

Use of Topical Anesthetics in the Management of Patients With Simple Corneal Abrasions: Consensus Guidelines from the American College of Emergency Physicians

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The management of corneal abrasions has largely excluded dispensing topical local anesthetics for home use due to concern for corneal toxicity. We have reviewed and critically appraised the available literature evidence regarding the use of topical anesthetics in patients with simple corneal abrasions. Using sequential Delphi review, we have developed these clinical guidelines. Herein are evidentiary summaries and consensus recommendations for 8 specific relevant questions. Our key observation is that for only simple corneal abrasions, as diagnosed and treated in accordance with the full protocol described herein, it appears safe to prescribe or otherwise provide a commercial topical anesthetic (ie, proparacaine, tetracaine, oxybuprocaine) for use up to every 30 minutes as needed during the first 24 hours after presentation, as long as no more than 1.5 to 2 mL total (an expected 24-hour supply) is dispensed and any remainder is discarded after 24 hours. Importantly, although published findings suggest absent harm for short courses, more rigorous studies with a greater cumulative sample size and ophthalmologic follow-up are needed. [Ann Emerg Med. 2024;■:1-13.]

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INTRODUCTION

Given that the cornea is one of the most densely innervated body tissues, corneal abrasions are often associated with significant pain and frequently prompt emergency department (ED) visits.¹⁻³ Superficial injury to the cornea is estimated to represent 357,000 ED visits annually in the United States.³

The ED management of corneal abrasions (Table 1) has largely excluded dispensing topical local anesthetics for home use due to concern for corneal toxicity.⁴⁻⁷ This practice has come under question, and topical anesthetics are provided for short-term use in some settings.^{6,8,12-18} Beyond the ED, there are several studies describing postoperative topical anesthetics for home use following photorefractive keratectomy, and some ophthalmologists prescribe them for either first-line or breakthrough therapy after photorefractive keratectomy.¹⁹⁻²⁷

Due to concerns regarding potential patient harm, the American Academy of Ophthalmology (AAO) approached the American College of Emergency Physicians (ACEP) with the request to jointly issue guidelines regarding the use of topical anesthetics following a corneal abrasion. Accordingly, a combined workgroup was assembled to review and critically appraise the peer-reviewed literature regarding the benefits and harms of topical anesthetics for

home use in the treatment of corneal abrasions as well as to appraise alternative analgesic therapies in this setting.

METHODS

Writing Workgroup

The AAO and ACEP each appointed 5 members to a joint workgroup, with cochairs from each specialty (Table E1, available at <http://www.annemergmed.com>). Participants were chosen based on their established clinical expertise; experience with research; literature appraisal; and the creation of clinical policies, guidelines, and/or consensus statements. All members disclosed conflicts of interest, and none reported any potential financial or intellectual conflicts relating to corneal abrasion or its associated pain therapy.

Literature Search

A medical librarian performed searches of the PubMed and Embase databases (search strategies in Appendix E1, available at <http://www.annemergmed.com>). We limited all searches to human studies from English-language sources published between 1968 and February 28, 2023. All patient ages were included. We screened titles and abstracts of all articles identified by the search, with full-text review

Table 1. Common recommended therapies for simple corneal abrasions in adults other than topical anesthetics.

Therapy	Benefit	Reference
Topical antibiotic therapy options	Limited evidence for benefit	Algarni et al, 2022 ¹⁰
Erythromycin ointment		
10% sulfacetamide drops		
Polymyxin/trimethoprim drops		
Ciprofloxacin drops		
Pain control		
Cycloplegia	Benefit unclear	Meek et al, 2010 ¹¹
2% homatropine drops		
Topical analgesia options:	Effective	Yu et al, 2021 ⁸
0.1% diclofenac drops		
0.5% ketorolac drops		
0.1% indomethacin drops		
Oral analgesia options (individually or in combination)	Effective	Yu et al, 2021 ⁸
Ibuprofen		
Acetaminophen		
Pressure patch	Apparently ineffective	Lim et al, 2016 ⁹

of reports pertinent to the guidelines. In addition, relevant articles from the bibliographies of included studies and more recent articles identified by committee members and reviewers were included. We reviewed the reference lists of identified publications and consulted with content experts to identify additional reports.

Given that our principal objective was to assess potential harms, we intentionally fashioned our search and review to include a variety of study formats (eg, randomized controlled trials, case reports, case series), clinical settings, and corneal conditions (including those more serious than uncomplicated abrasions) to assess the full context of the existing evidence on topical anesthetic toxicity.

