative trials. In settings were exposures risks and/or consequences of exposures are higher, safety goggles, face shields, and/or splash guards are recommended for prevention of eye injuries. However, Safety glasses likely prevent ocular injuries from

	splashes and injuries associated with penetrating eye trauma. Goggles, face shields and/or splash guards may be preferable where risk of splashes is high or where risks of projectile metal is quite high.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: eye, safety glasses, safety eyewear, safety goggles, eye protective devices, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 117 articles, and considered 3 for inclusion. In Scopus, we found and reviewed 2,782 articles, and considered zero for inclusion. In CINAHL, we found and reviewed 40 articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 10 articles, and considered zero for inclusion. We also considered for inclusion zero articles from other sources. Of the 3 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.
*Comment*s:	Goggles may be preferable where risk of splashes is high. Goggles may also be Indicated where risks of projectile metal is quite high. However, they are typically less well tolerated.

Diagnosis

Initial Assessment

Visual acuity should be assessed in all patients. It may be impaired, particularly if the visual axis is involved with the injury or the injury is extensive, e.g., with heavy tearing. This is followed by a careful history of the event(s), including duration of the condition. An eye history should be obtained that includes prior trauma and diseases. A history of systemic diseases should be sought. Prior treatment should be recorded.
An eye exam should ensue. Findings on inspection typically include redness, tearing and difficulty using the eye. Larger foreign bodies are visible on direct inspection. Unless large, abrasions are usually not visible without staining. Direct inspection may provide initial identification of larger foreign bodies. Magnification should identify foreign body(ies) and, if present, rust rings. Slit lamp examination is best. Fluorescein staining should be performed after the initial eye examination has occurred.
Prompt referral for definitive care is recommended for cases with penetrating wounds, lacerations, impaired ocular movements, new pupillary defects, signs of infection, loss of visual acuity (unless a minor abrasion is in the visual axis), and signs of iritis.

Diagnostic Criteria

Corneal abrasion:

- Linear uptake on fluorescein staining, may be multiple. May have identifiable parallel linear streaks of uptake. May also have one large defect.

Foreign body:

- Visible foreign matter in the eye, either upon inspection or with slit lamp examination
- Foreign matter does not move with eyelid movement if it is embedded or fixed

Rust ring:

- Generally requires a ferrous foreign body in the eye for at least 3-4 hours and, most commonly, overnight. Often visible without magnification, however small rust rings may require slit lamp examination to observe

Classification

Minor abrasions, rust rings and foreign bodies are not commonly classified.

History

The history should include a careful ascertainment of the event(s), including duration of the condition. Particularly important aspects are whether high-impact was used to attempt to estimate the impact and probability of a penetrating foreign body. For example, hammering a nail or metal stamping have higher potential for penetrating trauma, while looking up under a car for routine muffler work with debris dropping in the eye does not. Use of eye protection (glasses, goggles) should be ascertained, and generally (re)recommended if the exposure is ongoing. An eye history should be obtained that includes prior trauma, diseases especially affecting the eye(s). Systemic disease should be sought. Prior treatment should be recorded, including whether the eye has been irrigated or otherwise treated.

Physical Exam

In general, physical examination for simple corneal abrasions, rust rings and foreign bodies should include the following elements:

- Distant visual acuity, usually Snellen
- Inspection, appearance (sclera, conjunctiva, blood)
- Signs of other potential foreign bodies in the eyelids, eye brows and on the skin
- Periorbital appearance
- Extraocular movements
- Pupillary reactivity, iris and appearance
- Slit lamp examination
- Fluorescein staining

Other physical examination components that are sometimes used for apparent work-related foreign body eye injuries include pinhole testing (particularly if there is a reduction in visual acuity), direct ophthalmoscopy, and occasionally, ocular pressure/manometry.

Diagnostic Recommendations

Visual Acuity Testing

Distance visual acuity screening is performed at the initial visit to document current visual acuity, guide clinical management, and as a baseline for follow-up visits. The Snellen chart test is considered the gold standard in visual acuity testing. Most tests are conducted at a distance of 20 feet away, however smaller letters may be used when the chart or card is less than 20 feet away ([383] https://medlineplus.gov/ency/article/003396.htm). There are many other acuity tests that have been used including the Randot Stereoacuity test (RSA) [384], the Early Treatment Diabetic Retinopathy Study [385, 386], the Functional Acuity Contrast Test [387] and the Tritan Contrast Threshold test [388].

VISUAL ACUITY SCREENING WHEN EVALUATING EYE CONDITIONS
Recommended.

Vision screening is recommended for evaluation of eye function, including foreign body and corneal abrasion injuries.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Benefits:	Provides clinical assessment of vision
Harms:	None
Indications:	For the evaluation of eye function after eye injury from foreign bodies and corneal abrasions.
Rationale:	There are no quality studies to directly address the utility of visual acuity testing. However, it is the primary screening test for all injured eye patients, serving as the main basis for evaluating visual acuity, and as it also is not invasive and has negligible costs is thus recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Visual Acuity Testing, Snellen Test, E-Chart, Titmus test, Eye Exam, Snellen Test, Titmus test eye, eyes, disorders, sensitivity, specificity, predictive value of tests, gold standard, accurate, accuracy, precision, precise, and test. We found and reviewed 824 articles in PubMed, 49 in Scopus, 292 in CINAHL, 20 in Cochrane Library and 0 in other sources. We considered for inclusion 16 from PubMed, 5 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 21 articles considered for inclusion, 12 articles met the inclusion criteria.

Use of Slit Lamp and Fluorescein Stain for Evaluation and Diagnosis of Foreign Body and Corneal Abrasion

Recommended.

Slit lamp with fluorescein staining is recommended.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Benefits:	Provides identification of foreign body and corneal epithelial defect. Observation of Seidel's sign indicates possible anterior chamber leakage or globe perforation.
Harms:	None. Rare allergies
Indications:	The slit lamp examination is the most common method for visualizing corneal abrasions and other ocular defects. It is also the preferred method for visualizing uptake with fluorescein staining.
Rationale:	There are no quality trials comparing use of slit lamp with and without fluorescein staining. Some foreign bodies may be observed without a microscope or slit lamp. This technique requires modest practitioner skill. The procedure is moderately expensive, has no adverse effects for diagnostic purposes, is highly effective, and therefore is recommended.

Evidence: A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: slit lamp examination, slit lamp exam, eye, disorders, sensitivity, specificity, predictive value of tests, gold standard, accurate, accuracy, precision, precise, and test. We found and reviewed 1577 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 0 in other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Zero articles met the inclusion criteria.

X-ray

Roentgenograms (X-Rays) use x-ray beams to detect radiolucent objects, particularly metallic or calcified. They have been used to assess the eye's structural components and can be used to detect intraorbital foreign bodies (IOFBs), orbital and intraorbital fractures, orbital floor blow-outs and retinoblastomas [389-392].

X-ray for Evaluation of Orbital Fracture

Recommended.

X-rays have been used for evaluation of potential fractures, and penetrating eye trauma particularly if metallic [390].

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Benefits:	Detection of orbital fractures
Harms:	Mild radiation exposure
Indications:	Trauma sufficient to produce orbital fracture(s).
Rationale:	There are no quality studies of X-rays for the detection of orbital fracture, although they have been widely used. X-rays are not invasive, have no significant adverse effects and are low to moderate cost and are thus recommended for evaluation of potential orbital fracture.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Eye, Efficacy, Efficiency, Diagnostic, Sensitivity and Specificity, Predictive Value of Tests, Positive predictive value, Negative predictive value, Radiography, X-ray, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 225 articles in PubMed, 271 in Scopus, 3 in CINAHL, 1 in Cochrane Library and zero in other sources. We considered for inclusion 7 from PubMed, 1 from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the

8 articles considered for inclusion, 0 trials and zero systematic studies met the inclusion criteria.

X-RAY FOR EVALUATION OF OCULAR FOREIGN BODIES

Recommended.

X-rays have been used for evaluating the presence of ocular metallic bodies.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Benefits:	Detection of intraocular foreign bodies
Harms:	Mild radiation exposure
Indications:	High impact tool use likely to produce penetrating projectile(s) and thus risk of intraocular foreign bodies.
Rationale:	There are 2 moderate quality studies that included using x-rays for detection of intraocular foreign bodies. Clear superiority of one imaging method over another (e.g., CT, xray) has not been shown, and there is some evidence (i) CT is superior to xray for evaluation of trauma [393]; and (ii) MRI is superior to xray or CT to determine foreign body composition if non-ferrous [390]. X-rays are not invasive, have no significant adverse effects and are low to moderate cost and are thus recommended for evaluation of intraocular foreign bodies (especially metallic).
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Eye, Efficacy, Efficiency, Diagnostic, Sensitivity and Specificity, Predictive Value of Tests, Positive predictive value, Negative predictive value, Radiography, X-ray, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 225 articles in PubMed, 271 in Scopus, 3 in CINAHL, 1 in Cochrane Library and zero in other sources. We considered for inclusion 7 from PubMed, 1 from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 8 articles considered for inclusion, 0 trials and zero systematic studies met the inclusion criteria.

X-RAY FOR EVALUATION FOR SIMPLE ABRASIONS, RUST RINGS, AND NON-PENETRATING FOREIGN BODIES

Not Recommended.

X-rays are not recommended for routine evaluation of ocular abrasions, rust rings and foreign bodies.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – High

Benefits:	None for routine use
Harms:	Radiation exposure, cost
Indications:	Not indicated for simple abrasions, rust rings or foreign bodies.
Rationale:	There are no quality studies comparing use of xrays with evaluations without xray to ascertain differences in patient outcomes for simple abrasions, rust rings and/or foreign bodies. Xrays have no clear use for routine evaluation of foreign bodies that do not penetrate and thus are not recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Eye, Efficacy, Efficiency, Diagnostic, Sensitivity and Specificity, Predictive Value of Tests, Positive predictive value, Negative predictive value, Radiography, X-ray, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 225 articles in PubMed, 271 in Scopus, 3 in CINAHL, 1 in Cochrane Library and zero in other sources. We considered for inclusion 7 from PubMed, 1 from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 8 articles considered for inclusion, 3 trials and zero systematic studies met the inclusion criteria.

Computed Tomography (CT)

Computerized tomograms use x-rays but provide more detailed images with greater resolution [394]. It is considered superior to MRI for imaging fractures [395]. Its purported uses are similar to, but more extensive than xrays including detecting intraorbital foreign bodies (IOFBs), orbital fractures, orbital sepsis and traumatic optic neuropathy [39][396, 397].

CT for Evaluation of Ocular Foreign Bodies

Recommended.

CT imaging is selectively indicated for evaluation of penetrating and/or evaluation of potentially retained intraocular foreign bodies.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Benefits:	Improved diagnostic accuracy and potentially altered treatment plans
Harms:	Higher radiation exposure than x-rays, cost
Indications:	Selective use only in cases of 1) penetrating globe injuries, 2) penetrating corneal abrasions, with 3) concerns for potentially retained intraorbital foreign bodies (IOFBs).
Rationale:	There are no quality studies comparing use of CT scans with evaluations without CT scans to ascertain differences in patient outcomes. One small comparative study reported superiority of

	helical CT scans to conventional scans in the pre-operative setting (Lakits 1998). CT scans have been suggested to be helpful for evaluating intraorbital foreign bodies (IOFBs) [394, 396, 397] and thus are recommended for selective use.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: computed tomography, orbit injury, eye injury, eye foreign bodies, penetrating eye injuries, eye fractures, trauma, corneal abrasion, rust ring, hyphemia, conjunctivitis, bacterial infection, fungal infection, pterygium, surfer's eye, transplants, cataracts; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, review. We found and reviewed 847 articles in PubMed, 13 in Scopus, 49 in CINAHL, 4 in Cochrane Library and 0 in other sources. We considered for inclusion 10 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 10 articles considered for inclusion, 2 diagnostic studies and 1 systematic studies met the inclusion criteria. Of these, 2 were of moderate quality.

CT for Evaluation of Possible Orbital Fracture

Recommended.

CT imaging is selectively indicated for evaluation of penetrating globe injuries and/or abrasions accompanied by concerns for orbital fractures unaddressed by radiographs.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Benefits:	Improved diagnostic accuracy and potentially altered treatment plans
Harms:	Higher radiation exposure than x-rays, cost
Indications:	Selective use only in cases of suspected fractures not seen on simple X-ray, suspected orbital sepsis or traumatic optic neuropathy or penetrating globe injuries. May be indicated for likely fractures with complications (e.g., impaired visual function). Simple orbital fractures without complications do not require CT (e.g., no impaired extraocular movements, normal visual function). (Pasman 95; Lakits 98)
Rationale:	There are no quality studies comparing use of CT scans with evaluations without CT scans to ascertain differences in patient outcomes. There is one large trial with a risk tool suggesting efficacy with CT for blunt trauma (Bodanapally 2014). CT scans have been suggested to be helpful for evaluating orbital fractures, orbital sepsis and traumatic optic neuropathy [394, 396, 397] and thus are recommended for selective use.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date

limits using the following terms: computed tomography, orbit injury, eye injury, eye foreign bodies, penetrating eye injuries, eye fractures, trauma, corneal abrasion, rust ring, hyphemia, conjunctivitis, bacterial infection, fungal infection, pterygium, surfer's eye, transplants, cataracts; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, review. We found and reviewed 847 articles in PubMed, 13 in Scopus, 49 in CINAHL, 4 in Cochrane Library and 0 in other sources. We considered for inclusion 10 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 10 articles considered for inclusion, 2 diagnostic studies and 1 systematic studies met the inclusion criteria. Of these, 2 were of moderate quality.

Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imagery (MRI) has been used especially for soft tissue imaging [398-402] that includes intraocular, non-ferrous foreign bodies [403, 404].

MRI for Diagnosis of Foreign Body and Corneal Abrasion

Not Recommended.

MRI is not recommended for routine evaluation of eye foreign body or corneal abrasion, particularly if there is concern of ferrous-metallic object penetration of the globe. MRI may be a reasonable option to evaluate intraocular foreign bodies when there is assurance that an intraocular foreign body is non-ferrous [390, 403] and/or there are concerns for fracture with visual impairment

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – High

Benefits:	Identification of foreign body(ies)
Harms:	Contraindicated with ferrous-metal foreign body due to potential further trauma, costs
Indications:	Not recommended for most ocular events. Rarely recommended for soft tissue injuries. However, MRI is useful for evaluation of other conditions including orbital fractures, and trauma with visual impairment.
Rationale:	There are no quality studies comparing use of MRIs with evaluations without MRIs to ascertain differences in patients outcomes. MRI may be a reasonable option to evaluate intraocular foreign bodies if they are known to be non-ferrous [403]. MRIs have been shown to be helpful for evaluating soft tissues, including retinal imaging, evaluating staphyloma [405]. Workers are usually unable to identify whether a potential metal foreign body is ferrous or not, providing further concerns about the use of MRI in that setting. When there is concern regarding detection of orbital fractures, CT is generally preferable.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date

limits using the following terms: Magnetic Resonance Imaging (MRI), eye, orbit, eye foreign bodies, eye injuries, penetrating, sensitivity and specificity, predictive value of tests, gold-standard, accurate, accuracy, precision, precise and test. We found and reviewed 275 articles in PubMed, 5 in Scopus, 5 in CINAHL, 9 in Cochrane Library and zero in other sources. We considered for inclusion 9 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 0 from other sources. Of the 10 articles considered for inclusion, 3 articles met the inclusion criteria.

Treatment Recommendations

Foreign Body Removal

Depending on size and degree of embedding, foreign bodies are commonly removed through irrigation, cotton swab, hypodermic needle tip, burr tool, and natural tears [406-408]. Magnets are also successfully used for ferrous foreign body `removals [409, 410]. Rust rings also occur and are generally easily removed [411, 412].

Copious Irrigation for Removal of Superficial Foreign Body(ies)

Recommended.

Surgical Considerations

Copious irrigation (e.g., approximately 200mL to 1L) is recommended for removal of superficial foreign body(ies) in some circumstances. The use of a Morgan Lens is not recommended for simple foreign bodies and may cause (additional) abrasions unless there is concern related to chemical or other substance that may result in rapid corneal injury through pH imbalance or other mechanism. Copious irrigation after removal of a foreign body (see below) is often included as an adjunct to attempt to assure removal of foreign body(ies).

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – High

Indications:	Foreign body sensation, especially with mechanism suspected to result in unembedded foreign body(ies), such as fiberglas, windblown debris. Also selectively used after foreign body removal, particularly if the foreign body fragments.
Frequency/Dose/Duration:	Irrigation with from approximately 200mL to 1L of either sterile saline or lactated Ringer's solution is recommended [413]. Experimental evidence suggests solution choice is unimportant [413].
Benefits:	Removal of foreign body or irritants.
Harms:	Negligible when irrigated without an appliance. May have minor irritation
Indications for Discontinuation:	After completion. May repeat until symptoms resolved.
Rationale:	There are no quality studies comparing irrigation with no irrigation for foreign bodies of the eye. Irrigation is low cost, minimally invasive, associated with negligible risks, is successful and is recommended.