Methodology

In developing these guidelines, we adhered to the general principles and methodology advocated by the National Academy of Medicine and the Scottish Intercollegiate Guidelines Network (SIGN) and was quality checked by the National Guideline Clearinghouse Extent of Adherence to Trustworthiness Standards (NEATS) instrument.²⁸⁻³⁰ SMG served as the methodologist for the project. The group accomplished its work through email questionnaires and periodic virtual meetings. We defined our principal question and developed a list of relevant supporting questions. The full list of workgroup questions is shown in [Figure 1](#).

We concurrently identified terms to be defined and background issues important for context. These questions and items were solicited from workgroup members using the principles of the Nominal Group

Technique and refined with sequential review and consensus generation using the Delphi Method and with feedback from a lay person social media survey to obtain patient perspectives ([Appendix E2](#), available at <http://www.annemergmed.com>). We then drafted our specific methodology, definitions, and background items and developed and refined them using sequential Delphi review.

For our methodology, we chose an amalgamation of existing AAO and ACEP guideline processes. Articles found relevant to our review were rated for quality by workgroup members using the SIGN grading system ([Figure 2](#)).^{29,31} Each article was independently rated by 2 or more workgroup members, with disagreements resolved by the workgroup cochairs. We then drafted evidentiary summaries for our principal and supporting questions. These were developed and refined also using sequential Delphi review. Quality ratings for the body of evidence pertinent to each question was assigned using Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) ([Figure 2](#)).^{29,31}

Workgroup members assessed quality ratings and recommendations using a 5-point Likert scale as follows: Strongly Disagree, Disagree, No Strong Opinion, Agree, or Strongly Agree. We defined consensus agreement as at least 80% of members choosing “Agree” or “Strongly Agree.” We defined strong consensus as at least 90% of respondents choosing “Agree” or “Strongly Agree.”

This iterative process for this guideline development spanned a period of 14 months. By May 2023, these

Principal question:

- Among ED adults discharged home with a simple corneal abrasion, is there evidence that analgesia using short courses (up to 24 hours) of commercially available topical anesthetics, when compared to saline placebo or nonuse, is associated with more frequent adverse visual outcomes or healing?

Supporting questions:

Topical anesthetic benefits

- In ED adults discharged home with a simple corneal abrasion, are topical anesthetics beneficial in reducing pain? What is their associated patient satisfaction?

Topical anesthetic harms

- In ED adults discharged home with a simple corneal abrasion, is there evidence that potential harms from topical anesthetics vary by specific local anesthetic drug, concentration, or duration of therapy?
- In ED adults discharged home with a corneal abrasion, is there evidence that potential harms from topical anesthetics vary by whether the abrasion is simple or not simple?
- In ED adults discharged home with a corneal abrasion, is there evidence that potential harms from topical anesthetics vary by patient

comorbidities, medications, or social factors like homelessness? Were certain patient types or underlying conditions excluded from most research?

Alternatives benefits

- In ED adults discharged home with a simple corneal abrasion, what are the relative benefits of alternative therapies (eg, topical analgesics, cycloplegics, and antibiotic ointment; analgesia by other routes; pressure patching and bandage contact lens) compared to topical anesthetics? What are the differences in patient satisfaction?

Alternatives harms

- In ED adults discharged home with a simple corneal abrasion, what are the relative potential harms of alternative therapies (eg, topical analgesics, cycloplegics, and antibiotic ointment; analgesia by other routes; pressure patching and bandage contact lens) to topical anesthesia?

Pediatrics

- In ED children or adolescents discharged home with a simple corneal abrasion, what aspects of the prior series of topical anesthetic benefit and harm questions differ by age?

Figure 1. Workgroup questions.

guidelines had reached a stage where all questions and recommendations were addressed, there was no dissent, and the remaining feedback centered on minor revisions and stylistic refinements. The workgroup cochairs together determined that the core tasks had been successfully accomplished, and the group congratulated each other on their consensus.

The document was then submitted for review and critique by leaders and committees from the AAO (Cornea Preferred Practice Pattern® Panel, Ophthalmic Technology Assessment Panel, Secretary for Quality of Care) and ACEP (Clinical Policies, Emergency Medicine Practice, Quality & Patient Safety). Minor comments were received from ACEP, and feedback provided from the AAO included a variety of opposing comments for which the principal themes were concerns regarding the skills of an emergency physician, traditional teachings on the topic, anecdotal reports of harms of topical anesthetic usage in any amount, and the nonavailability in many settings of commercially packaged bottles containing 2 mL or less. The emergency medicine members of the

workgroup responded to all concerns raised with written arguments.