Evidence:

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: nonpenetrating, superficial, ocular, corneal, penetrating, foreign body, eye foreign bodies, “rust ring, eye, eyes, removal, extraction, leaving in the eye, mydriatics, cycloplegic, meidiatric effect, extraction size, extraction location, woods lamp, slit lamp, fibrin tissue adhesive, fibrin sealant, autologous fibrin tissue adhesive, fibrin klebe system immune, transglutine, crosseal, tisseel, tissel, tussucol, beriplast, seal fibrin, eye irrigation, irrigation, morgan lens, morgan lenses, patching, patch, treatment, eye magnet, eye burr, diamond burr, alger brush, ophthalmic burr, aaron burr, burr, contusion, Acuvail, acular LS, acular PF, acuvil, bromday, bromfenac ophthalmic, diclofenac ophthalmic, flurbiprophen ophthalmic, Ilevro, ketorolac ophthalmic, phenylephrine ophthalmic, nepafenac ophthalmic, nevanac, ocufen, omidria, prolensa, voltaren ophthalmic, ketoroloac tromethamine, topical NSAID, “Anti-Inflammatory Agents, Non-Steroidal", Gentamicin, tobramycin, besifloxacin, ciproflaxin, gatifloxacin, levofloxacin, moxifloxacin, ofloxacin, azithromycin, erythromycin, bacitracin, polymyxin, natamycin, neomycin, gramicidin, trimethoprim, sulfacetamide, Neosporin, polytrim, natacyn, romycin, Azasite, ocuflox, vigamox, lquix, quixin, Zymar, Ciloxan, besivance, tobrex, Anti-Bacterial Agents, Anti-Bacterial, Agents, antibiotic ointment, antibacterial ointment, anesthetics, lidocaine, tetracaine, proparacaine, fluress, topical anesthetic, prednisolone, fluorometholone, steroids, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 85 articles, and considered 13 for inclusion. In Scopus, we found and reviewed 10,342 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed 137 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 173 articles, and considered 0 for inclusion. We also considered for inclusion 4 articles from other sources. Of the 18 articles considered for inclusion, 2 randomized trials and 0 systematic studies met the inclusion criteria.

FOREIGN BODY REMOVAL OF SUPERFICIAL FOREIGN BODY(IES) WITH COTTON SWAB, NEEDLE OR MAGNET

Recommended.

Surgical Considerations

Foreign body removal is recommended. The device used (e.g., needle, tool, magnet, swab) is recommended to be based on expected foreign body composition, depth of embedding and clinician's experience. Copious irrigation after removal of a foreign body (see above) may also be included as an adjunct to attempt to assure removal of foreign body(ies) especially if fragmentation occurs on attempted removal. Use of slit-lamp examination is usually helpful, but is optional for simple removals, especially when the foreign body is visible without magnification and removal is easy (e.g., use of magnet). Slit-lamp is essential if prior removal attempts fail. [406]

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	Foreign body visualized, and non-mobile.
Benefits:	Removal of foreign body
Harms:	Negligible in experienced hands. Rare infections, although that risk may not be associated with the foreign body removal, and instead is more associated with embedded organic matter.
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	With resolution of issue
Rationale:	Foreign body removal has not been evaluated in quality comparative trials. Use of a magnetized tool tip is quite simple and may result in less corneal damage, but its use is limited to ferrous bodies. Quality data do not clearly define that a slit-lamp examination is required [406], although for some removals it is essential. Foreign body removal is moderate cost, minimally invasive, associated with negligible risks, is highly successful and is recommended.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: nonpenetrating, superficial, ocular, corneal, penetrating, foreign body, eye foreign bodies, "rust ring, eye, eyes, removal, extraction, leaving in the eye, mydriatics, cycloplegic, meidiatric effect, extraction size, extraction location, woods lamp, slit lamp, fibrin tissue adhesive, fibrin sealant, autologous fibrin tissue adhesive, fibrin klebe system immune, transglutine, crosseal, tisseel, tissel, tussucol, beriplast, seal fibrin, eye irrigation, irrigation, morgan lens, morgan lenses, patching, patch, treatment, eye magnet, eye burr, diamond burr, alger brush, ophthalmic burr, aaron burr, burr, contusion, Acuvail, acular LS, acular PF, acuvil, bromday, bromfenac ophthalmic, diclofenac ophthalmic, flurbiprophen ophthalmic, Ilevro, ketorolac ophthalmic, phenylephrine ophthalmic, nepafenac ophthalmic, nevanac, ocufen, omidria, prolensa, voltaren ophthalmic, ketoroloac tromethamine, topical NSAID, "Anti-Inflammatory Agents, Non-Steroidal", Gentamicin, tobramycin, besifloxacin, ciproflaxin, gatifloxacin, levofloxacin, moxifloxacin, ofloxacin, azithromycin, erythromycin, bacitracin, polymyxin, natamycin, neomycin, gramicidin, trimethoprim, sulfacetamide, Neosporin, polytrim, natacyn, romycin, Azasite, ocuflox,

vigamox, lquix, quixin, Zymar, Ciloxan, besivance, tobrex, Anti-Bacterial Agents, Anti-Bacterial, Agents, antibiotic ointment, antibacterial ointment, anesthetics, lidocaine, tetracaine, proparacaine, fluress, topical anesthetic, prednisolone, fluorometholone, steroids, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 85 articles, and considered 13 for inclusion. In Scopus, we found and reviewed 10,342 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed 137 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 173 articles, and considered 0 for inclusion. We also considered for inclusion 4 articles from other sources. Of the 18 articles considered for inclusion, 12 randomized trials and 1 systematic study met the inclusion criteria.

Comments: *[Can include harms, benefits, advantages, limitations, etc.]*

Removal of Rust Ring

Recommended.

Surgical Considerations

Removal of a corneal rust ring is recommended. Rust rings can develop in as little as three to four hours after ferrous metal adheres to, or penetrates the cornea [56-58]. Due to its insolubility in the corneal tissues, oxidation occurs and rust infiltrates the surrounding corneal tissue [56-58]. However, it is usually readily removed [57, 58].

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	Presence of rust ring with or without foreign body. If foreign body visualized, it must be removed and by definition, use of a magnet for an initial tool to attempt to remove the foreign body is preferred. For rust ring removal, use of a burr under slit lamp examination is the preferable procedure. [412] Use of a hypodermic needle may be adequate to successfully remove some tiny rust rings.
Benefits:	Removal of rust ring. Improvement in visual acuity if rust ring is in the visual axis. Removal is thought to also reduce scarring.
Harms:	Negligible in experienced hands.
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There is no trial comparing rust ring removal with non-removal. Rust ring removal has been evaluated in one moderate quality trial that compared manual rust ring removal with use of an electric drill and found the drill superior [412]. A low quality

trial found comparative results with an electric drill compared with a burr [412]. Delayed and/or inadequate rust ring removal has been associated with worse ocular rehabilitation. [414] Rust ring removal is minimally invasive, associated with negligible risks, generally quite successful, moderately costly, and thus is recommended.

Evidence: A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Rust ring removal, cornea, corneal, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 12 articles in PubMed, 5 in Scopus, 0 in CINAHL, 2 in Cochrane Library and 0 in other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 4 articles considered for inclusion, 2 clinical trials and 0 systematic studies met the inclusion criteria.

Eye Patching

Eye patching has been used as a treatment for corneal abrasion injuries related to foreign body or traumatic injury of the corneal epithelium [362, 415-419]. Patching for 24 hours has been traditionally prescribed to purportedly reduce pain and a theory of promoting healing through reducing eyelid movement across the wound [417].

Eye Patching for Corneal Abrasion

Moderately Not Recommended.

Devices

Eye patching for simple corneal abrasions is moderately not recommended, including after removal of foreign bodies or rust rings.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Level of Confidence – Moderate

Indications: None

Benefits: None demonstrated

Harms: Inability to use the eye, elimination of binocular vision, reduced depth perception.

Frequency/Dose/Duration:

Indications for Discontinuation:

Rationale: There are five moderate quality trials that compared the use of an eye patch with no patch for simple corneal abrasions. [362, 416-419] There are no quality trials comparing patch to non-patching without cointerventions, as each of the trials utilized other treatments in addition to patching, including mydriatics, ophthalmic antibiotic drops or ointments, which may also have had some therapeutic effect. However, the trial results

uniformly found no clinically significant differences demonstrated between the groups in healing times, pain control or adverse outcomes. The use of an eye patch did not demonstrate altered increased risk of infection in any of the trials. Use of an eye patch may be problematic for activities requiring binocular vision and good depth perception. Evidence is consistent that an eye patch does not provide faster healing or fewer complications, and therefore patching is not recommended for simple abrasions. There are 8 low quality trials comparing the use of an eye patch with no patch concomitant in the appendix, with mostly comparable results. [417, 418, 420-425]

Evidence: A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: nonpenetrating, superficial, ocular, corneal, penetrating, foreign body, eye foreign bodies, “rust ring, eye, eyes, removal, extraction, leaving in the eye, mydriatics, cycloplegic, meidiatric effect, extraction size, extraction location, woods lamp, slit lamp, fibrin tissue adhesive, fibrin sealant, autologous fibrin tissue adhesive, fibrin klebe system immune, transglutine, crosseal, tisseel, tissel, tussucol, beriplast, seal fibrin, eye irrigation, irrigation, morgan lens, morgan lenses, patching, patch, treatment, eye magnet, eye burr, diamond burr, alger brush, ophthalmic burr, aaron burr, burr, contusion, Acuvail, acular LS, acular PF, acuvil, bromday, bromfenac ophthalmic, diclofenac ophthalmic, flurbiprophen ophthalmic, Ilevro, ketorolac ophthalmic, phenylephrine ophthalmic, nepafenac ophthalmic, nevanac, ocufen, omidria, prolensa, voltaren ophthalmic, ketoroloac tromethamine, topical NSAID, “Anti-Inflammatory Agents, Non-Steroidal", Gentamicin, tobramycin, besifloxacin, ciproflaxin, gatifloxacin, levofloxacin, moxifloxacin, ofloxacin, azithromycin, erythromycin, bacitracin, polymyxin, natamycin, neomycin, gramicidin, trimethoprim, sulfacetamide, Neosporin, polytrim, natacyn, romycin, Azasite, ocuflox, vigamox, lquix, quixin, Zymar, Ciloxan, besivance, tobrex, Anti-Bacterial Agents, Anti-Bacterial, Agents, antibiotic ointment, antibacterial ointment, anesthetics, lidocaine, tetracaine, proparacaine, fluress, topical anesthetic, prednisolone, fluorometholone, steroids, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 85 articles, and considered 13 for inclusion. In Scopus, we found and reviewed 10,342 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed 137 articles,

and considered 0 for inclusion. In Cochrane Library, we found and reviewed 173 articles, and considered 0 for inclusion. We also considered for inclusion 4 articles from other sources. Of the 18 articles considered for inclusion, 5 randomized trials and 5 systematic studies met the inclusion criteria.

Medications

The use of ophthalmic antibiotic solutions or ointments have been prescribed following traumatic corneal abrasion. The incidence of bacterial keratitis following corneal abrasion is thought to be low, however there may be increased risk with injuries associated with vegetative or organic matter. [72-74]. There also is a reportedly higher incidence of keratitis from foreign body injuries in the developing world than industrialized countries [75][426].

Topical nonsteroidal anti-inflammatory medications (NSAIDs) function as local analgesics and are administered to provide relief from pain associated with corneal abrasions [76], postoperative pain from various surgical procedures [77] and pain associated with many other disorders.

Topical antifungal medications, generally in ointment form, have been used to attempt to prevent (or treat) fungal keratitis that typically arises from corneal abrasions with unsanitary objects or sources. [427]

Prophylactic Ophthalmic Antibiotics for Simple Corneal Abrasion, Rust Rings, and Foreign Bodies

No Recommendation.

Medications (including topical creams)

There is no recommendation for or against the use of prophylactic ophthalmic antibiotics for simple corneal abrasion, rust rings, and foreign bodies that do not involve vegetative matter.

Strength of Evidence – **No Recommendation, Insuffcient Evidence (I)**

Level of Confidence – Low

Indications:	None in the absence of vegetative matter (see below)
Benefits:	N/A
Harms:	Potential for allergic reaction
Frequency/Dose/Duration:	
Indications for Discontinuation:	
Rationale:	There are no quality studies suggesting efficacy of prophylactic ophthalmic antibiotics for prevention of eye infections in the setting of minor ocular trauma and not involving vegetative matter; vegetative matter is thought to significantly increase risk of infections and the recommendation is different (see below). There is only one low quality study using antifungals for corneal abrasions which showed lack of efficacy between treatment groups. As there is no quality evidence, antibiotics are not invasive, have few adverse effects and are low cost, there is no recommendation for or against use of antibiotics in the absence of vegetative matter.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular

injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Prophylactic Ophthalmic Antibiotics for Organic Matter Injuries

Recommended.

Medications (including topical creams)

Prophylactic ophthalmic antibiotics are recommended for abrasions associated with significant organic or vegetative matter.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Abrasions due to organic or vegetative matter, regardless of whether a foreign body removal procedure was required.
Benefits:	Potential for reduced risk of infection.
Harms:	Allergic reactions in susceptible patients, intolerance
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	When the condition has resolved
Rationale:	There are no quality trials comparing prophylactic antibiotic use with placebo or non-use in the setting of trauma involving organic matter. However, there is thought to be considerably higher risk of infection when vegetative matter is involved due to potential microbial load/dose, and this is thought to increase risk of infection. Prophylactic use is widely practiced in this setting. Ophthalmic antibiotics are noninvasive with low risk for systemic effects, but do carry small risk of adverse events such as allergic reaction, eyelid itching and swelling, and conjunctivitis. Costs range from inexpensive to relatively high cost for new wide spectrum antibiotics. Eye injuries associated with plant or vegetative matter or organic matter likely have higher risk for bacterial or fungal infection and may warrant use of these medications, and thus they are recommended for this limited indication.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects,

anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

NSAID Drops after Removal of Rust Ring or Foreign Body Removal

Moderately Recommended.

Medications (including topical creams)

NSAID ophthalmic drops are recommended for large abrasions and/or after removal of a corneal rust ring or foreign body, particularly if larger sized.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Level of Confidence – Moderate

Indications:	Rust ring with or without foreign body removal with larger sized ocular trauma.
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	Allergic reactions in susceptible patients, intolerance.
Frequency/Dose/Duration:	Per manufacturer's recommendations. Duration is until the abrasion is resolved.
Indications for Discontinuation:	When the condition and pain has resolved
Rationale:	There are 6 moderate quality trials comparing NSAIDs with placebo or drug vehicle for analgesia of simple corneal abrasion [428-433]. Ophthalmic drops were evaluated in one moderate quality study after rust ring removal and found evidence of efficacy [411]. Each of the trials suggest efficacy in providing analgesia, with no significant increases in adverse events or reduction in healing times. NSAID drops have been shown to reduce pain, have low adverse effects, are low cost, and are thus recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses,

anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 8 randomized trials and 0 systematic studies met the inclusion criteria.

Prophylactic Ophthalmic Antifungals for Routine Prophylaxis of Simple Corneal Abrasions, Rust Rings, and Foreign Bodies

Not Recommended.

Medications (including topical creams)

The use of topical antifungal medications is not recommended for routine prophylaxis of simple corneal abrasions, rust rings and foreign bodies. They may be of benefit in select populations at risk for contaminated injuries such as from plants or organic matter.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**
Level of Confidence – Low

Indications:	Not indicated for simple abrasions, rust rings and foreign bodies. May be used for very select patients who sustained a contaminated exposure.
Benefits:	N/A
Harms:	N/A
Frequency/Dose/Duration:	N/A
Indications for Discontinuation	N/A
Rationale:	There are no quality trials of efficacy in a developed country. There is one moderate quality comparative trial comparing use of antibiotics and topical clotrimazole with antibiotics in a developing world tribal population [427]. There were no differences in healing rates. The study may be limited by power, generalizability from Southern India, potentially different foreign body source(s) and/or complications may have differed [427]. Topical prophylactic antifungal medications are noninvasive, have low risk for adverse events, low to moderate cost, and are not shown to be effective and thus are not recommended for routine use as prophylaxis for simple corneal abrasions.

Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 1 randomized trial and 1 systematic study met the inclusion criteria.

Therapeutic Contact Lens for Corneal Abrasions, Rust Rings, and Foreign Bodies

Not Recommended.

Devices

A therapeutic contact lens or contact bandage is not recommended for corneal abrasions, rust rings, or foreign bodies.

Strength of Evidence: Abrasions – **Not Recommended, Evidence (C)**

Strength of Evidence: Rust Rings, Foreign Bodies – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – Moderate

Indications:	Generally not indicated for corneal abrasions, rust rings or foreign bodies as a stand-alone treatment
Benefits: None	
Harms:	N/A
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There is one moderate quality trial that compares use of patching with therapeutic contact lens and topical antibiotic for healing rates of simple corneal abrasion. There was no difference between the two groups. [65] Thus, there is no evidence of efficacy of the therapeutic contact lens and it is not recommended for these purposes.