In June 2023, the AAO informed the workgroup that the AAO would be willing to support the literature summaries but would not endorse the patient care recommendations. They acknowledged that there is literature support, though not strong, for safe use for 24 hours or less. The AAO further requested that the workgroup reconvene to revisit their patient care recommendations. The emergency medicine workgroup members declined the request given that the recommendations were already affirmed by the workgroup and that any potential changes in the viewpoint of any ophthalmology member after the fact might reasonably be based on the resistance and disapproval rather than the evidence.

Discussion between AAO and ACEP leaders continued through October 2023, when the AAO reaffirmed its endorsement of the literature review from the workgroup but nonendorsement of the guidelines' recommendations. The final reasons cited were that (1) "the Delphi process was not utilized for the recommendations and figures," (2) "the quality of the evidence is not sufficiently strong to

SIGN (rating of individual articles)²⁹

- I++ High-quality meta-analyses, systematic reviews of randomized controlled trials (RCTs), or RCTs with a very low risk of bias.
- I+ Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias.
- I- Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias.
- II+ Well-conducted case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal.
- II- Case-control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal.
- III Nonanalytic studies (eg, case reports, case series)
III* Interventional case series.

The following studies were not assigned a SIGN level and were labeled NA: Reviews, Basic Scientific Research, Textbook Chapters, Cost-Effective Analysis, Survey Studies, and Diagnostic Testing.

GRADE (body of evidence quality ratings)³¹

- Good quality: Further research is very unlikely to change our confidence in the estimate of effect.
- Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

- Insufficient quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate. Any estimate of effect is very uncertain.

Recommendations

- Level A recommendations. Generally accepted principles for patient care that reflect a high degree of clinical certainty (ie, based on evidence from one or more Class of Evidence I or multiple Class of Evidence II studies).
- Level B recommendations. Recommendations for patient care that may identify a particular strategy or range of strategies that reflect moderate clinical certainty (ie, based on evidence from one or more Class of Evidence II studies or strong consensus of Class of Evidence III studies).
- Level C recommendations. Recommendations for patient care that are based on evidence from Class of Evidence III studies or, in the absence of any adequate published literature, based on expert consensus. In instances where consensus recommendations are made, “consensus” is placed in parentheses at the end of the recommendation.

Figure 2. Tools used to rate articles and appraise the quality of evidence.

warrant specific therapeutic protocols,” and (3) the purportedly conflicting findings of a newly released Cochrane review.

The first claim, which had not been previously made, is, in our opinion, inaccurate. The Delphi process was consistently employed with full support and affirmation from the full workgroup. Throughout the above collaboration and aftermath, there have been no instances where ophthalmology workgroup members expressed concerns or raised issues regarding any aspect of the workgroup’s methodology and procedures to their emergency medicine counterparts. The second assertion contradicts the viewpoint of the scientific appointees selected by the AAO, as documented in this report. In the Discussion section of this document, we outline how differences in methodology and scope between our work and the Cochrane review explain the apparently discrepant findings.

Each ophthalmology member, citing their society’s nonendorsement, asked to be removed as authors

and requested anonymity. Each attested that they had no suspicions of fraud or misconduct during the project.

With no further ophthalmology participation, the emergency medicine members of the workgroup then finalized the document to incorporate minor suggestions from ACEP review and those from the AAO that could be addressed. None of these edits substantively altered the prior literature summaries or recommendations.

DEFINITIONS AND BACKGROUND

Corneal Abrasions, Simple and Complicated

A corneal abrasion is a superficial injury (scratch or scrape) to the corneal epithelium that usually occurs from contact with a fingernail, sand, wood shavings, metal particles, or contact lenses.

We defined simple abrasions as those, based on a standard evaluation including a slit-lamp, that are not unduly large

(not quantified) and lack any of the following complicating features: corneal penetration or laceration, damage to any other part of the eye, duration more than 2 days at presentation, chemical or thermal cause, isolated ultraviolet-induced photokeratitis, gross contamination, infection, retained foreign body (including rust ring after ED removal), underlying corneal pathology (eg, corneal dystrophies, recurrent corneal erosions), history of herpetic eye disease, previous corneal surgery or transplant in the affected eye, or other ocular surgery within the last month.^{14,17} We defined any abrasion with one or more of the previous features as complicated. We chose to not consider a contact lens origin as a complicating feature, although we acknowledge that this source of abrasion should be viewed with heightened concern given the associated infection risk.

Commonly described therapeutic recommendations for corneal abrasion are shown in Table 1.^{8-11,32,33}

Short-term Use

The largest ED studies and the largest ophthalmology trials of postoperative photorefractive keratectomy restricted home use of topical anesthetics to 24 hours, although there were studies in each group where therapy ranged up to 1 week.^{12-14,17,19-21} Accordingly, we

defined short-term use as up to 24 hours after presentation.