	There are two low quality trials included in the appendix. [83, 84]
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 1 randomized trial and 1 systematic study met the inclusion criteria.

Epidermal Growth Factor (EGF) for Corneal Abrasions, Rust Rings, and Foreign Bodies

Not Recommended.

Medications (including topical creams)

Epidermal growth factor (EGF) is not recommended in the treatment of corneal abrasion, rust rings and foreign bodies.

Strength of Evidence: Abrasions – **Not Recommended, Evidence (C)**

Strength of Evidence: Rust Rings, foreign bodies – **Not Recommended, Insuffcient Evidence (I)**
Level of Confidence – Low

Indications:	Not indicated for the treatment of corneal abrasions, rust rings and foreign bodies.
Benefits:	"Potential for faster re-epithelialization and healing.
Risks:	Possible allergic response to EGF
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There is one quality trial comparing the use of EGF with placebo suggesting faster healing times measured in hours rather than days. [434] Topical ophthalmic EGF is not available on the U.S. FDA approved list of medications (accessed

drugs@FDA 4/20/15). Thus, EGF is not recommended for simple corneal abrasions.

Evidence: A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 1 randomized trial and 1 systematic study met the inclusion criteria.

Mydriatic Medications for Simple Corneal Abrasions, Rust Rings, and Foreign Bodies

Moderately Not Recommended.

Medications (including topical creams)

Mydriatic medications are not recommended for treatment of simple corneal abrasions, rust rings and foreign bodies.

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Level of Confidence – Moderate

Indications:	N/A
Benefits:	N/A
Harms:	N/A
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There is one high quality trial demonstrating no efficacy of mydriatic medication compared with synthetic teardrops for analgesia after corneal abrasion. [436] Mydriatic medications are not invasive, but cause dilation of the pupil and potentially light sensitivity and decreased visual acuity that may be a safety concern for reading, driving, etc. They are low cost. The use of mydriatic medications for corneal abrasion is not recommended except in circumstances that require pupil dilation.

There are 8 moderate and low quality trials that utilized mydriatic medications in conjunction with other treatments with no comparison of efficacy. These articles are found in other tables elsewhere in this guideline or the appendix. [362, 416, 420, 422, 423, 437-439]

Evidence: A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 1 randomized trial and 8 systematic study met the inclusion criteria.

Artificial Tears or Lubrication for Extensive Corneal Abrasions, Rust Rings, and Foreign Bodies

Recommended.

Medications (including topical creams)

Artificial tears or lubricants are selectively recommended for treatment of patients with extensive corneal abrasions, rust rings and foreign bodies, especially among those who do not tolerate ophthalmologic NSAIDs.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Corneal abrasions of sufficient size and pain that require adjunctive treatment. However, NSAIDs are more effective [429, 433], thus artificial tears reserved for those not tolerating ophthalmological NSAIDs.
Benefits:	May potentially alleviate some symptoms.
Harms:	Negligible.
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	Resolution of the condition
Rationale:	There are two quality trials comparing artificial tears to topical NSAIDs, demonstrating greater efficacy of the NSAID than

	artificial tears [429, 433]. There are no quality trials for artificial tears or lubrication vs. placebo. Artificial tears are inexpensive, noninvasive, and have low adverse effects. There is insufficient evidence for or against use of artificial tears, and other interventions may be more beneficial. However, these may be a low cost, low adverse effect option for those who do not tolerate NSAIDs yet require some additional minor treatment. Low quality –[433, 438, 439].
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 2 randomized trials and 2 systematic studies met the inclusion criteria.

Use of Topical Anesthetics for Corneal Abrasions, Rust Rings, and Foreign Bodies
Moderately Recommended.

Medications (including topical creams)

The selective use of topical anesthetics as a patient treatment option is recommended for short-term analgesia for corneal abrasion, rust rings and foreign bodies. However, self-treatment by the patient at home is not recommended.

Strength of Evidence – **Moderately Recommended, Evidence (B)**
Level of Confidence – Moderate

Indications:	Particularly large and/or painful injuries. Short term use of only one or two days is recommended.
Benefits:	Immediate relief of corneal and conjunctiva irritation and pain
Harms:	Potential for systemic toxicity, mask retained foreign body or nonhealing defect
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	Resolution of the condition

Rationale:	There is one high quality trial and one moderate quality trial demonstrating analgesic efficacy over the first 24 hours after injury [440, 441]. The prolonged use of topical anesthetics is controversial, with concerns for toxicity from overuse, or complications from overtreatment of pain such as retained foreign body. Topical anesthetic is not invasive, has low but potentially important adverse effects and is generally low cost. Topical anesthetics are recommended for selective use.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 3 randomized trials and 2 systematic studies met the inclusion criteria.

Topical Opioids for Analgesia of Corneal Abrasions, Rust Rings, and Foreign Bodies

Not Recommended.

Medications (including topical creams)

The use of topical fentanyl and opioids for analgesia of corneal abrasions, rust rings, and foreign bodies is not recommended.

Strength of Evidence – **Not Recommended, Evidence (C)**
Level of Confidence – Moderate

Indications:	N/A
Benefits:	N/A
Harms:	Decreased lacrimation, corneal sensitivity loss, increased corneal permeability, disruption of corneal cell motility, swelling and inhibition of corneal re-epithelialization.
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A

Rationale:	There is one quality trial comparing the use of topical fentanyl with no fentanyl that demonstrated no improved in analgesia at the dose tested. [442] There are no commercially available topical opioids approved for use in the eye in the U.S. These medications are not invasive, have reported adverse effects, and have no demonstrated efficacy and are thus not recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: cornea, corneal, corneas, eye injuries, scratch, scratches, abrasion, abrasions, defect, defects, anti-bacterial agents, antibiotic prophylaxis, contact lenses, anesthetics, injections, intravitrial injections, intraocular injections, analgesics, non-steroidal anti-inflammatory agents, narcotics, mydriatics, ointments, ophthalmic solutions, patch, patches, capping, rubbing, everting, flushing, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and nonexperimental Studies. We found and reviewed 163 articles in PubMed, 100 in Scopus, 78 in CINAHL, 143 in Cochrane Library and 12 in other sources. We considered for inclusion 29 from PubMed, 3 from Scopus, 2 from CINAHL, 3 from Cochrane Library and 1 from other sources. Of the 38 articles considered for inclusion, 26 randomized trials and 8 systematic studies met the inclusion criteria.

Follow-Up Visits

There are no quality studies on the frequencies of following up patients with these injuries, thus guidance is by expert consensus. Patients with minor abrasions may require no follow-up other than if symptoms persist and fail to resolve in one to two days. Patients with more extensive abrasions, abrasions from vegetative matter, large foreign body removals and/or large rust ring removals may require followups every 1-3 days until healed. The primary purposes of frequent followup appointments are to assess healing, detect complications and address work limitations all of which may change quickly.

Traumatic Injuries

Overview

Penetrating trauma and rupture of the globe are rare injuries, although work is an occasional cause of those injuries, particularly high impact or motor vehicle crashes [44, 90, 443-446]. These are diverse and complex injuries that include a range of injuries from simple corneal lacerations to deep structural injuries. Complications of these injuries include visual impairments, astigmatisms, endophthalmitis, infections, sympathetic ophthalmia, cataracts, blindness, and enucleation [371, 447, 448].

Corneal Lacerations

Corneal lacerations are deeper wounds than abrasions and include flap wounds. More extensive wounds may include injury to intraocular structures such as the lens. Retinoic acid has been used for adjunctive treatment of corneal lacerations [449], however, there are no quality studies and it is **Recommended, Insufficient Evidence (I)**. Rigid gas-permeable contact lenses have been used to attempt to provide better healing [450-453]. There are no quality studies of contact lenses for this purpose, and they are

Recommended, Insufficient Evidence (I). Injuries with significantly impaired vision, e.g. due to uncorrectable astigmatisms or opacities may need corneal transplantation (see Corneal Transplantation for Blindness or Other Corneal Scarring/Defects after Chemical Eye Exposures) [452].
Penetrating trauma and intraocular foreign bodies are **Recommended, Insufficient Evidence (I)** to be initially treated with stabilization of the intraocular foreign body without removal to avoid further trauma, and prompt, emergent referral for definitive treatment. Many small intraocular foreign bodies, particularly metallic, do not require removal, and instead can be conservatively managed [454-456].
This guideline does not address these penetrating eye injuries in detail that require referral for highly individualized, definitive care [367, 455, 457-470].

Blunt Trauma and Traumatic Hyphema

Blunt ocular trauma is most commonly due to transportation crashes, sports injuries and altercations [84, 471, 472]. Other occupational causes occur beyond those due to work-related vehicular crashes [84, 473]. Predictors of worse outcomes reportedly include afferent or nonreactive pupil, fracture, and inability to open the eye [474].
Blunt trauma injures are highly diverse and include contusions, fractures, hyphema, retinal detachments, anterior chamber angle recession, ocular hypertension, and other complications [72, 475, 476]. As multiple other injuries are potentially present, a comprehensive evaluation of the patient and his/her neighboring tissues/organ systems is required. Orbital blowout fractures most commonly involve the medial wall followed by the orbital floor [473]. Associated nasal fractures have been reported in 16% [473]. While x-rays are often performed for initial evaluations and are **Recommended, Insufficient Evidence (I),** CT scans are considered the main imaging procedure [396] and are **Recommended, Insufficient Evidence (I)**.
Traumatic hyphema is susceptible to recurrent bleeding in approximately 10-40% of patients. [477-483]. Prevention of re-bleeding is believed to be important to prevent worse outcomes and prednisone and aminocaproic acid have been utilized.
This guideline does not address those blunt trauma eye injuries that are complex, particularly those with pupillary defects, impairments and/or require definitive surgical care. Surgical approaches and techniques are diverse that are used for treating orbital fractures [211, 315, 484-492].

Treatment Recommendations

Topical Aminocaproic Acid for Traumatic Hyphema

Moderately Recommended.

Medications (including topical creams)

Topical aminocaproic acid is recommended for treatment of traumatic hyphema [493].

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Level of Confidence – Moderate

Indications:	Non-penetrating traumatic hyphema.
Benefits:	Improved visual acuity, reduced risk of corneal blood staining, glaucoma,
Harms:	Negligible.
Frequency/Dose/Duration:	Aminocaproic acid 30% in 2% carboxypolymethylene gel, 0.2mL applied in the inferior fornix Q6hrs for 5 days. Patients in the highest quality trial were also treated with 30º of head elevation, metal eye shield and moderate ambulation. [493, 494]
Indications for Discontinuation:	Completion of the treatment course.

Rationale:	The highest quality trial compared controls with oral or topical aminocaproic acid and found markedly superior visual acuity results with either aminocaproic acid treatment arm [493]. Other studies have also suggested efficacy compared with placebo [494-496] with another underpowered study also trending towards efficacy [497]. Another trial found comparable results between aminocaproic acid and prednisone [498], while another trial failed to find efficacy of glucocorticosteroid [499]. Topical aminocaproic acid is not invasive, has low adverse effects, is moderately costly, but is efficacious for preserving and/or recover visual acuity and thus is moderately recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: traumatic hyphemia, hyphema, hyphaema, eye, eyes, topical glucocorticoid eye drops, topical beta adrenergic blocker eye drops, patching, ophthalmic solutions, prednisone,, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 17 articles in PubMed, 2 in Scopus, 70 in CINAHL, one in Cochrane Library and 0 in other sources. We considered for inclusion 5 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 13 articles considered for inclusion, 11 randomized trials and 2 systematic studies met the inclusion criteria.

Tranexamic Acid for Traumatic Hyphema

Recommended.

Medications (including topical creams)

Tranexamic acid is recommended for treatment of traumatic hyphema [500].

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Low

Indications:	Non-penetrating traumatic hyphema.
Benefits:	Reduced risk of re-bleeding
Harms:	Negligible.
Frequency/Dose/Duration:	Tranexamic acid 25mg/kg orally three times a day [500].
Indications for Discontinuation:	When visual acuity is restored.
Rationale:	One moderate quality trial suggested efficacy of oral tranexamic acid for treatment of hyphema and further suggested superiority to steroid [500]. Tranexamic acid is not invasive, has some adverse effects, is moderately costly, but is highly efficacious to preserve and/or recover visual acuity and thus is moderately recommended.

Evidence:

A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: nonpenetrating, superficial, ocular, corneal, penetrating, foreign body, eye foreign bodies, “rust ring, eye, eyes, removal, extraction, leaving in the eye, mydriatics, cycloplegic, meidiatric effect, extraction size, extraction location, woods lamp, slit lamp, fibrin tissue adhesive, fibrin sealant, autologous fibrin tissue adhesive, fibrin klebe system immune, transglutine, crosseal, tisseel, tissel, tussucol, beriplast, seal fibrin, eye irrigation, irrigation, morgan lens, morgan lenses, patching, patch, treatment, eye magnet, eye burr, diamond burr, alger brush, ophthalmic burr, aaron burr, burr, contusion, Acuvail, acular LS, acular PF, acuvil, bromday, bromfenac ophthalmic, diclofenac ophthalmic, flurbiprophen ophthalmic, Ilevro, ketorolac ophthalmic, phenylephrine ophthalmic, nepafenac ophthalmic, nevanac, ocufen, omidria, prolensa, voltaren ophthalmic, ketoroloac tromethamine, topical NSAID, “Anti-Inflammatory Agents, Non-Steroidal", Gentamicin, tobramycin, besifloxacin, ciproflaxin, gatifloxacin, levofloxacin, moxifloxacin, ofloxacin, azithromycin, erythromycin, bacitracin, polymyxin, natamycin, neomycin, gramicidin, trimethoprim, sulfacetamide, Neosporin, polytrim, natacyn, romycin, Azasite, ocuflox, vigamox, lquix, quixin, Zymar, Ciloxan, besivance, tobrex, Anti-Bacterial Agents, Anti-Bacterial, Agents, antibiotic ointment, antibacterial ointment, anesthetics, lidocaine, tetracaine, proparacaine, fluress, topical anesthetic, prednisolone, fluorometholone, steroids, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 85 articles, and considered 13 for inclusion. In Scopus, we found and reviewed 10,342 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed 137 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 173 articles, and considered 0 for inclusion. We also considered for inclusion 4 articles from other sources. Of the 18 articles considered for inclusion, 1 randomized trial and 1 systematic study met the inclusion criteria.

Infections and Corneal Ulcers

Related Terms

- Viral conjunctivitis
- Bacterial conjunctivitis
- Fungal conjunctivitis
- Fungal keratitis
- Corneal ulcer
- Epithelial keratitis
- Nummular keratitis
- Interstitial keratitis
- Ulcerative keratitis

Overview

Most eye infections are diagnosed as viral conjunctivitis [501-507]. These infections are highly contagious [508-511]. Viral conjunctivitis normally does not require treatment other than instructions on careful handwashing, potentially isolating the patient/worker from others, avoiding touching the eye and any other object (contact precautions) [512]. Conjunctivitis caused by herpes simplex or herpes zoster may be resolved faster with treatments [513] [503-506, 514-516]. Herpetic and zoster corneal infections are considerably more complex than conjunctivitis caused by, e.g., adenovirus. Herpetic and zoster corneal infections may be vision-threatening and require prolonged treatment with anti-viral medications. Bacterial infections are the second most common cause [501-503, 506, 507]. Bacterial infections may be self-limited and thus not require treatment [508], but they can also be more serious. Fungal infections are more serious and require treatment. One of the more serious conditions is ulcer(s) complicated by bacterial and fungal infection; these require treatment and more vigilant follow-up care. Fungal infections typically take at least a month to resolve [517]. Contact-lens related infections are caused by bacterial, fungal and Acanthamoeba infections and are beyond the scope of this guideline [518]. Simple infections are mostly treated by primary care, urgent care and other non-ophthalmological and non-optometric specialists [509]. Corneal ulcers are considered an ophthalmologic emergency. They may result in permanent visual impairment. They may be bacterial, viral, fungal, or parasitic in origin and may occur following corneal lacerations, abrasions, and intrusion of foreign bodies. They may result from poorly fitted or inadequately cleaned contact lenses. Patients with corneal ulcers present with complaints of changes in visual acuity, photophobia and/or eye pain, tearing, and a sensation that a foreign body is in the eye. The presence of corneal ulcers can be determined by direct visualization, but magnified viewing with fluorescein staining is needed to completely rule out their presence.

Risk and Causation

Risk Factors

Viral conjunctivitis is highly contagious. Thus in some circumstances, the source or index case may be apparent. In most cases, the case appears spontaneously and thus the source and location of the source is unknown.

Bacterial and fungal infections most commonly occur as complications of either acute injuries or contact lens use [519, 520]. Other cases may occur without apparent cause. Risk factors include poor hygiene, poor contact lens hygiene, immunocompromised states, dry eyes, rheumatological disorders with ocular effects, recent eye surgery, crowded living conditions, dry eyes, blepharitis, contaminated cosmetics, use of topical medications, and sexually transmitted disease (especially Neisseria).

Causation
Work-relatedness of ocular infections as direct complications of acute injury (e.g., work-related corneal abrasion with subsequent fungal infection) is not difficult as the mechanism of injury and acuity of symptom onset generally begets a straightforward determination of work-relatedness. Causation of infections that occur without a work-related injury is also relatively simple, as the lack of an association is usually apparent and in most jurisdictions simplifies a determination of non-work relatedness.

Prevalence/Incidence
Infections are estimated to cause approximately 6 million infections in the US annually [521]. The incidence of culture-proven microbial infection has been estimated as 0.26/10,000 overall with a rate of 1.8/10,000 among those using contact lenses [522]. Those estimates compare with presumed incidence rates of 0.36/10,000 and 2.44/10,000 respectfully [522]. The incidence of fungal eye infections is unknown (CDC).

Work Relatedness
A determination of work-relatedness is usually determined in most juridictions based on the presence of a work-related acute injury that precedes the infection. In some unusual cases, an epidemic of viral conjunctivitis may occur in an occupational setting and the probability of the acquisition of a case in that setting exceeds 50% making a case work-related.

Signs and Symptoms

Medical History
Symptoms of corneal infections commonly include:

- Red or pink eye
- Tearing
- Purulence
- Crusty eyelids, especially on awakening
- Mild pruritis is sometimes present
- Photophobia, especially if more severe
- Visual acuity is usually preserved unless visual axis affected, e.g., by corneal ulcer or corneal abrasion
- Corneal ulcers typically include a foreign body sensation

Onset
- Symptom onset is usually gradual. However, as onset is most often noticed on awakening with mattering of the eyelids, some patients may report this as sudden onset.
- Some infectious cases occur after acute onset of trauma to the cornea, e.g., corneal abrasion.
- Onset of corneal ulcers are similarly gradual, although the inciting event may have been an acute injury.

Current treatments used
- Usually none, although may have included flushing of the eye.
- Some cases will occur on a delayed basis after acute injury. Thus, some cases will have had prior corneal foreign body(ies) removed.

Red Flags
Corneal ulcers are considered ophthalmological emergencies and thus are red flags.

Other red flags for potentially more serious infections include:

- Reduced visual acuity
- Periocular swelling and inflammation
- History of penetrating trauma or high impact metalworking without eye protection
- Suspected penetration of the globe
- Impaired extraocular eye movements
- Photophobia
- Systemic symptoms or diseases, especially rheumatological
- Copious purulence

Diagnosis

Initial Assessment

The most important clinical assessment is whether the infection is vision-threatening or not. In general, vision threatening infections involve corneal ulcers and/or corneal infections.
The patient evaluation should include assessment of temperature, visual acuity, observation, extraocular movements, type of discharge, corneal opacity, eyelid swelling, proptosis, shape and size of the pupil, and sensitivity to light [512]. Lymphadenopathy is more commonly associated with viral as compared to bacterial conjunctivitis [523].

Diagnostic Criteria

Infections are among the differential diagnoses for a red eye (See Table 1. Symptoms of Red Eye) and eye infections may be acute, subacute or chronic. Infections of the conjunctive or cornea are generally accompanied by mattering of the eyelids on awakening as well as either an absence of or minimal pruritis [523, 524]. Thus, a symptom of mattering is somewhat helpful to narrow the differential diagnosis to be more likely an infectious etiology. Bilateral mattering is thought to be more likely bacterial [512]. However, mattering is not particularly helpful to distinguish the type of infection. Mattering also is a symptom of blepharitis (low level infection along the lid margins), as well as a few other conditions.

The diagnostic criteria for viral conjunctivitis are: (i) watery discharge (although it may also be mucopurulent), (ii) minimal or no purulent discharge, (iii) in an erythematous eye, (iv) with preserved visual acuity and (v) with no corneal opacities.

Diagnostic criteria for corneal viral infections (e.g., herpes simplex or zoster) are: (i) watery discharge, (ii) minimal or no purulent discharge, (iii) in an erythematous eye, (iv) with impaired visual acuity (or preserved visual acuity but impaired visual fields if the infected corneal area is out of the visual axis) and (v) with corneal opacities.

Diagnostic criteria for bacterial and fungal eye infections are: (i) the presence of purulent discharge [525, 526], (ii) in an erythematous eye [527, 528], (iii) with preserved visual acuity, (iv) lack of pruritis, (v) no history of conjunctivitis, and (vi) that may or may not be confirmed by culture [529, 530]. Bacterial and fungal Infections may be confirmed with gram stain, KOH (potassium hydroxide) preparation and bacterial and fungal cultures. Cultures are often not performed especially in milder cases where the condition may be self-limited and thus resolve with no or limited empiric treatment [512]. Cultures are necessary for cases with neonatal conjunctivitis, severe infections, recurrent infections, Neisserial infections, chlamydia infections, and cases that are difficulty to treat [512].

Particularly with acute infections, there usually is marked conjunctival injection. The main infectious etiologies in the differential diagnosis among immunocompetent individuals in the developed world are viral conjunctivitis, bacterial and fungal infection. In other parts of the world or elsewhere among select populations, other etiologies include mycobacterium, parasites, and trachoma. Infections due to chlamydia trachomatis or Neisseria gonorrhea are beyond the scope of this guideline, yet for completeness are noted to require treatment with a systemic antibiotic plus an ophthalmologic antibiotic preparation.

Bacterial or fungal infections may also accompany and/or complicate corneal ulcers. Diagnostic criteria for bacterial or fungal ulcers are the same as those for infection with the added finding of corneal defect(s) or ulcer(s) on slit lamp examination.

TABLE 6: SELECTED DIFFERENTIAL DIAGNOSIS OF RED EYE (ADAPTED FROM CRONAU 2010)

Condition	Signs	Symptoms	Causes
Conjunctivitis			
Viral	Normal vision, normal pupil size and reaction to light, diffuse conjunctival injections (redness), preauricular lymphadenopathy, lymphoid follicle on the undersurface of the eyelid	Mild to no pain, diffuse hyperemia, occasional gritty discomfort with mild itching, watery to serous discharge, photophobia (uncommon), often unilateral at onset with second eye involved within one or two days, severe cases may cause subepithelial corneal opacities and pseudomembranes	Adenovirus (most common), enterovirus, coxsackievirus, VZV, Epstein-Barr virus, HSV, influenza
Herpes zoster ophthalmicus	Vesicular rash, keratitis, uveitis	Pain and tingling sensation precedes rash and conjunctivitis, typically unilateral with dermatomal involvement (periocular vesicles)	Herpes zoster
Bacterial (acute and chronic)	Eyelid edema, preserved visual acuity, conjunctival injection, normal pupil reaction, no corneal involvement	Mild to moderate pain with stinging sensation, red eye with foreign body sensation, mild to moderate purulent discharge, mucopurulent secretions with bilateral glued eyes upon awakening (best predictor)	Common pathogens in children: Streptococcus pneumoniae, nontypeable Haemophilus influenzae Common pathogen in adults: Staphylococcus aureus Other pathogens: Staphylococcus species, Moraxella species, Neisseria gonorrhoeae, gram-negative organisms (e.g., Escherichia coli), Pseudomonas species
Bacterial (hyperacute)	Chemosis with possible corneal involvement	Severe pain; copious, purulent discharge; diminished vision	N. gonorrhoeae

Condition	Signs	Symptoms	Causes
Chlamydial (inclusion conjunctivitis)	Vision usually preserved, pupils reactive to light, conjunctival injections, no corneal involvement, preauricular lymph node swelling is sometimes present	Red, irritated eye; mucopurulent or purulent discharge; glued eyes upon awakening; blurred vision	Chlamydia trachomatis (serotypes D to K)
Allergic	Visual acuity preserved, pupils reactive to light, conjunctival injection, no corneal involvement, large cobblestone papillae under upper eyelid, chemosis	Bilateral eye involvement; painless tearing; intense itching; diffuse redness; stringy or ropy, watery discharge	Airborne pollens, dust mites, animal dander, feathers, other environmental antigens

Classification

Viral, bacterial and fungal eye infections are not commonly classified other than by the inciting organism when known.

History

Symptoms usually begin gradually. Mattering of the eyelid(s) and a red eye on awakening is often the first sign of an eye infection. Common symptoms of corneal infections include: red/pink eye, tearing, purulence, crusty eyelids, mild pruritis, photophobia (if more severe), and potentially a mild foreign body or irritation sensation. Visual acuity is generally preserved, although some viral infections, especially herpes or zoster, may involve the visual axis and reduce visual acuity.

Diagnostic Recommendations

Viral Screening

Adenovirus screening has been performed in clinical settings to diagnose viral conjunctivitis [531] as most cases of viral conjunctivitis are caused by adenovirus [523].

Adenovirus Screening, Select Patients

Recommended.

Adenovirus screening is selectively recommended for evaluation of infectious conjunctivitis where there is diagnostic uncertainty and a significant consideration for bacterial conjunctivitis. It is not recommended for routine evaluation of typical viral conjunctivitis cases.

Strength of Evidence – **Recommended, Evidence (C)**
Level of Confidence – Low

Indications:	Adenovirus screening is highly selectively recommended for evaluation of eye infections where there is diagnostic uncertainty and a significant consideration for bacterial conjunctivitis and the condition is more serious, thus there is contemplation of other treatment(s). The main purpose of this screening is to determine the cause and prevent unnecessary antibiotic use. Screening is not recommended for routine evaluation of typical viral conjunctivitis cases.
Indications for Discontinuation:	N/A
Benefits:	Potential to improve diagnostic accuracy and reduce use of antibiotics.

Harms: May mislead especially with negative test results as assumptions may be incorrect that the agent is a bacterium. False positive results are also possible.

Comments:

Rationale: There is 1 high-quality study showing 89% sensitivity and 94% specificity [531]. The primary purpose of adenovirus screening is to rule out other infections and prevent excessive antibiotic usage for a condition that is usually self-limited. Yet, there are other viral causes, thus it is an imperfect test. As most cases resolve readily without treatment, routine screening is not recommended. Adenovirus screening is not invasive, has negligible adverse effects, is low cost, has demonstrated efficacy and is thus indicated for selectively diagnosing viral conjunctivitis.

Adenovirus Screening, Routine

Not Recommended.

Routine adenovirus screening is not recommended for evaluation of infectious conjunctivitis.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – High

Indications:

Indications for Discontinuation:

Benefits:

Harms:

Comments:

Rationale: There is 1 high-quality study showing 89% sensitivity and 94% specificity [531]. The primary purpose of adenovirus screening is to rule out other infections and prevent excessive antibiotic usage for a condition that is usually self-limited. Yet, there are other viral causes, thus it is an imperfect test. As most cases resolve readily without treatment, routine screening is not recommended. Adenovirus screening is not invasive, has negligible adverse effects, is low cost, has demonstrated efficacy and is thus indicated for selectively diagnosing viral conjunctivitis.

Evidence:

Culture and Sensitivity

Gram Stain, Potassium Iodide (KOH) preparation, Culture and Sensitivity of Eye Infections (Select Patients)

Recommended.

Gram Stain, KOH preparation, culture and sensitivity of eye infections are selectively recommended, especially for moderate to severe and/or poorly responding and/or recurrent cases.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – High

Indications: Gram Stain, potassium iodide (KOH) preparation, culture and sensitivity of eye infections are selectively recommended, especially for evaluation of eye infections where there is a moderate to severe infection [532, 533]. These are also recommended if there is either poor clinical response to empiric treatment and/or a recurrent infection. The main

	purpose of this screening is to determine the most appropriate treatment.
Indications for Discontinuation:	
Benefits:	Potential to improve diagnostic accuracy and reduce use of inappropriate antibiotics.
Harms:	Negligible. There is potential for misinterpretation if current antibiotic use produces a false negative test result.

Gram Stain, Potassium Iodide (KOH) preparation, Culture and Sensitivity of Eye Infections (Routine)

Not Recommended.

Routine Gram Stain, KOH preparation, culture and sensitivity of eye infections is not recommended as many cases are able to be treated empirically.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**
Level of Confidence – Moderate

Indications:	
Indications for Discontinuation:	
Benefits:	
Harms:	
Comments:	
Rationale:	There is evidence suggesting antibiotic anti-fungal resistance correlates with worse outcomes [532, 533]. The primary purpose of Gram Stain, potassium iodide (KOH) preparation, culture and sensitivity of eye infections is to secure a diagnosis that allows for a specific, focused treatment regimen. This also helps prevent excessive antibiotic use and/or excessively broad spectrum use that may foster the development of resistant organisms. age for a condition that is usually self-limited. Yet, there are other viral causes, thus it is an imperfect test. As many cases of milder conjunctivitis resolve readily without treatment and others resolve readily with empiric treatment, routine Gram Stain, potassium iodide (KOH) preparation, culture and sensitivity of eye infections is not recommended. Gram Stain, potassium iodide (KOH) preparation, culture and sensitivity of eye infections is not invasive, have negligible adverse effects, are low cost, have demonstrated clinical efficacy and are thus indicated for selectively diagnosing bacterial and fungal eye infections.
Evidence:	

Other Diagnostic Testing

Generally, other diagnostic testing is not needed for evaluating eye infections. Occasionally, there may be a need for other tests based on any other accompanying symptoms and/or injuries (e.g., sinus x-ray, sinus CT scan, CT of orbits, MRI of orbits).

Treatment

Initial Care

For presumptive viral conjunctivitis and mild bacterial conjunctivitis, there is no medication necessary. However, careful instructions about vigilant hand-eye hygiene is important to reduce risks of further spread. For moderate to severe bacterial conjunctivitis, closer follow-up is required for progress and

recovery. For corneal infections or corneal ulcers, medication(s) are necessary and close follow-up is required to minimize risk of visual loss.

Treatment Recommendations

Medications

No antibiotic treatment is required for common causes of viral conjunctivitis [534]. Herpes simplex and herpes zoster corneal infections require anti-viral treatment, but are beyond the scope of this guideline as they are not considered occupational conditions. In adults, the most common causes of bacterial conjunctivitis are *Streptococcus pneumoniae (51%), Pseudomonas (23%), Staphylococcus sp* and *Hemophilus influenzae* [535, 536]. Treatment of bacterial conjunctivitis shortens the clinical course [512, 537-540]. Yet, mild mucopurulent infections are not improved faster with antibiotics [541]. Ulcer severity is strongly correlated with outcome [542]. Fungal infections are generally more severe and require longer treatment times to resolve [543].

Antibiotics for Bacterial Conjunctivitis and Bacterial Infections Complicating Corneal Ulcers

Moderately Recommended.

Medications (including topical creams)

Antibiotics are recommended for select treatment of bacterial conjunctivitis and bacterial infections complicating corneal ulcers.

Strength of Evidence – **Moderately Recommended, Evidence (B)**

Level of Confidence – Moderate

Indications:	Moderate to severe bacterial conjunctivitis to shorten the clinical course. May not be necessary for mild cases, as mild mucopurulent infections are not improved faster with antibiotics (Reitveld 05). Cases of Neisseria require both topical and systemic treatment and are beyond the scope of this guideline. Bacterial infections complicating corneal ulcers also require treatment with the additional indication of treatment until the corneal defect has also resolved. Baseline visual acuity is predictive of visual recovery [544].
Frequency/Dose/Duration:	There is quality evidence of comparable efficacy among all of the following ophthalmologic antibiotic preparations: ciprofloxacin 0.3%, gatifloxacin 0.3%, levofloxacin 0.5%, lomefloxacin 0.3%, moxifloxacin 0.5-1.0%, ofloxacin 0.3%, ofloxacin- benzalkonium chloride, tobramycin-cefazolin 1.33-1.5%/5-10%, cefazolin-amikacin, cefazolin-gentamicin, and thimerosal 0.005%. Thimerosal is not recommended due to a 5-fold rate of toxicity [545]. Tailoring the antibiotic selection to the estimated bacteria genus and specie as well as incorporating local antibiotic resistance profiles is advisable. Gram stain is not commonly performed but may assist in preliminary antibiotic tailoring, and further adjustments of the selected antibiotic may be necessary based on culture and sensitivity results, if obtained, as there is evidence suggesting antibiotic resistance correlates with worse outcomes [533]. Length of treatment is for the duration of symptoms and for ulcers is typically for the duration of the ulcer until the corneal defect is resolved. Antibiotic regimens used in the highest quality studies include:

- Amikacin/Cefazolin eye drops every 10 minutes during first 30 minutes of treatment and later decreased to hourly every 3 days [546]
- Ciprofloxacin 0.3% eye drops every 15 minutes for 1st 6 hours, 1 drop every hour 1st day, then hourly [547],
- Gatifloxacin 0.3% eye drops hourly [548]
- Levofloxacin 0.5% eye drops every 10 minutes during first 30 minutes of treatment and later decreased to hourly every 3 days [546]
- Lomefloxacin ophthalmic solution 0.3% 1 drop every 15 minutes for 1st 6 hours, 1 drop every hour 1st day, then hourly the following days [547]
- Moxifloxacin 1 drop every hour for 48 hours, day 3 every hour by day and 2 hours by night, days 4 and 5, 1 drop every 2 hours and 4 by night, days 6 and 7, 1 drop every 4 hours and after every 6 hours [549]
- Ofloxacin 0.3% every ½ hr on study day 1, every hour on days 2 - 4, and every 2 hours on days 5 – 21 [550]
- Ofloxacin 0.3% eye drops every 30 minutes for 6 hours, hourly on days 1-3, 2-hourly on days 4-5 and 4 hours until 1 week [551]
- Azithromycin 1% 1 drop twice daily for 3 days [552-554]
- Tobramycin 1.33% / Cefazolin 5% group received 1 drop every hour for 48 hours, day 3 every hour by day and 2 hours by night, days 4 and 5, 1 drop every 2 hours and 4 by night, days 6 and 7, 1 drop every 4 hours and after every 6 hours [549]
- Tobramycin/Cefazolin 1.5%/5% solution 0.3% 1 drop every 30 minutes for 6 hours, hourly on days 1-3, 2-hourly on days 4-5 and 4 hours until 1 week [551]

Indications for Discontinuation: Resolution of infection, resolution of all corneal defects. In case of allergy, discontinuation of an antibiotic and initiation of a second from a different antibiotic class is indicated.