PRINCIPAL QUESTION

Among ED adults discharged home with a simple corneal abrasion, is there evidence that analgesia using short courses (up to 24 hours) of commercially available topical anesthetics, when compared to saline placebo or nonuse, is associated with more frequent adverse visual outcomes or healing?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. In adult ED patients with simple corneal abrasions as defined in these guidelines, it appears safe to prescribe or otherwise provide a commercial topical anesthetic (ie, proparacaine, tetracaine, oxybuprocaine) for use up to every 30 minutes as needed during the first 24 hours after presentation as long as no more than 1.5 to 2 mL total (an expected 24-hour supply) is dispensed and any remainder is discarded after 24 hours. See Figures 3 and 4 for our recommended protocol and patient instructions, respectively.^{17,18}

Level C recommendations. None specified.

Ensure that the corneal abrasion is simple using a standard evaluation including a slit-lamp examination.

To be considered simple, the corneal abrasions must not be unduly large (not quantified) and lack any of the following complicating features: corneal penetration or laceration, damage to any other part of the eye, duration more than 2 days at presentation, chemical or thermal cause, isolated ultraviolet-induced photokeratitis, gross contamination, infection, retained foreign body (including rust ring after ED removal), underlying corneal pathology (eg, corneal dystrophies, recurrent corneal erosions), history of herpetic eye disease, previous corneal surgery or transplant in the affected eye, or other ocular surgery within the last month.

Consider the likely higher risk of infection when simple abrasions result from contact lenses or from foreign plant matter.

Discuss the benefits, potential harms, and proper usage of topical anesthesia with the patient.

Provide no more than 1.5 to 2.0 mL of topical anesthetic to the patient. Have them throw away any residual after 24 hours.

There are 3 formats* for such provision:

- Use a portion of the leftover examination bottle: “I use the 15 mL bottle I just used for the patient’s slit-lamp examination and dispose of the majority of it in the sink (leaving only approximately 1 to 2 mL) before handing it over to the patient to take home to use for no cost, with strict instructions to throw away after 24 hours.” (We thank Stacia Shipman, DO, for granting us permission to reproduce this personal communication quote.)
- Commercial preparation: In some settings commercial preparations are available in 0.5 mL plastic vials. In the studies by Waldman et al, 3 of these vials (1.5 mL) were provided to each patient.^{17,18}
- Custom pharmacy preparation: Have your pharmacy prepare custom bottlings of 1.5 to 2.0 mL.

*If any one of these methods is felt problematic or unworkable within a given locality, then another can be selected.

Figure 3. Recommended ED protocol for dispensing topical anesthetics for simple corneal abrasions.

Patient/caregiver advice for topical anesthetic drops

- Your physician/caregiver has prescribed or otherwise provided you with a small amount of a topical anesthetic to numb or block the sensation of pain in your eye. These instructions concern these anesthetic eye drops and are in addition to the separate instructions you have received for your corneal abrasion.
- **If needed for pain, place 1 drop into the affected eye no more frequently than every 30 minutes for the first 24 hours. Throw away any amount that remains after 24 hours. Your cornea may be damaged if you use them longer than 24 hours, and such damage may result in visual impairment or blindness that could be permanent.**
- Keep the eye drops in the refrigerator. This will help preserve them and, since the drops will feel cold, this sensation will help you identify that they have properly entered your eye.

- Discontinue use of these drops if your eye pain worsens after using them, if your eye becomes red and swollen, or you develop a rash. You may have developed an allergy to the drops. Return to the emergency department or otherwise seek care for re-examination.
- The pain from a corneal abrasion is typically gone within 48 hours. If you are still having more than minimal pain after 48 hours, there may be a serious change in your condition, and you need to be promptly reevaluated by an eye physician or a return visit to the emergency department.
- The local anesthetic effect of these drops will interfere with your protective blinking reflex mechanism. Avoid rubbing or touching the eye or using eye washes.

Adapted with thanks from Neil Waldman, MD.¹⁸

Figure 4. Recommended information to add to patient discharge instructions (these can be templated into an electronic medical record discharge form).