Benefits: Shortened clinical course. Likely improved visual acuity compared with non-treatment in those with baseline visual field defects. Improve ulcer healing if bacterial infection complicating an ulcer.

Harms: Risks of antibiotic use, mostly allergies and increased bacterial resistance.

Comments:

Rationale: There are many quality comparative trials evaluating treatment of bacterial infections with keratitis or complicating corneal ulcers. There are several placebo-controlled trials, all showing earlier clinical resolution with antibiotic treatment [537-540]. There is no quality evidence that any antibiotic is superior to another for treatment of these infections and all of the following have quality evidence of comparable efficacy: besifloxacin [537, 538, 555, 556], ciprofloxacin [547, 548, 550, 557-559], gatifloxacin [548, 560-563], levofloxacin [546, 564] lomefloxacin [547, 565, 566], moxifloxacin [549, 560, 562, 567, 568] [569], ofloxacin [549-551, 564, 570, 571], ofloxacin-benzalkonium chloride [545], tobramycin-cefazolin [549, 551, 557, 560, 570-572], cefazolin-amikacin [546], cefazolin-

gentamicin [558, 565], azithromycin [552-554], and thimerosal [545]. However, thimerosal is not recommended due to a 5-fold rate of adverse effects [545]. Topical ophthalmological antibiotic preparations are not invasive, have low adverse effects, are low cost, and are effective for treatment of moderate to severe bacterial eye infections and ulcers complicated by bacterial infections. Thus, they are recommended.

Evidence:

Adjuvant Glucocorticosteroids for Bacterial Conjunctivitis and Bacterial Infections Complicating Corneal Ulcers

Not Recommended.

Medications (including topical creams)

Adjuvant glucocorticosteroids are not recommended for treatment of bacterial conjunctivitis and bacterial Infections complicating corneal ulcers.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:

Frequency/Dose/Duration:

Indications for Discontinuation:

Benefits:

Harms:

Comments:

Rationale: Adjuvant glucocorticosteroid use for bacterial corneal ulcers has been widespread with a strong belief in efficacy at improving visual outcomes [573]. There are quality trials evaluating adjuvant glucocorticosteroid use for treatment of bacterial keratitis after initial treatment with an antibiotic and failing to show significant differences in outcomes over intermediate to longer terms [544, 567, 574, 575]. Another trial suggested delayed epithelialization with glucocorticosteroid compared with placebo [574]. It has also been suggested steroids may not be helpful for nocardial infections [544, 567, 574-576]. Topical ophthalmological preparations of glucocorticosteroids are not invasive, and are low cost. These medications do not have significant demonstrated efficacy [544, 561, 567, 574, 575], appear to have the adverse effect of delaying healing, and are thus not recommended.

Evidence:

Antibiotics for Viral Conjunctivitis

Not Recommended.

Medications (including topical creams)

Antibiotics are not recommended for routine treatment of viral conjunctivitis.

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Indications:

Frequency/Dose/Duration:

Indications for Discontinuation:

Benefits:

Harms:

Rationale: There are is one moderate quality trial of antibiotics for treatment of viral conjunctivitis that showed minimal shortening of symptom duration with empiric antibiotic treatment [534]. Topical ophthalmological antibiotics are not invasive, have few adverse effects, are low cost, but do not have a sound rationale for use in viral conjunctivitis and are thus generally not recommended. However, the threshold for treatment with antibiotics is fairly low as they have low rates of adverse effects. Additionally, it can be difficult to separate some viral from bacterial infections, thus there are many cases that are treated with antibiotics. Severe infections or those thought to be bacterial are obvious candidates for treatment. Herpes simplex and herpes zoster corneal infections do require anti-viral treatment but are beyond the scope of this guideline.

Evidence:

Non-steroidal Anti-inflammatory Drugs for Symptoms of Viral Conjunctivitis

Not Recommended.

Medications (including topical creams)

NSAIDs are not recommended for treatment of viral conjunctivitis.

Strength of Evidence – **Not Recommended, Evidence (C)**

Level of Confidence – High

Indications:

Frequency/Dose/Duration:

Indications for Discontinuation:

Benefits:

Harms:

Comments:

Rationale: Two quality articles failed to find superiority of an NSAID to artificial tears [577] [578], thus there is no demonstrable efficacy. NSAIDs are not invasive, have low adverse effects especially for short-term use, are low cost, but are not effective and thus are not recommended.

Evidence:

Glucocorticosteroids for Symptoms of Viral Conjunctivitis

No Recommendation.

Medications (including topical creams)

There is no recommendation for or against glucocorticosteroid for treatment of viral conjunctivitis.

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – High

Indications:

Frequency/Dose/Duration:

Indications for Discontinuation:

Benefits:

Harms:

Comments:

Rationale: There is one trial that had methodological issues including protocol deviation which was interpreted as suggesting reduced symptoms [579]. Glucocorticosteroids are not invasive,

have low adverse effects, are low cost, but effectiveness is unclear and thus there is no recommendation.

Evidence:

Antifungal Medications for Fungal Conjunctivitis and Fungal Infections Complicating Corneal Ulcers

Recommended.

Medications (including topical creams)

Antifungal medications are recommended for treatment of fungal conjunctivitis and fungal infections complicating corneal ulcers.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Low

Indications: Fungal conjunctivitis. Fungal infections complicating corneal ulcers also require treatment with the additional indication of treatment until the corneal defect has also resolved.

Frequency/Dose/Duration: There is quality evidence of comparable efficacy among most of the following ophthalmologic antibiotic preparations: econazole 2%, natamycin 5%, voriconazole 1%, and Amphotericin B. Metanalysis of multiple trials suggests natamycin is superior to voriconazole [543], thus voriconazole is not recommended. One trial suggested superiority of chlorhexidine gluconate compared with natamycin 5% [580]. One trial found superiority of Amphotericin B drops plus subconjunctival injections of fluconazole to topical treatment alone [581]. Potassium iodide (KOH) is not always performed but may assist in preliminary antifungal regimen tailoring, and further adjustments in the medication(s) used may be necessary based on culture and sensitivity results. Length of treatment is until resolution of the ulcers, which varies widely and is commonly 4-6 weeks.

Antifungal regimens used in the highest quality studies include:

- Econazole 2% drops on hourly basis between 7 am to 9 pm [582].
- Natamycin 5% every hour while awake until reepithelialization, then 4 times daily for at least 3 weeks [542, 580, 582-584].
- Amphotericin B 0.2 mg/ml Q2hrs for 21 days [581]
- Amphotericin B 0.2 mg/ml Q2hrs for 21 days plus subconjunctival injections of fluconazole 2mg/mL daily for 10 days [585]
- Chlorhexidine gluconate 0.2%, 1/2-hourly to 2-hourly for up to 5 days, then with reduced frequency, and all patients re-assessed at 21 days. [580]

Indications for Discontinuation: Resolution of infection, resolution of all corneal defects. In case of allergy, discontinuation of an antifungal and initiation of a second may be indicated.

Benefits: Improve ulcer healing if fungal infection complicating an ulcer. Likely improved visual acuity compared with non-treatment in those with baseline visual field defects.

Harms: Risks of antifungal use, mostly allergies and increased fungal resistance.

Rationale:	There are multiple quality comparative trials evaluating treatment of fungal infections with keratitis or complicating corneal ulcers. There are no placebo-controlled trials. There is limited quality evidence that one antifungal may be superior to another, as multiple trials suggest natamycin is superior to voriconazole [543]. One moderate quality trial found Amphotericin B drops plus subconjunctival injections of fluconazole superior to topical treatment alone [585]. There is also limited evidence the chlorhexidine gluconate may be superior to natamycin drops [580]. All of the following have been assessed in quality trials: Amphotericin B [581], econazole [582], natamycin [542, 580, 582-584, 586], voriconazole [542, 580, 582-584, 586]. Topical ophthalmological antifungal preparations are not invasive, have low adverse effects, are low cost and are likely effective for treatment of fungal eye infections and ulcers complicated by fungal infections. Thus, they are recommended. Adjuvant antifungal injections in addition to topical treatment may be effective and may be best for severe cases, but evidence is currently insufficient to conclude an evidence-based recommendation [581].

Prognosis

The prognosis of most eye infections is quite good, as most resolve with minimal difficulty. The prognosis may be more guarded for those with immunodeficiencies, severe infections, certain types of infections, or complicating ulcers.

Corneal ulcers are ophthalmological emergencies. The clinical results are dependent on many factors including age, immunocompetence, extent, involvement of visual axis, speed of diagnosis and treatment.

Differential Diagnosis

A list of potential differential diagnoses of a red eye is found in Table 1. Symptoms of Red Eye.

Complications / Comorbidities

Complications and comorbidities include:

- Increasing age
- Retained foreign body(ies)
- Dry eyes
- Rheumatological disorders (e.g., Sicca syndrome, Reiter's syndrome)
- Immunodeficiency states

Follow-up Care

There are no quality studies comparing the frequency and/or intensiveness of follow-up of patients with eye infections with or without ulcers. There are also no quality studies evaluating education in conjunction with care for these infections. In general, follow-up is every few days for more severe infections and then less frequently until complete resolution. Follow-up intensity initially may also be more frequent for concerns about retained foreign bodies complicating the condition, as additional treatment may be required to remove foreign matter that is otherwise delaying recovery [587].

For bacterial or fungal infections, different frequencies of follow-up visits have been utilized in the randomized controlled clinical trials with most starting follow-up visits at least twice a week. Follow-up may be more or less frequently depending on the patient's age, severity of the infection, compliance with

treatment, immunocompetency of the patient, and the clinical judgment as to the risk(s) of complications. Bacterial infections are expected to resolve in 1 to 2 weeks [512, 526]. Ulcers can take longer to heal and are recovery time is proportional to the size and depth of the ulcer.

Examples of specific follow-up visit frequencies include visits: (i) every 3 days [547, 548]; (ii) days 2, 4, 7, 14 and then longer if needed [557]; and (iii) days 2-3, 6-7, 11-12, 18-19 and 28, [570]. Fungal infections usually require longer follow-up due to longer healing times that have averaged 4-5 weeks in clinical trials [585].

Job Analysis

Generally not indicated. If the inciting event was an acute traumatic event, then protective eye programs, eye gear, engineering, and education may be indicated (see above)

Blepharoconjunctivitis

Overview

Blepharoconjunctivitis is a chronic inflammation of the eyelid along the base of the eyelashes. This results in irritation, itchy eyes, watery eyes, mattering, frequent blinking and may result in photophobia. It may be caused by insufficient oil gland production, bacterial infection, allergies, rosacea and other conditions. Staphylococcal infection is a common cause of blepharoconjunctivitis. Overall quality of the literature on this subject is notably poor [588]. Although It is generally considered a non-occupational condition, it is commonly identified on clinical evaluation, and is included in the guideline for completeness.

The most common treatment is lid hygiene, which involves daily washing of the eyelid with a cotton tip applicator, baby shampoo and water. Lid hygiene suffices for the majority of people. Artificial tears and warm compresses may be helpful. Thus treatment is also nearly always non-prescription self-care.

Treatment Recommendations

Daily Lid Hygiene for Blepharoconjunctivitis

Recommended.

Activity Modification and Exercise

Daily Lid Hygiene is recommended for treatment of blepharoconjunctivitis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	Nearly all cases of blepharoconjunctivitis
Frequency/Dose/Duration:	Daily eyelid and eyelash scrubbing with tepid water, baby shampoo and using a cotton tip applicator.
Indications for Discontinuation:	Resolution of the symptoms. Reduction in scrubbing frequency may be possible when the condition is under control.
Benefits:	Self-management of the condition and symptoms, but with negligible cost.
Harms:	Negligible
Comments:	
Rationale:	There are a few trials of various disorders, especially for dry eyes that suggest efficacy of is evidence to suggest lid hygiene is helpful for managing lipid deficient dry eyes [589]. A thermodynamic lipid device has also been reportedly successful for Meibomian gland dysfunction [590]. Lid hygiene is not invasive, has few adverse effects, is low cost, appears clinically effective and thus is recommended.

Evidence:

Antibiotics for Blepharoconjunctivitis

Recommended.

Medications (including topical creams)

Topical antibiotics are recommended for treatment of anterior blepharoconjunctivitis.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	Anterior blepharoconjunctivitis. Generally, lid hygiene is instituted and antibiotics are used for clinical failures. Initial prescriptions of topical antibiotics may be particularly prescribed for treatment of more severe presentations.
Frequency/Dose/Duration:	Per manufacturer's recommendation
Indications for Discontinuation:	Completion of a clinical course or sufficient management of symptoms without need of further antibiotic treatment.
Benefits:	May help eradicate bacteria from lid margin. Symptom reduction
Harms:	Antibiotic resistance. Adverse reactions.
Comments:	
Evidence:	
Rationale:	There are trials of topical antibiotics for treatment of anterior blepharitis. Some trials do not clearly specify anterior blepharitis, providing a potential confounder. Most trials appear to show efficacy for reductions in symptoms. Topical antibiotics are not invasive, have few adverse effects, are low cost for short courses, appear effective and are thus recommended for anterior blepharitis.
Evidence:	

Allergic Disorders

Related Terms

- Itchy eye
- Seasonal allergic conjunctivitis (SAC)
- Allergic rhinoconjunctivitis
- Perennial allergic conjunctivitis (PAC)
- Vernal keratoconjunctivitis (VKC)
- Contact dermatoconjunctivitis
- Giant papillary conjunctivitis
- Pink eye (often this infectious not allergic conjunctivitis)

Overview

Allergic conjunctivitis (the inflammatory response of the conjunctiva to allergens) is estimated to affect up to 40% of the general population [591]. It encompasses a spectrum of severity and chronicity including seasonal allergic conjunctivitis (SAC), perennial allergic conjunctivitis (PAC), vernal keratoconjunctivitis (VKC), and atopic keratoconjunctivitis (AKC) [592]. SAC and PAC are considered the most common forms of ocular allergies and affect 15-20% of the population [592] [593]. Some cases of allergic eye disease are largely confined to the eyes, while most also involve the upper respiratory tract. More severe cases usually involve asthma (see Occupational/Work-Related Asthma Guideline).

Risk and Causation

Risk Factors

While allergies may occur at any age, children and young adults are at greatest risk. A past history of atopy, whether upper respiratory tract or asthma, is a risk for subsequent development of additional allergies, including those to workplace allergens. There are many studies supporting a lower risk of atopy if the person is raised in a building and in close proximity with animals (Hygiene Hypothesis) [594-598] and more recent data support relationships with microflora [599-603]. A family history of allergies is also a risk factor. Among those with pre-existing allergies, high exposures to allergens (e.g., dust mites, tree pollen, mold) are risks for allergy exacerbations. Allergic conjunctivitis may also develop in response to various occupational exposures (e.g., flour) and chemicals (e.g., thimerosal, specific perfumes). Work-related cases general involve exposure(s) to airborne allergens. See also Work-related Asthma Guideline.

Causation

Determinations of causation range from relatively simple with a high degree of certainty to those with a high degree of complexity and low certainty. Simpler causal associations involve limited or no non-occupational symptoms, exposure to a well-known sensitizer, symptoms occurring at work and complete resolution on nights and weekends. More complex cases have pre-existing atopic problems, perennial, largely unremitting symptoms that are worse at work and exposure to a known or potential allergen(s). Because more severe cases tend to involve asthma, see also Work-related Asthma Guideline.

Prevalence/Incidence

The prevalence of allergic conjunctivitis is steadily increasing with estimates approximating 40% of the U.S. population being affected. Seasonal allergic conjunctivitis (SAC) constitutes 90% of all allergic conjunctivitis. [591] Typically, all allergies are more common in younger persons and it is substantially less common for serious allergies to develop in an older adult.

Work Relatedness

A determination of work-relatedness is usually determined in most jurisdictions based on the presence of a work-related exposure to a known allergen, which precedes the allergic response. Generally, it is helpful for the causal assessment that there should be complete recovery from symptoms of allergic conjunctivitis after prolonged removal from exposure. Exceptions to complete recovery most commonly include those with ongoing exposure(s) and/or those susceptible to non-occupational allergens.

Signs and Symptoms

Symptoms of allergic conjunctivitis may include:

- Bilateral itchy eyes (pruritis)
- Bilateral watery eyes
- Bilateral swollen eyelids (ocular edema)
- Bilateral erythematous eyes
- Bilateral eye pain (usually not severe)
- Bilateral eye inflammation
- Rhinorrhea (runny nose)
- Itchy nose, itchy roof of mouth
- Sneezing

Symptom onset in an occupational setting may be rapid or gradual. In general, the higher the dose of exposure, the faster and more intense the symptom development tends to be. Still there is a wide range. Subsequent symptom experiences tend to parallel frequency, intensity and duration of the exposure(s). Typically, both eyes are equally affected in allergic conjunctivitis. Eyes may be unequally affected if there is differential introduction of the allergen into the eyes (e.g., flour dust rubbed into one eye).

Red Flags

If symptoms worsen or persist (swelling, inflammation, etc.) there may be something more serious than allergic conjunctivitis.
If visual acuity worsens, it is probably not allergic in etiology.

- Acquired abnormal visual fields
- Purulence
- Systemic diseases, especially auto-immune

Diagnosis

Initial Assessment

The initial assessment consists of a careful history and limited testing to rule out other conditions. The history focuses on symptoms, patterns of symptoms and probable allergens.

Diagnostic Criteria

Proposed criteria from the American Optometric Association for allergic conjunctivitis include symptoms, signs and limited testing [604]. A clinical history and assessment of environmental factors are considered to be the first step in diagnosing allergic conjunctivitis [604]. Following the initial assessment, an allergy workup based on skin tests and determination of serum specific IgE is generally recommended. Occasionally, a conjunctival challenge is performed. [604, 605]. Increased conjunctival sickle cells, frequent eosinophils in corneal scrapings and a high total serum IgE are indicators of allergic conjunctivitis [604].

Allergic eye diseases present with episodic bilateral pruritic, watery, erythematous eyes, and photophobia [604]. Symptoms most often wax and wane based on exposure, although persistent symptoms may be present if exposures are ongoing. For those with intermittent symptoms, a pattern of symptom development, or aggravation after exposures is present that is often quite helpful in assessing the causative allergen(s). The degree of pruritis is highly helpful diagnostically to increase the probability of allergic disease, although infectious diseases may present with some pruritis. Confirmatory testing of atopy is possible for some specific allergens (see Occupational/Work-Related Asthma Guideline).
Some patients also have systemic symptoms, such as asthma. All patients with allergic eye disease should be assessed for systemic manifestations as those with asthma and ongoing exposure may incur progressive pulmonary impairments that may become permanent (See Occupational/Work-Related Asthma Guideline). Occupational asthma also increases the potential for a fatal outcome (See Occupational/Work-Related Asthma Guideline).).

Classification

The consensus classification for allergic conjunctivitis (AC) takes into account the frequency and severity of ocular signs and symptoms [604]. AC generally affects both eyes and is considered *intermittent* when it involves ocular signs and symptoms (conjunctival pruritus, tearing, a burning sensation, blurred vision, photophobia, and hyperemia) for up to 4 days a week or up to 4 consecutive days. AC is considered *persistent* when the ocular signs and symptoms have been present more than 4 days per week or more than 4 consecutive days [604].
The severity of AC is classified as *mild* when signs and symptoms are 1) not bothersome, 2) do not effect vision, 3) there are no interferences with activities of daily living, and 4) no interferences with school or work tasks. It is considered *moderate* when 1-3 items are met and *severe* when all conditions are met. [604].

History

The history consists of a search for both positive responses to identify a probable allergic disease process. The history also consists of a search for pertinent negatives, e.g., to rule out other conditions such as other immunological disorders. Exposure to likely allergens is of critical interest in a history for allergic conjunctivitis. A search through occupational exposures to identify potential allergens is another important part of the history. Timing of both the onset of symptoms and relief of symptoms is key in ascertaining the probability of allergic conjunctivitis.

Medical History Questionnaire

- Do you have a history of allergies? If so, which ones? At what age of onset?
- Do you have itchy eyes (pruritis)? Bilateral?
- Are your eyes watery or teary?
- Do you get pink or red eyes? Bilateral?
- Do you have any eye pain? Bilateral? How severe?
- Is there any eye inflammation?
- Does your nose run (rhinorrhea)?
- Do you have an itchy nose, itchy roof of mouth?
- Do you have sneezing?
- Do these symptoms come on during spring or fall pollen seasons?
- Are the symptoms timed with anything you do or are exposed to at work?
- Are symptoms perennial (year round)?
- Are both eyes affected equally?
- Have you ever been diagnosed with pink eye?
- Are you allergic to certain animals like cats?
- Do you have any known food allergies?

- Do your eyes tear when wearing certain perfumes, or cosmetics?
- Do you need to use decongestants or antihistamines to control sneezing coughing and congestion?
- Has your visual acuity been affected?
- Is your peripheral vision normal?
- Have you had discharge from your eyes? Mucous? Purulence?
- Do you have systemic diseases, especially auto-immune such as Reumatoid arthritis, Lupus, Reiter's Sicca Syndrome?
- Do you have glaucoma?

Physical Exam

The physical examination includes testing of visual acuity and vision fields. Slit lamp examination is often performed. Tonometry is helpful to rule out glaucoma. Other physical examination components may include evaluations of joints and mucous membranes, particularly if there are symptoms suggestive of autoimmune diseases.
For initial evaluations, slit lamp examination is not always required, as a preliminary diagnosis and treatment plan is possible in some situations, such as mild cases.

Diagnostic Recommendations

High Molecular Weight Specific Antigens

Strongly Recommended.

Specific immunological testing (IgE) is strongly recommended for workers with symptoms consistent with occupational asthma to certain high molecular weight specific allergens and when standardized antigens and assay protocols exist. The specificity and sensitivity of the allergens should have been evaluated in quality studies using validated test methods that are commercially available. High molecular weight allergens for which there is sufficient evidence in quality studies include flour dusts, bovine danders, laboratory, and other animal allergens. Natural rubber latex (NRL) allergy can be confirmed by serum IgE testing, but the assay does not include all potential NRL allergens, such that a negative result does not necessarily exclude the diagnosis of NRL allergy.

> *Strength of Evidence* – **Strongly Recommended, Evidence (A)**
> *Level of Confidence* – High

IgG Specific Immunological Testing for High Molecular Weight Specific Antigens

Not Recommended.

Specific immunological testing (IgG) is not recommended as a diagnostic tool for select workers with symptoms consistent with occupational asthma to high molecular weight specific allergens. It can be used for a marker of exposure to certain allergens, but in and of itself does not diagnose disease.

> *Strength of Evidence* **– Not Recommended, Evidence (C)**
> *Level of Confidence* – High

Low Molecular Weight Specific Antigens

Not Recommended.

Specific immunological testing (IgE) is not recommended for workers with symptoms consistent with occupational asthma to low molecular weight specific allergens due to low sensitivity and specificity and lack of method validation.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**
Level of Confidence – Moderate

Treatment

Initial Care

Initial treatment generally consists of identification of the probable allergen. Subsequently, reduction or elimination of exposure is the preferred initial management. Many cases involve environmental exposures that may not be readily reduced or controlled. In such cases, hygiene to reduce exposure, medications are implemented. Immunotherapy may be attempted for select cases with moderate to severe disease and inability to sufficiently modify exposures.
All of the following are common treatments used:

- Avoidance of known antigen
- Antihistamines
- Eye drops
- Decongestants (vasoconstrictors)
- Mast cell stabilizers
- NSAIDS
- Steroids
- Immunotherapy if severe (consult an allergist)

Treatment Recommendations

Medical removal is usually based on pulmonary symptoms and development of asthma, particularly if progressive loss is determined by spirometry (see above). Medical removal solely for ocular symptoms is relatively rare, and typically only occurs after education, institution of exposure reduction, exposure controls, and persistence of symptoms beyond a tolerable level.

Management of Allergic Eye Symptoms without Asthma (Reduction of Exposure)

Recommended.
Activity Modification and Exercise

For allergic eye symptoms, it is recommended that exposure reduction and medical monitoring to assess the presence or worsening of asthma should be performed to ensure ocular symptoms are acceptably reduced as well as to provide early identification of asthma.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Moderate

Indications:	All patients with moderate to severe symptoms of allergic conjunctivitis. Exposure reduction is also indicated for mild allergic conjunctivitis cases where feasible.
Frequency/Dose/Duration:	
Indications for Discontinuation:	
Benefits:	Potential to eliminate the need for medical treatment. Otherwise, potential to reduce the intensity of other medical treatment(s) required.

Harms:	May be problematic in some settings. May not be possible and worker may need to accept the symptoms due to economic issues. As noted in the Work-related Asthma guideline, "The clinical benefit of removal from exposure or exposure reduction should be balanced against the increased risk of unemployment."[606]"
Comments:	
Rationale:	There are quality studies for evaluation of removal from work exposures in the settings of occupational asthma. This approach is not always effective, and from the Work-Related Asthma guideline, "The guidelines of the BOHRF and ACCP stated that reduction of exposure "is not always effective"[607] and that "there is little evidence for using this approach."[608]" Still there are patients who appear to benefit significantly from reductions in exposure. Exposure reduction is not invasive, has low to high adverse effects, could be high cost and thus selective removal from exposure is indicated, especially for those with severe symptoms.
Evidence:	

EDUCATION FOR ALLERGIC CONDITIONS

Recommended.

Activity Modification and Exercise

Education is recommended for assisting patients to better manage their allergic condition.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – High

Indications:	All patients with ocular eye manifestations, particularly those without the ability to avoid future exposure. Education includes exposure reduction, exposure elimination, hand hygiene to avoid contaminating the eyes, and medication management.
Frequency/Dose/Duration:	One appointment for education may suffice. An occasional, additional visit may be indicated, especially for reinforcement, complex cases, or if the disease substantially worsens.
Indications for Discontinuation:	
Benefits:	Better ability to avoid symptoms from introducing allergens from the hands to the eyes. More informed medical removal decision-making for severe cases.
Harms:	Negligible
Comments:	
Rationale:	There are no quality studies evaluating efficacy of education for ocular allergic diseases. However, clinically, education is helpful in improving management of the patient's condition and for avoiding and/or reducing exposures to allergens. Education is not invasive, has no adverse effects, is low cost, is clinically effective and is thus recommended.
Evidence:	

Medications for Ocular Allergies

There are multiple medications in several medication classes that are used for allergic ocular symptoms. These different classes of medications have different strengths and weaknesses that may be utilized to optimize treatment and/or treatment compliance. Classes of medications include non-selective histamine receptor blockers, selective histamine receptor blockers, non-steroidal anti-inflammatory medications (NSAIDs), mast cell stabilizers, glucocorticosteroids, oral anti-histamines, and others. Normally, one medication suffices. Occasionally, moderate to severe symptoms may be addressed with combinations of agents, usually utilizing one medication from each of two different classes with different mechanisms of action.

Medications administered by ocular drops are cleared via the lacrimal ducts. These medications also tend to treat allergic nasal symptoms. Some evidence suggests ocular drops treat nasal symptoms better than ocular symptoms [609].

Antihistamine and/or Mast Cell Stabilization Medications for Allergic Diseases

Strongly Recommended.

Medications (including topical creams)

Antihistamine and/or mast cell stabilization medications are strongly recommended for treatment of ocular symptoms from allergic diseases.

Strength of Evidence – **Strongly Recommended, Evidence (A)**
Level of Confidence – High

Indications: Ocular eye symptoms from presumptive or proven allergic disease. Exposure elimination is the preferred initial treatment before medication. However, many cases benefit from prompt medical treatment.

Frequency/Dose/Duration: Medications used follow. Dose, Frequency, Duration is as per manufacturer's recommendations.

Histamine blockers:

- Alcaftadine 0.25% 1 drop QD
- Azelastine 0.05% 1 drop B.I.D.
- Emadastine 0.05% 1 drop up to Q.I.D.

Anti-histamine/mast cell stabilizer

- Bepotastine 1.5% 1 drop B.I.D.
- Epinastine 0.05% 1 drop B.I.D.
- Olopatadine 0.1% 1 drop B.I.D. (or longer preparation QD use)

Mast Cell Stabilizer

- Cromolyn 1 drop 4-6 times/day
- Ketotifen 1 drop Q8-12 hrs
- Lodoxamine 1-2 drops Q.I.D.
- Nedocromil 1-2 drops B.I.D.
- Pemirolast 1-2 drops Q.I.D.

Indications for Discontinuation: Resolution of symptoms, removal from exposure, intolerance, adverse effects.

Benefits:	Reduction in pruritus, watering eyes. May also reduce allergic nasal symptoms.
Harms:	May briefly burn, sting and/or cause dry eyes.
Comments:	
Rationale:	Antihistamines are typically used as the first line medication. Both antihistamines and mast cell stabilizers have strong evidence of efficacy. While there is efficacy, there is less evidence of efficacy for ketorolac. Antihistamine eye drops and/or mast cell stabilizing medication eye drops are not invasive, have low adverse effects, are low to moderate cost depending on length of treatment, have proven efficacy and are thus recommended for treatment of allergic eye diseases. There are dozens of moderate and high-quality RCTs. Nearly all have documented efficacy. All of the following medications have been assessed in quality studies: Bepotastine esilate 1.0-1.5% [609-613]; Alcaftadine [614, 615]; Epinastine HCl [616-620]; Emedastine HCl [621-626], Ketotifen fumorate [622, 627-634], Azelastine HCl [627, 635-643], Olopatadine HCl [614, 617, 619, 621, 628, 631, 632, 634, 644-656], Fluorometholone [621, 656, 657], Levobastine [618, 649], Levocabastine [630] [658] [659] [660] [661] [624], Cromolyn sodium [633, 649, 662-664], Sodium cromoglycate [638, 658, 660] [665-668], Nedocromil [650, 661, 665, 669-675], Pranoprofen [657] Ketorolac [651, 654, 676]; [677-679], Diclofenac [677], [680], Loteprednol etabonate [652, 681], Pentigetide [682], Oxymetazoline [683], and Mequitazine [684]. Oral medications assessed in trials for eye symptoms include Loratadine [620, 655], desloratadine [685] Cyclosporin A has been shown to be ineffective [686]. Comparative trials have mostly found comparable efficacy among more recent medications. For example, more trials suggested Olopatadine is superior to Ketotifen [634, 651, 655] but one found the opposite [632].

NSAID Eye Drops for Allergic Diseases

Moderately Recommended.

Medications (including topical creams)

NSAID eye drops are moderately recommended for treatment of ocular symptoms from allergic diseases.

Strength of Evidence – **Moderately Recommended, Evidence (B)**
Level of Confidence – Moderate

Indications:	Ocular eye symptoms from presumptive or proven allergic disease. Exposure elimination is the preferred initial treatment before medication. However, many cases benefit from prompt medical treatment.
Frequency/Dose/Duration:	Medications used follow. Dose, Frequency, Duration is as per manufacturer's recommendations. Ketorolac 0.5% 1 drop Q.I.D.

Indications for Discontinuation:	Resolution of symptoms, removal from exposure, intolerance, adverse effects.
Benefits:	Reduction in pruritus, watering eyes. May also reduce allergic nasal symptoms.
Harms:	May briefly burn, sting and/or cause dry eyes.
Rationale:	NSAIDs drops are not invasive, have low adverse effects, are low to moderate cost depending on length of treatment, have proven efficacy and are thus recommended for treatment of allergic eye diseases. There are dozens of moderate and high-quality RCTs. Nearly all have documented efficacy. All of the following medications have been assessed in quality studies: Bepotastine esilate 1.0-1.5% [609-613]; Alcaftadine [614, 615]; Epinastine HCl [615]; Abelsopn 04 [618-620, 687]; Emedastine HCl [621, 622, 624-626, 659], Ketotifen fumorate [622, 627-634], Azelastine HCl [627, 635-643], Olopatadine HCl [614, 617, 619, 621, 628, 631, 632, 634, 644-656], Fluorometholone [621, 656, 657] Levobastine [618, 649], Levocabastine [624, 630, 658-661], Cromolyn sodium [633, 649, 662-664], Sodium cromoglycate [638, 658] [660, 665-668], Nedocromil [650, 661, 665, 669-675], Pranoprofen [657] Ketorolac [651, 654, 676-679], Diclofenac [677, 680], Loteprednol etabonate [652, 681], Pentigetide [682], Oxymetazoline [683], and Mequitazine [684].