Evidentiary Summary

The literature evidence informing this question takes the form of case reports of anesthetic-associated toxicity (Table E2, available at <http://www.annemergmed.com>), the ophthalmology experience using topical anesthetics for photorefractive keratectomy postoperative analgesia (Table E3, available at <http://www.annemergmed.com>), and the ED experience with topical anesthetics (Table 2).^{12-15,17,18}

Animal and basic science studies. Our search of the human literature identified research studies addressing topical anesthetic corneal toxicity using animals, corneal cell cultures, or *in vitro* human corneas, and our nonsystematic review of these and their reference lists produced 7 studies summarized in Table E4 (available at <http://www.annemergmed.com>). These heterogeneous studies report minimal to no toxicity with low doses and short exposures, but progressively increasing toxicity (primarily impaired healing) with higher doses and/or longer duration of administration.

Case reports and case series. Table E2 details the case reports of topical anesthetic-associated corneal complications. These include a variety of underlying conditions above and beyond simple abrasions (eg, herpes keratitis, ultraviolet keratitis, eye surgery); however, they are listed in this table to best depict the breadth and heterogeneity of the reported experience.

There are also 3 larger case series from nations in which topical anesthetics are available over the counter. Shirzadeh et al³⁴ describe 162 patients seen in their eye clinic for ocular discomfort, of whom 72—mostly welders with UV keratitis—were using ongoing tetracaine drops. They describe occurrences of “corneal damage” but do not quantify or further describe these adverse events. Sharifi et al³⁵ detail 24 patients using tetracaine for a mean of 9 days—mostly for UV keratitis—who were noted to have epithelial defects, infiltrates, and other abnormalities. Healing occurred in 11 patients, with others experiencing opacities or decreased acuity. In addition, one patient who refused to discontinue the drug experienced phthisis bulbi. Yagci et al³⁶ describe 19 patients with keratopathy attributable to ongoing misuse of proparacaine. Most healed over 5 to 60 days, except one with phthisis bulbi and 4 with substantially decreased severity. All of these cases involve exposures to anesthetic drops for durations beyond 24 hours, except for one patient with corneal haziness and an epithelial defect reported after 2 drops of tetracaine, with healing after 3 days.³⁵

A summary appraisal of this cumulative case report and case series experience is challenged by the wide variety of initial diagnoses, the varying duration and timing of topical anesthetic exposures, and frequently missing details about the abrasions and corneal complications. Further, most of the described cases were seen in eye clinics for initial diagnosis and follow-up and had initial diagnoses more

Table 2. Emergency department studies or descriptions of topical anesthetic home use for corneal abrasion.

Study	n	Format	Intervention	Comparator	Primary Outcome	Benefits	Harms	SIGN Rating
Randomized controlled trials								
Ting et al, 2009 ¹⁵	47	RCT	0.4% tetracaine 1 drop hourly for 36 to 48 hours	Placebo plus other analgesia at physician discretion	Benefits	Similar pain scores and patient satisfaction	No statistical difference*	I-
Ball et al, 2010 ¹²	33	RCT	0.05% proparacaine 2 to 4 drops prn over 7 days	Placebo plus acetaminophen plus codeine	Benefits	Lower pain scores, higher patient satisfaction	No statistical difference*	I-
Waldman et al, 2014 ¹³	116	RCT	1% tetracaine q30 minutes for 24 hours	Placebo plus acetaminophen	Benefits	Similar pain scores, higher effectiveness rating	No statistical difference*	I+
Shipman et al, 2021 ¹⁴	111	RCT	0.5% tetracaine q30 minutes for 24 hours	Placebo plus acetaminophen plus hydrocodone	Benefits	Lower pain scores, decreased opioid use	No statistical difference*	I+
Non-randomized reports								
Waldman et al, 2018 ¹⁷	459	Retrospective series	1% tetracaine q30 minutes for 24 hours (1.5 mL total dispensed)	None	Harms	Not assessed	No serious outcomes attributable to tetracaine	III
Waldman et al, 2023 ¹⁸	Estimated 1,524	Experience description	0.4% oxybuprocaine q30 minutes for 24 hours (1.5 mL total dispensed)	None	Harms	Not assessed	No known serious outcomes attributable to oxybuprocaine	III

RCT, randomized controlled trials; SIGN, Scottish Intercollegiate Guidelines Network.
*Not powered for the comparisons.

complicated than patients typically evaluated in the ED. Of the 9 patients from Table E2 with exposure times reported as 4 days or less, all healed, and no unusually long healing times were reported. In those with exposure times more than 4 days, healing was reported in 16/39 (41%) with other cases experiencing permanent sequelae or being lost to follow-up. Importantly, many of these latter patients had extended exposures ranging up to 6 months, with 29/39 (74%) exposed for 2 or more weeks. Many in this prolonged exposure group had complicated initial diagnoses that could have contributed to the poor outcomes. For the 10 patients for whom the duration of exposure was not specified, most were primarily evaluated in eye clinics, and most had complicated corneal abnormalities.

In summary, despite the inherent selection biases, this case report sampling did not identify patients with short-term exposures who suffered permanent harm. Although these encouraging findings suggest safety in this setting, they are limited by their case report format (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

Photorefractive keratectomy experience. Photorefractive keratectomy is a form of refractive surgery that involves removal of the epithelium and is associated with short-term pain.²⁵ Given the similarities with pain following corneal abrasion, there has been similar interest and research in management using topical anesthetics. One important difference is that photorefractive keratectomy is associated with a sterile corneal wound, whereas abrasions may be associated with inoculation of infectious agents.

Three small randomized, controlled trials (Table E3) have shown lower pain scores with topical tetracaine or proparacaine and no apparent differences in harms although substantially underpowered for the latter comparison.¹⁹⁻²¹ Three small, nonrandomized case series (Table E3) note apparently successful analgesia without evident complications; the largest study included 48 eyes with therapy up to 1 week in length.²²⁻²⁴

There has been an existing practice pattern of ophthalmologists prescribing topical anesthetics for photorefractive keratectomy postoperative analgesia either for initial use or for breakthrough pain.^{23-25,27} Two cases of complicating keratopathy have been reported. The first patient used tetracaine every 30 minutes while awake for 8 days, and the second patient intermittently used proparacaine over 6 months. Both had complete healing on cessation.^{27,37}

In summary, the current photorefractive keratectomy evidence consists of 684 total eyes treated with home topical anesthetics (Table E3) and a pattern of ongoing clinical use—both without evidence of harm with short-term exposures. Although these findings suggest no harm in this particular setting involving a sterile surgical epithelial

defect, more rigorous studies with a greater cumulative sample size are needed (*Moderate quality of evidence*. Strong consensus: 10/10 strongly agree).

ED experience. Four randomized controlled trials that were not powered for adverse outcomes or healing, a larger observational study, and a follow-up report from the latter (Table 2) inform this question.^{12-15,17,18}

Waldman et al¹³ randomized 116 patients with uncomplicated corneal abrasions to receive tetracaine 1% (n=59) versus saline solution (n=57), with drops to be applied every 30 min for 24 hours while awake. Both groups were given chloramphenicol eye ointment. Follow-up at 48 hours showed no difference in corneal healing or persistent symptoms.

Shipman et al¹⁴ randomized patients with uncomplicated corneal abrasions to tetracaine 0.5% (n=56) versus placebo (n=55) drops every 30 min as needed for 24 hours. At follow-up between 24 and 48 hours, there was no difference in residual corneal abrasion between the 2 groups.

Ting et al¹⁵ randomized a total of 47 patients with corneal abrasions and welding flash burns to 0.4% tetracaine eye drops versus normal saline solution hourly while awake for 36 to 48 hours. Of the 34% of patients who had follow-up, there was no difference in primary outcome of persistent corneal defect at 36 to 48 hours (2/7 in the tetracaine group, 1/9 in the saline group). At the 2-week telephone follow-up (81% of the 47 randomized patients), there was no difference in visual problems.

Ball et al¹² randomized patients to 0.05% proparacaine (n=15) versus placebo (n=18) drops as needed for up to 7 days. Both groups were given topical gatifloxacin. Follow-up at 1, 3, and 5 days showed no delayed wound healing in either group.

The 2 nonrandomized reports describe real-world clinical experience in a defined region (southern tip of New Zealand's South Island) served by a single hospital and its associated single ophthalmology clinic. This relative geographical isolation and government health care should have minimized unaccounted complications in patients lost to follow-up. In the first report, Waldman et al¹⁷ reviewed 459 ED patients with simple corneal abrasions treated according to a local home use protocol of 1% tetracaine (Table 2).^{12-15,17,18} Although follow-up was not mandated, there were no serious or permanent complications identified within the regional system. In a less rigorous follow-up report in which their protocol changed to 0.4% oxybuprocaine (Table 2), no associated serious or permanent complications were identified over 7 years in an estimated 1,524 ED patients. Both studies instructed patients to discard the drops after 24 hours.^{12-15,17,18} When combining the patients treated in their 3 studies,

there were no associated serious or permanent complications identified in an estimated 1,891 patients (harm 0 of 1,891; 95% confidence intervals 0% to 0.2%).^{13,17,18}

In summary, these studies of short-term use of topical anesthetics in simple corneal abrasions found no statistical differences in adverse effects or healing relative to placebo and identified no instances of serious or permanent harm. The studies are limited by sample size, differing anesthetic drugs involved, inconsistent use of concurrent treatments, and incomplete follow-up. Importantly, all studies gave limited amounts of topical anesthetic drops to avoid overextended use. Although these findings suggest absent harm for short courses, more rigorous studies with a greater cumulative sample size and ophthalmologic follow-up are needed (*Moderate quality of evidence*. Strong consensus: 10/10 strongly agree).