Glucocorticosteroid Eye Drops

Sometimes Recommended.
Medications (including topical creams)

Glucocorticosteroid eye drops are selectively recommended for short term treatment of severe ocular symptoms from allergic diseases.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Indications:	Acute, severe ocular eye symptoms from presumptive or proven allergic disease. Exposure elimination is the preferred initial treatment before medication. However, many cases benefit from prompt medical treatment. Not indicated for mild to moderate disease due to adverse effects potentially outweighing potential benefits.
Frequency/Dose/Duration:	Medications used follow. Dose, Frequency, Duration is as per manufacturer's recommendations. Loteprednol 0.2% 1 drop up to Q.I.D. Loteprednol 0.5% 1-2 drops Q.I.D.
Indications for Discontinuation:	Resolution of symptoms, removal from exposure, intolerance, adverse effects.
Benefits:	Reduction in pruritus, watering eyes. May also reduce allergic nasal symptoms.
Harms:	May briefly burn, sting and/or cause dry eyes.
Rationale:	Glucocorticosteroid drops have concerns about significant adverse effects, including cataracts and aggravating glaucoma.

Thus, they are recommended for more limited use to treat short courses of severe symptoms.
There are dozens of moderate and high-quality RCTs. Nearly all have documented efficacy. All of the following medications have been assessed in quality studies: Bepotastine esilate 1.0-1.5% [609-613]; Alcaftadine [614, 615]; Epinastine HCl [616-620] Emedastine HCl [621, 622, 624-626, 659], Ketotifen fumorate [622, 627, 629-634, 688], Azelastine HCl [616, 635-643], Olopatadine HCl [621] [614, 617, 619, 631, 632, 634, 644-656, 688], Fluorometholone [621, 656, 657]), Levobastine [618, 649], Levocabastine [624, 630, 658-661], Cromolyn sodium [633, 649, 662-664], Sodium cromoglycate [638, 658, 660, 665-668], Nedocromil [650, 661, 665, 669-675], Pranoprofen [657] Ketorolac [651, 654, 676-679], Diclofenac [677, 680], Loteprednol etabonate [652, 681], Pentigetide [682], Oxymetazoline [683], and Mequitazine [684].

Prognosis

The prognosis of ocular allergies is generally good. The prognosis is progressively worse with increasingly worse symptoms, especially with systemic symptoms such as occupational asthma. If symptoms include anaphylactic symptoms, then complete removal from exposure is indicated (see Work-related Asthma Guideline).

Differential Diagnosis

While the diagnosis is generally straightforward, the differential diagnosis includes:

- Blepharitis
- Chemical irritation
- Mechanical irritation (e.g., small particulates)
- Infections, including viral and bacterial conjunctivitis
- Giant papillary conjunctivitis
- Angle closure glaucoma
- Superior limbic keratoconjunctivitis
- Dry eyes
- Auto-immune disorders
- Sicca syndrome
- Ocular rosacea
- Keratitis
- Episcleritis/scleritis
- Vernal keratoconjunctivitis
- Atopic keratoconjunctivitis

Complications / Comorbidities

The main complication is systemic allergic diseases, particularly work-related asthma (see Work-Related Asthma guideline). Anaphylaxis is also a rare potential among those with severe allergies, especially when combined with a high exposure.

Follow-up Care

Follow-up care is highly variable and based primarily on severity of the case and response(s) to treatment. In mild cases, infrequent followup is indicated. In others, work-up and evaluation for concomitant asthma and consideration of exposure modification and/or removal from work is indicated. In others, immunotherapy is indicated, in which case treatments every 1-2 weeks for a period of many months to up to approximately 2 years may be indicated.

Job Analysis

A review of the workplace chemicals, products and agents is indicated to help identify likely allergen(s). In some cases, measurements of those agent(s) may be indicated to help quantify the exposure and guide treatment. Occasionally, the exposures may be reduced and following the measured exposure levels may be of assistance. In others settings (e.g., ragweed or other environmental allergens), measurement of the agent is not indicated.

Keratoconjunctivitis

Vernal keratoconjunctivitis is a relatively rare, chronic, severe allergic inflammation of the ocular surface mediated by Th2-lymphocytes. Yet, 50% of patients do not have IgE mediated mechanisms [689]. It is considered the ocular manifestation of atopic dermatitis. It primarily begins in childhood [592, 689], thus is largely considered non-occupational. It is more common in the tropics than the northern climates. [592] Occasional cases can occur throughout the United States and Canada. It may be worsened by non-specific hyperreactivity due to wind, dust and sunlight. [592]
The evaluation of patients with vernal keratoconjunctivitis is similar to other allergy investigations (see above). Limited RCTs on treatments result in a relatively weak evidence base. By inference, treatments recommended for other allergic eye diseases are also recommended for vernal keratoconjunctivitis.

Chemical Burns

Overview

Workplace chemical eye burns result most commonly from exposures to either alkaline agents (e.g., lime or sodium hydroxide) or acids, although they can occur with petrochemicals and other substances. [690-696]. The specific chemical(s) involved, its concentration, quantity and duration of exposure are critical in determining extent of, and limiting the insults of, the injury. Rapid, initial management is likely the most critical aspect of the management and conveys subsequently improved prognosis when rapidly executed. [693, 694, 696-699].

Prevention

See sections above.

Education

See sections above.

Treatment Recommendations

Immediate treatment to irrigate the eye with copious water or other aqueous irrigating solutions is believed to be critical for improved, successful patient treatment [696, 698, 700]. Uncontrolled studies suggest better outcomes with longer duration of irrigation [699].

Copious Irrigation for Chemical Eye Exposures

Recommended.

Medications (including topical creams)

Copious Irrigation is recommended for chemical eye exposures.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	All chemical eye exposures and injuries. It is recommended to begin irrigation immediately after eye exposure, rather than waiting for symptoms to develop. It is also recommended to begin irrigation promptly while others attempt to identify the specific chemical(s)/agent(s), concentration(s) and duration of

	exposure. Irrigation should also be used until Morgan lens, if indicated, is available for more severe injuries.
Harms:	Negligible. Mild discomfort from solution and irrigation
Benefits:	Limiting extent of burn/injury, earlier relief of pain
Frequency/Dose/Duration:	Tap water is most commonly available and should be used if that is the most readily available solution, especially for first line, in-plant settings. Irrigation bottles with irrigating solutions are also useful in in-plant medical departments, clinical settings and distributed in some chemical laboratories and facilities. Normal saline, lactated Ringer's solution are additional options for initial irrigation and are preferable to tap water, but only if immediately available. Substitute normal saline or lactated ringer's or other balanced saline solution for tap water when available. Generally use topical anesthetic to anesthetize the eye when available, as it will assist in better tolerance of irrigation.
Indications for Discontinuation:	Only after extensive irrigation, usually at least 1-2 liters has been used to flush out the chemical. Neutralization of pH should be demonstrable for acid or alkaline exposures. The pH should be 7.0-7.2. The pH should be checked after discontinuing irrigation to assure that additional irrigation is not needed to maintain pH neutrality.
Rationale:	There are no quality studies identifying use compared with non-use of irrigation. There are experimental studies of irrigating solutions for treatment especially of animal models. These animal studies suggest superiority of balanced salt solutions (e.g., normal saline, lactate Ringer's solution) over hypotonic solutions (such as tap water). Still, experience suggests earlier irrigation with the most readily available solution, including tap water, is the preferred initial strategy and is recommended. Once irrigation is underway, tailoring of further irrigation, including possible use of an irrigating system (e.g., "Morgan lens") may be considered.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Non-experimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal

	randomized trials and 4 systematic studies met the inclusion criteria.
Comments:	[Can include harms, benefits, advantages, limitations, etc.]

Irrigating Systems (e.g., Morgan Lens) for Chemical Eye Exposures

Recommended.

Devices

Irrigating Systems (e.g., Morgan Lens) is recommended for chemical eye exposures.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Indications:	High volume exposures and/or highly alkaline/acidic and/or high-risk injuries. It is recommended to begin irrigation immediately after eye exposure (see Copious Irrigation for Chemical Eye Exposures, above), rather than waiting for setting up an irrigation system. Irrigation should also continue while setting up the irrigation system.
Harms:	Mild to moderate discomfort from the irrigating system
Benefits:	Potential to further limit extent of burn/injury beyond that obtainable without the system for more severe exposures
Frequency/Dose/Duration:	Generally use a balanced salt solution (e.g., normal saline (0.9%), lactated Ringer's solution). For most chemicals, 500mL at fast rate (run in 'open') is recommended. Reassess and consider additional fluid depending on chemical, concentration, dose, duration of contamination, severity and clinical effects. For alkali burns, 2 liters wide open is recommended, then 50mL/hr until pH in eye cul-de-sac is neutral. If balanced salt solution unavailable, tap water may be substituted until balanced salt available or transit to definitive care from an in-plant setting.
Indications for Discontinuation:	Only after thorough irrigation of affected area. Neutralization of pH should be demonstrable for acid or alkaline exposures (pH 7.0-7.2).
Rationale:	There are no quality studies comparing use with non-use of irrigating systems. There are animal models suggesting successful use. Irrigating systems, including "Morgan Lenses" are minimally invasive, have minimal adverse effects, are low cost and are selectively recommended for chemical eye exposures.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review,

retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

Artificial Tears or Lubrication for Chemical Ocular Burns

Recommended.

Medications (including topical creams)

Artificial tears or lubricants are selectively recommended for treatment of patients with chemical ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**
Level of Confidence – Low

Indications:	Chemical ocular burns of sufficient size and pain, and particularly among those with inadequate tearing.
Benefits:	May provide sufficient tears to reduce symptoms and potentially improve healing.
Harms:	Undefined but likely negligible.
Frequency/Dose/Duration:	Prn
Indications for Discontinuation:	Resolution of symptoms
Rationale:	There are no quality trials of artificial tears for chemical ocular burns. Patients with more extensive burns tend to have greater need for artificial tears. Artificial tears are inexpensive, noninvasive, and have low adverse effects and are recommended particularly for those patients with inadequate tears.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed

1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

NSAID Drops for Chemical Ocular Burns

Recommended.

Medications (including topical creams)

NSAID ophthalmic drops are recommended for treatment of chemical ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Chemical ocular burns
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	allergic reactions in susceptible patients, intolerance.
Frequency/Dose/Duration:	As per manufacturer's recommendation
Indications for Discontinuation:	With symptom improvement
Rationale:	There are no quality trials for treatment of chemical ocular burns with ophthalmic NSAID drops. NSAID drops are low cost, not invasive, associated with low risks and are recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

Glucocorticosteroid drops have been used for treatment of chemical burns, sometimes in conjunction with vitamin C. ([701]) ([692]; [702, 703])

Glucocorticosteroid Drops for Chemical Ocular Burns

Recommended.

Medications (including topical creams)

Glucocorticoid ophthalmic drops are recommended for select treatment of chemical ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Moderate to severe chemical ocular burns
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	Increased risk of infection, increased risk of cataracts, intolerance.
Frequency/Dose/Duration:	As per manufacturer's recommendation
Indications for Discontinuation:	With symptom improvement. Generally discontinued at one week.
Rationale:	There are no quality trials for treatment of chemical ocular burns with ophthalmic glucocorticoid drops. These medications are used to attempt to reduce the inflammatory process associated with healing chemical burns. These drops are low cost, not invasive, associated with low to moderate risks and are recommended for more severely affected patients. Animal studies are also supportive of a week of treatment [704-706].
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, **6 human randomized trials** and **27 animal randomized trials** and 4 systematic studies met the inclusion criteria. No quality trials for treatment of chemical ocular burns with ophthalmic glucocorticoid drops were found.

Eye Patching for Chemical Ocular Burns

Recommended.

Devices

Eye patching is selectively recommended for treatment of chemical ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Chemical ocular burn that is sufficiently large to have limited vision and inadequate tearing.
Benefits:	"May" provide comfort to affected eye.
Harms:	None
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There are no quality trials for patching eyes with extensive chemical burns. Extensive burns may involve significant discomfort and inadequate tearing. Patching with an ointment in place may facilitate healing and thus is recommended.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

Surgical Interventions

A minority of chemical exposures result in permanent defects, including scarring of the lens and blindness. These cases are generally amenable to surgical procedures, especially corneal transplantation for those with corneal defects and/or scarring involving the visual axis.

Amniotic membrane transplantation (AMT) has been used to treat chemical ocular burns. [702, 707-711]

Amniotic Membrane Transplantation for Chemical Ocular Burns

Recommended.

Surgical Considerations

Amniotic membrane transplantation in conjunction with medical therapy is selectively recommended for treatment of moderately severe chemical ocular burns.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Low

Indications:	Ocular burn Roper-Hall classification grades II-IV. [712, 713]
Benefits:	Patient comfort and decreased inflammation with potential for early re-epitheliazation.
Harms:	Potential allergic response to the membrane.
Frequency/Dose/Duration:	Medical therapy to be administered at the same time is: topical 1% prednisolone acetate Q 6 hrs, ofloxacin Q 6 hrs, sodium ascorbate (10%), sodium citrate (10%), plus preservative-free lubricants every 2 hours, plus homatropine (2%) 1-2 times Q.D., and vitamin C 500 mg P.O. Q 6 hrs for 2 to 4 weeks [712]
Indications for Discontinuation:	N/A
Rationale:	There are two moderate quality trials of amniotic membrane transplantation compared with medical therapy and both trials suggested earlier re-epithelialization [712] [713]. Amniotic membrane transplantation is invasive, has some adverse effects, is costly but has demonstrated efficacy and is selectively recommended for treatment of ocular burns.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: thermal Burn Cornea, thermal ocular burn, thermal eye burn, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 14 articles, and considered 4 for inclusion. In Scopus, we found and reviewed 44 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed zero articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 1 articles, and considered zero for inclusion. We also considered for inclusion 1 articles from other sources. Of the 6 articles considered for inclusion, 3 randomized trials and 2 systematic studies met the inclusion criteria.

Corneal Transplantation for Blindness or Other Corneal Scarring/Defects after Chemical Eye Exposures

Strongly Recommended.

Surgical Considerations

Corneal transplantation is strongly recommended for restoration of vision due to blindness or other effects such as corneal scarring post chemical eye exposures.

Strength of Evidence – **Strongly Recommended, Evidence (A)**

Level of Confidence – High

Indications:	Corneal scarring and/or blindness after chemical eye exposure with visual acuity less than 20/40. There should be reasonable expectation that the retina is normal (e.g., pre-injury status).
Harms:	Further degradation of vision if unsuccessful
Benefits:	Potential to resolve visual deficiency
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There is strong evidence that corneal transplants are highly successful. Transplants are invasive, do have some adverse effects, are high-cost, but are also potentially highly successful and are thus strongly recommended for those with uncorrectable and significant visual acuity deficits.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

Thermal Burns

Overview

Thermal ocular burns occur in occupational environments, although relatively infrequently compared with chemical injuries.

Immediate treatment to irrigate the eye with copious water or other aqueous irrigating solutions is believed to be important for the outcomes of thermal eye injuries. [696, 697, 700].

Ocular surface burns may be caused by intense ultraviolet exposures, most commonly welding while not wearing protective eye gear. They may also be incidental to being near a welder but without adequate eye protection. The presentation typically occurs one day after exposure with a red, painful irritated eye. A diffuse granular appearance of the cornea is usually seen. The history and initial physical examination are highly characteristic. Slit lamp examination findings are characteristic of diffuse granular uptake generally with sparing of the upper and lower corneal margins where the eyelids protect the cornea.

Eye burn accidents occur mostly at work and can result from exposure to alkaline agents (lime or sodium hydroxide), acids, liquid metals, or fireworks. Treatment can include immediate rinsing of the eye [714].

Another treatment is amniotic membrane transplantation (AMT) for acute ocular surface burns. A systematic review found lack of evidence to support the use of this treatment [132].

Treatment Recommendations

NSAID Drops for Welder's Flash

Recommended.

Medications (including topical creams)

NSAID ophthalmic drops are recommended for treatment of welder's flash.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Indications:	Welder's flash
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	Allergic reactions in susceptible patients, intolerance.
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	Symptom resolution
Rationale:	There are no quality trials for treatment of welder's flash. NSAID drops are low cost, not invasive, associated with low risks and are recommended.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: uv corneal burn, welder's eye, keratitis, corneal ulcers, keratouveitis, snow blindness, arc eye, welder's flash, bake eyes, corneal flash burns, flash burns, keratoconjunctivitis photoelectric, photokeratitis, ultraviolet keratitis, eye patch, antibiotics, antifungals, polyhexamethylene biguanide, NSAIDS, non-steroidal anti-inflammatory agents, steroids, eyeglasses, lubricating eye drops, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 362 articles, and considered 68 for inclusion. In Scopus, we found and reviewed 27 articles, and considered 2 for inclusion. In CINAHL, we found and reviewed 3 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 1 for inclusion. We also considered for inclusion 3 articles from other sources. Of the 75 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.
Comments:	[Can include harms, benefits, advantages, limitations, etc.]

Eye Patching for Welder's Flash

Not Recommended.

Devices

Eye patching for welder's flash is not recommended.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – Moderate

Indications:	N/A
Benefits:	N/A
Harms:	N/*A*
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There are no quality trials of patching for treatment of welder's flash. However, eye patching has been shown to have no benefits for treatment of corneal abrasions and rust rings. Thus, patching is also not expected to be efficacious for welder's flash, and therefore patching is not recommended for welders flash.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: uv corneal burn, welder's eye, keratitis, corneal ulcers, keratouveitis, snow blindness, arc eye, welder's flash, bake eyes, corneal flash burns, flash burns, keratoconjunctivitis photoelectric, photokeratitis, ultraviolet keratitis, eye patch, antibiotics, antifungals, polyhexamethylene biguanide, NSAIDS, non-steroidal anti-inflammatory agents, steroids, eyeglasses, lubricating eye drops, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 362 articles, and considered 68 for inclusion. In Scopus, we found and reviewed 27 articles, and considered 2 for inclusion. In CINAHL, we found and reviewed 3 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 1 for inclusion. We also considered for inclusion 3 articles from other sources. Of the 75 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Copious Irrigation for Thermal Eye Exposures

Recommended.

Medications (including topical creams)

Copious Irrigation is recommended for thermal eye exposures.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

Indications:	All thermal eye exposures and injuries. It is recommended to begin irrigation immediately after eye exposure, rather than waiting for symptoms to develop.
Harms:	Negligible. Mild discomfort from solution and irrigation
Benefits:	Limiting extent of burn/injury, earlier relief of pain
Frequency/Dose/Duration:	Tap water is most commonly available and should be used if that is the most readily available solution, especially for first line, in-plant settings. Irrigation bottles with irrigating solutions are also useful in in-plant medical departments, clinical settings and distributed in some facilities. Normal saline, lactated Ringer's solution are additional options for initial irrigation and are preferable to tap water, but only if immediately available. Substitute normal saline or lactated ringer's or other balanced saline solution for tap water when available. Generally use topical anesthetic to anesthetize the eye when available, as it will assist in better tolerance of irrigation.
Indications for Discontinuation:	Only after copious irrigation, usually at least 500mL has been used to flush out the eye.
Rationale:	There are no quality studies identifying use compared with non-use of irrigation. There are experimental studies of irrigating solutions for treatment especially of animal models. These animal studies suggest superiority of balanced salt solutions (e.g., normal saline, lactate Ringer's solution) over hypotonic solutions (such as tap water). Still, experience suggests earlier irrigation with the most readily available solution, including tap water, is the preferred initial strategy and is recommended. Once irrigation is underway, tailoring of further irrigation, including possible use of an irrigating system (e.g., "Morgan lens") may be considered although is less necessary in thermal than in chemical injuries.
Evidence:	A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: thermal Burn Cornea, thermal ocular burn, thermal eye burn *, cornea, , chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Non-experimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the

78 articles considered for inclusion, 6 human randomized trials and 27 animal randomized trials and 4 systematic studies met the inclusion criteria.

Comments: [Can include harms, benefits, advantages, limitations, etc.]

Irrigating Systems (e.g., Morgan Lens) for Thermal Eye Exposures

Not Recommended.

Devices

Irrigating Systems (e.g., Morgan Lens) are not recommended for thermal eye exposures.

Strength of Evidence – **Not Recommended, Insuffcient Evidence (I)**

Level of Confidence – Moderate

Rationale: There are no quality studies comparing use with non-use of irrigating systems for thermal injuries. They are generally not thought to be necessary for most thermal injuries. Exceptions may include combinations of chemicals and thermal. (see above)

Evidence: A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: *eye burn, cornea, cornea burn, chemical, lye, alkaline, burn or burns, alkali or lime or cement or ammonia or sulfurous acid or nitric acid;* controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 623 articles, and considered 72 for inclusion. In Scopus, we found and reviewed 1190 articles, and considered 4 for inclusion. In CINAHL, we found and reviewed 4 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 12 articles, and considered 1 for inclusion. We also considered for inclusion 14 articles from other sources. Of the 78 articles considered for inclusion, **6 human randomized trials** and **27 animal randomized trials** and 4 systematic studies met the inclusion criteria.

Artificial Tears or Lubrication for Thermal Ocular Burns

Recommended.

Medications (including topical creams)

Artificial tears or lubricants are selectively recommended for treatment of patients with thermal ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Thermal ocular burns of sufficient size and pain, and particularly among those with inadequate tearing.
Benefits:	May provide sufficient tears to reduce symptoms and potentially improve healing.
Harms:	Undefined but likely negligible.
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	Symptom resolution
Rationale:	There are no quality trials of artificial tears for thermal ocular burns. Artificial tears are inexpensive, noninvasive, and have low adverse effects and are recommended particularly for those patients with inadequate tears.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: uv corneal burn, welder's eye, keratitis, corneal ulcers, keratouveitis, snow blindness, arc eye, welder's flash, bake eyes, corneal flash burns, flash burns, keratoconjunctivitis photoelectric, photokeratitis, ultraviolet keratitis, eye patch, antibiotics, antifungals, polyhexamethylene biguanide, NSAIDS, non-steroidal anti-inflammatory agents, steroids, eyeglasses, lubricating eye drops, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 362 articles, and considered 68 for inclusion. In Scopus, we found and reviewed 27 articles, and considered 2 for inclusion. In CINAHL, we found and reviewed 3 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 1 for inclusion. We also considered for inclusion 3 articles from other sources. Of the 75 articles considered for inclusion, 48 randomized trials and 4 systematic studies met the inclusion criteria.
Comments:	[Can include harms, benefits, advantages, limitations, etc.]

NSAID Drops for Thermal Ocular Burns

Recommended.

Medications (including topical creams)

NSAID ophthalmic drops are recommended for treatment of thermal ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Thermal ocular burns
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	Allergic reactions in susceptible patients, intolerance.
Frequency/Dose/Duration:	Per manufacturer's recommendations
Indications for Discontinuation:	Symptom resolution
Rationale:	There are no quality trials for treatment of thermal ocular burns with ophthalmic NSAID drops. NSAID drops are low cost, not invasive, associated with low risks and are recommended.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: uv corneal burn, welder's eye, keratitis, corneal ulcers, keratouveitis, snow blindness, arc eye, welder's flash, bake eyes, corneal flash burns, flash burns, keratoconjunctivitis photoelectric, photokeratitis, ultraviolet keratitis, eye patch, antibiotics, antifungals, polyhexamethylene biguanide, NSAIDS, non-steroidal anti-inflammatory agents, steroids, eyeglasses, lubricating eye drops, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 362 articles, and considered 68 for inclusion. In Scopus, we found and reviewed 27 articles, and considered 2 for inclusion. In CINAHL, we found and reviewed 3 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 1 for inclusion. We also considered for inclusion 3 articles from other sources. Of the 75 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Eye Patching for Thermal Ocular Burns

Recommended.

Devices

Eye patching is selectively recommended for treatment of moderate to severe thermal ocular burns.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Indications:	Moderate to severe thermal ocular burn that is sufficiently large to have limited vision and inadequate tearing.
Benefits:	Comfort
Harms:	None
Frequency/Dose/Duration:	N/A

Indications for Discontinuation: Symptom resolution

Rationale: There are no quality trials of patching for treatment of thermal ocular burns. Thermal ocular burns may be selectively treated with eye patching to help provide better protection of the cornea when there is limited tearing and a considerable burn.

Evidence: A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: thermal Burn Cornea, thermal ocular burn, thermal eye burn, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 14 articles, and considered 4 for inclusion. In Scopus, we found and reviewed 44 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed zero articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 1 articles, and considered zero for inclusion. We also considered for inclusion 1 articles from other sources. Of the 6 articles considered for inclusion, 3 randomized trials and 2 systematic studies met the inclusion criteria.

Amniotic Membrane Transplantation with Medical Therapy for Thermal Ocular Burns

Recommended.

Surgical Considerations

Amniotic membrane transplantation in conjunction with medical therapy is selectively recommended for treatment of thermal ocular burns.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Low

Indications: Thermal ocular burn Roper-Hall classification grades II-IV. [712]; [713]

Benefits: Faster re-epithelialization (healing) leading to improved vision.

Harms: Few reported

Frequency/Dose/Duration: Medical therapy recommended to be administered at the same time is: topical 1% prednisolone acetate Q 6 hrs, ofloxacin Q 6 hrs, sodium ascorbate (10%), sodium citrate (10%), plus preservative-free lubricants every 2 hours, plus homatropine (2%) 1-2 times Q.D., and vitamin C 500 mg P.O. Q 6 hrs for 2 to 4 weeks (Tamhane 05)

Indications for Discontinuation:

Rationale:	There are three moderate quality trials of amniotic membrane transplantation compared with medical therapy and both trials suggested earlier re-epithelialization (Tamhane 05, 10; Tandon 10). However, the benefits have not been shown to extend to improved visual function. Amniotic membrane transplantation is invasive, has some adverse effects, is costly but has demonstrated efficacy and is selectively recommended for treatment of ocular burns.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: thermal Burn Cornea, thermal ocular burn, thermal eye burn, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 14 articles, and considered 4 for inclusion. In Scopus, we found and reviewed 44 articles, and considered 1 for inclusion. In CINAHL, we found and reviewed zero articles, and considered zero for inclusion. In Cochrane Library, we found and reviewed 1 articles, and considered zero for inclusion. We also considered for inclusion 1 articles from other sources. Of the 6 articles considered for inclusion, 3 randomized trials and 2 systematic studies met the inclusion criteria.

Standalone Amniotic Membrane Transplantation for Acute Ocular Burns

No Recommendation.

Surgical Considerations

AMT as standalone therapy for acute ocular burns is not recommended due to lack of high quality evidence to support the surgery (see AMP plus medications).

Strength of Evidence – **No Recommendation, Insuffcient Evidence (I)**
Level of Confidence – Moderate

Indications:	Currently not indicated for acute ocular burns
Benefits:	Potential for improved vision
Harms:	None reported
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	N/A
Rationale:	There are no quality, sizeable studies of amniotic membrane transplantation, thus there is no recommendation.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms:

uv corneal burn, welder's eye, keratitis, corneal ulcers, keratouveitis, snow blindness, arc eye, welder's flash, bake eyes, corneal flash burns, flash burns, keratoconjunctivitis photoelectric, photokeratitis, ultraviolet keratitis, eye patch, antibiotics, antifungals, polyhexamethylene biguanide, NSAIDS, non-steroidal anti-inflammatory agents, steroids, eyeglasses, lubricating eye drops, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 362 articles, and considered 68 for inclusion. In Scopus, we found and reviewed 27 articles, and considered 2 for inclusion. In CINAHL, we found and reviewed 3 articles, and considered 1 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 1 for inclusion. We also considered for inclusion 3 articles from other sources. Of the 75 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Pterygium

Overview

Pterygium is an abnormal growth consisting of a triangular fold of tissue that advances progressively over the cornea, usually from the nasal side [715, 716] [717]. Localized conjunctival inflammation may be associated with pterygiae [116, 715]. Most cases occur in tropical climates, dry climates, and amongst those who work outside with ultraviolet exposure. Most cases are cosmetic, although a minority may be symptomatic. However, surgical excision is indicated if the pterygium encroaches on the visual axis. Topical NSAIDs function as local anesthetics and analgesics. Topical NSAIDS are administered to provide relief from inflammatory pain associated with inflamed pterygia, pingueculae [718], corneal abrasions [429], postoperative pain from various surgical procedures [433] and pain associated with many other disorders.

Treatment Recommendations

NSAID Drops for Inflamed Pterygia or Pingueculae

Recommended.

Medications (including topical creams)

NSAID ophthalmic drops are recommended for inflamed pterygia or pingueculae.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Moderate

Indications:	Inflamed pterygia or pinguecuae [719]
Benefits:	Reduced pain, decreased inflammatory response.

Harms:	allergic reactions in susceptible patients, intolerance.
Frequency/Dose/Duration:	Per manufacturer's recommendations. The one quality trial utilized indomethacin 0.1% drops 6 times daily for 3 days, then 4 times daily to complete 2 weeks [719].
Indications for Discontinuation:	Symptom resolution, intolerance or adverse effects.
Rationale:	There is one moderate-quality trial suggesting equal efficacy of NSAID drops compared with glucocorticoid drops for treatment of in flamed pterygia or pinguecuae [719]. There also are multiple moderate quality trials comparing NSAIDs with placebo or drug vehicle for analgesia of simple corneal abrasion. [428-433] (see above). NSAID drops are low cost, not invasive, associated with low risks and are recommended.

Evidence:

Topical glucocorticosteroids have been used to provide relief from inflammatory pain associated with inflamed pterygia, pingueculae [719].

Glucocorticosteroid Drops for Inflamed Pterygia or Pingueculae

Recommended.

Medications (including topical creams)

Glucocorticosteroid ophthalmic drops are recommended for inflamed pterygia or pingueculae.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Moderate

Indications:	Inflamed pterygia or pinguecuae [719]. Generally preferable to use NSAID drops first as the adverse effects are generally lower.
Benefits:	Reduced pain, decreased inflammatory response.
Harms:	allergic reactions, intolerance.
Frequency/Dose/Duration:	Per manufacturer's recommendations. One moderate quality trial utilized 0.1% dexamethasone drops 6 times daily for 3 days, then 4 times daily to complete 2 weeks. [719]
Indications for Discontinuation:	Symptom resolution, intolerance, adverse effects or completion of a course.
Rationale:	There is one moderate-quality trial suggesting equal efficacy of NSAID drops compared with glucocorticoid drops for treatment of in flamed pterygia or pinguecuae [719]. Glucocorticosteroid drops are low cost, not invasive, associated with low risks for short course and are recommended.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: eye, pterygium, pterygia, recurrent pterygia, mitomycin C, surgery, mitomycin, indomethacin, beta irradiation, beta particles, radiation, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological

research, and Nonexperimental Studies. In PubMed we found and reviewed 216 articles, and considered 109 for inclusion. In Scopus, we found and reviewed 7 articles, and considered 0 for inclusion. In CINAHL, we found and reviewed 176 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 0 for inclusion. We also considered for inclusion 1 articles from other sources. Of the 110 articles considered for inclusion, 1 randomized trial and 0 systematic studies met the inclusion criteria.

Pterygia have been surgically removed using many different techniques and approaches (Ozsutcu 14)

Pterygium Excision for Pterygia

Recommended.

Surgical Considerations

Pterygium excision is recommended for pterygia that near the visual axis.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Moderate

Indications:	Pterygia that near the visual axis.
Benefits:	Reduced risk of peripheral vision impairment. Reduced risk of visual axis impairment if more extensive.
Harms:	Recurrence, surgical complications.
Frequency/Dose/Duration:	N/A
Indications for Discontinuation:	
Rationale:	There are many trials of various approaches for removal of pterygia. There are no trials comparing removal with non-removal. Surgical excision is invasive, has adverse effects, is costly, but may prevent serious complications and is selectively recommended for those with impending visual impairments.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: eye, pterygium, pterygia, recurrent pterygia, mitomycin C, surgery, mitomycin, indomethacin, beta irradiation, beta particles, radiation, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 216 articles, and considered 109 for inclusion. In Scopus, we found and reviewed 7 articles, and considered 0 for inclusion. In CINAHL, we found and reviewed 176 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 0 for inclusion. We also considered for inclusion 1 articles from other sources. Of the

110 articles considered for inclusion, 100 randomized trials and 10 systematic studies met the inclusion criteria.

Pterygia have been intra- and postoperatively treated to attempt to prevention recurrence and/or complications.

Bevacizumab for Prevention of Pterygia Recurrence

Recommended.

Surgical Considerations

Bevacizumab is recommended for pterygia that near the visual axis.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Moderate

Indications:	Surgical cases of excision of pterygia, especially in younger patients at higher risk of recurrences.
Benefits:	Reduced risk of recurrence.
Harms:	Intolerance, adverse effects.
Frequency/Dose/Duration:	Topical bevacizumab (5 mg/mL) 4 times daily for 2 months. [720][181]
Indications for Discontinuation:	Intolerance, adverse effects, completion of a course.
Rationale:	There are many trials of various approaches for removal of pterygia. There are no trials comparing removal with non-removal. Surgical excision is invasive, has adverse effects, is costly, but may prevent serious complications and is selectively recommended for those with impending visual impairments.
Evidence:	A comprehensive literature search was conducted using multiple search engines including PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: eye, pterygium, pterygia, recurrent pterygia, mitomycin C, surgery, mitomycin, indomethacin, beta irradiation, beta particles, radiation, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. In PubMed we found and reviewed 216 articles, and considered 109 for inclusion. In Scopus, we found and reviewed 7 articles, and considered 0 for inclusion. In CINAHL, we found and reviewed 176 articles, and considered 0 for inclusion. In Cochrane Library, we found and reviewed 9 articles, and considered 0 for inclusion. We also considered for inclusion 1 articles from other sources. Of the 110 articles considered for inclusion, 101 randomized trials and 10 systematic studies met the inclusion criteria.

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