Question summary. In the available case reports, case series, and studies of topical anesthetics in both photorefractive keratectomy and ED settings, no patients were identified who experienced serious or permanent harm with short-term exposure to topical anesthetics, including patients with contact lens-associated abrasions. However, we noted numerous case reports of patients suffering harm after lengthier exposures. These underlying studies are limited by aggregate sample size that is not powered for adverse outcomes and healing, differing anesthetic drugs involved, inconsistent use of concurrent treatments, and incomplete follow-up. Although these findings suggest absent harm for short courses as outlined in [Figures 3](#) and [4](#), more rigorous studies with a greater cumulative sample size are needed (*Moderate quality of evidence*. Strong consensus: 10/10 strongly agree).^{17,18}

SUPPORTING QUESTIONS

In ED adults discharged home with a simple corneal abrasion, are topical anesthetics beneficial in reducing pain? What is their associated patient satisfaction?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. None specified.

Level C recommendations. When topical anesthetics are provided, clinicians should recognize that the evidence generally suggests beneficial reduction in pain but is mixed regarding patient satisfaction.

Evidentiary Summary

What do patients value? What are their preferences when diagnosed with simple corneal abrasions?

The drafting of clinical practice guidelines should incorporate patient preferences and involvement, so we considered literature on patient satisfaction related to corneal abrasion treatment, the personal and clinical experience of the task force members, and the results from a lay person social media survey ([Appendix E2](#)).^{28,29}

Pain is the most common chief complaint of patients presenting to an ED.³⁴ Patients have an expectation for rapid delivery of pain medication and tend to be more satisfied with their overall care when pain needs are met.³⁵⁻³⁸ A variety of treatments, including opioids, are often prescribed in further attempts to provide pain relief. However, given the opioid epidemic, some patients and physicians have concerns regarding their use for treating corneal abrasions.

Regardless of analgesic modality, patients are also reasonably concerned about their involved costs and their convenience of use, eg, frequency of administration. Although patients desire effective pain control, they may not be immediately concerned about potential medication side effects that can lead to unwanted morbidities.³⁸ However, there is an implicit assumption from patients that prescribed treatments are reasonably safe.

Three studies have been published evaluating pain reduction with topical anesthetics for simple corneal abrasions ([Table 2](#)).^{12-15,17,18} Ball et al¹² randomized 33 patients either to a 0.05% proparacaine solution or placebo to be used as needed by patients. The primary outcome (pain before and 5 minutes after the use of study medication on a 10-cm visual analog scale) was lower for the proparacaine group (median reduction of 3.9 versus 0.6 for placebo, $P=.007$).¹

Shipman et al¹⁴ randomized 111 patients to either 0.5% tetracaine solution or placebo every 30 minutes as needed by patients up to 24 hours. Median pain scores recorded at the 24 to 48 hour follow-up visit were much lower for the proparacaine group than placebo on a 10-cm numeric rating scale (1 versus 8, $P<.001$).² They also noted a significant decrease in hydrocodone usage in the tetracaine group for breakthrough pain compared with placebo. Lastly, Waldman et al¹³ randomized 116 patients to receive 1% tetracaine or placebo every 30 minutes for the first 2 hours then every 2 hours while awake for 48 hours. Average pain scores at 24 and 48 hours were similar between the groups; however, their participants rated tetracaine's effectiveness significantly higher than that of placebo (7.7 versus 3.8 numeric rating scale).³

Two studies have been published evaluating patient satisfaction with topical anesthetics using a 10-cm visual analog scale ([Table 2](#)). Ball et al¹² reported significantly

higher satisfaction with proparacaine compared with placebo (8.0 versus 2.6, $P=0.027$). Ting et al,¹⁶ however, found similar patient satisfaction between tetracaine and placebo.

In summary, these studies showed generally reduced pain with topical anesthesia (*Moderate quality of evidence*. Strong consensus: 10/10 strongly agree) and mixed results for patient satisfaction (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

In ED adults discharged home with a simple corneal abrasion, is there evidence that potential harms from topical anesthetics vary by specific local anesthetic drug, concentration, or duration of therapy?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. Restrict topical therapy to a maximum of 24 hours.

Level C recommendations. Among the 3 topical anesthetics most studied (tetracaine, proparacaine, and oxybuprocaine), all appear similarly safe at standard concentrations.

Evidentiary Summary

There have been no comparative trials to specifically address these issues. Although all topical anesthetic drugs appear capable of toxicity, based on indirect data, there appears no reason to regard any of the 3 most studied (tetracaine, proparacaine, oxybuprocaine) as more or less prone to toxicity at the typical commercially available concentrations used. Similarly, based on indirect data, it appears that each of these drugs is associated with minimal to no toxicity with low doses and brief exposures, but then progressive increases in toxicity with higher doses and/or longer administration. In the available case reports, case series, and studies, we did not identify patients who experienced serious or permanent harm with exposure to topical anesthetics for 24 hours or less (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

In ED adults discharged home with a corneal abrasion, is there evidence that potential harms from topical anesthetics vary based on whether the abrasion is simple or not simple?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. Avoid topical anesthetic therapy for corneal abrasions that are not simple.

Level C recommendations. None specified.

Evidentiary Summary

There have been no comparative trials to specifically address this issue. The ED trials (Table 2) were specifically limited to simple abrasions.^{12-15,17,18} Many of the case reports (Table E2) describe patients with complex abrasions or other epithelial defects who frequently experienced poor outcomes following topical anesthetic exposure. The contribution of the topical anesthetics to these outcomes is uncertain.

In summary, there are no direct data to address this question, and indirect data suggest but cannot verify worse outcomes with complicated abrasions. (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

In ED adults discharged home with a corneal abrasion, is there evidence that potential harms from topical anesthetics vary by patient comorbidities, medications, or social factors like homelessness? Were certain patient types or underlying conditions excluded from most research?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. None specified.

Level C recommendations. Consider patient comorbidities, medications, or social factors like homelessness when choosing whether to provide a topical anesthetic, while recognizing that there is insufficient evidence to support differences in potential harms based on them.

Evidentiary Summary

There have been no comparative trials to specifically address these issues. There are no apparent associations or trends based on indirect data either.

The ED-based randomized trials (Table 2) limited their enrollment to uncomplicated corneal abrasions but did not exclude patients based on comorbidities except prior eye pathology, immunosuppression, or deafness.^{12-15,17,18} There were no restrictions based on medications or social factors (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

In ED adults discharged home with a simple corneal abrasion, what are the relative benefits of alternative therapies (eg, topical nonsteroidal anti-inflammatory drugs, cycloplegics, and antibiotic ointment; analgesia by other routes; pressure patching and bandage contact lens) compared to topical anesthetics? What are the differences in patient satisfaction?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. Topical anesthesia appears a more effective analgesic than acetaminophen with or without an opioid.

Level C recommendations. No recommendation can be made between topical anesthetics and alternative therapies, such as nonsteroidal anti-inflammatories. The benefits between therapies have not been established.

Evidentiary Summary

The 2 ED-based randomized trials (Table 2) that compared topical anesthetics to acetaminophen plus an opioid, both showed lower pain scores with the former, and the trial that measured patient satisfaction also found improvement with topical anesthesia.^{12-15,17,18} The trial that compared tetracaine to acetaminophen without an opioid found similar pain scores but higher patient ratings of effectiveness with topical anesthesia.¹³ The final trial that compared tetracaine to analgesia at the physician's discretion (specific therapies not reported) found similar pain scores and patient satisfaction.¹⁵ These findings support the premise of generally better analgesia with topical anesthesia relative to acetaminophen with or without an opioid (*Moderate quality of evidence*. Strong consensus: 10/10 strongly agree).

There are no trials comparing topical anesthesia to any of the other treatments outlined in Table 1 (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).⁸⁻¹¹

In ED adults discharged home with a simple corneal abrasion, what are the relative potential harms of alternative therapies (eg, topical nonsteroidal anti-inflammatory drugs, cycloplegics, and antibiotic ointment; analgesia by other routes; pressure patching and bandage contact lens) to topical anesthesia?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. None specified.

Level C recommendations. No recommendation can be made between topical anesthetics and alternative therapies, such as nonsteroidal anti-inflammatories. The harms between therapies have not been established.

Evidentiary Summary

Short courses of these alternative therapies as used for uncomplicated corneal abrasions are widely regarded as safe. Corneal melting has been rarely associated with topical nonsteroidal anti-inflammatory drugs in settings of

underlying comorbidities and prolonged therapy; however, it has not been reported with uncomplicated corneal abrasion.³⁸

There have been no comparative trials of topical anesthetics relative to any of these agents sufficiently powered to assess harms (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

In ED children or adolescents discharged home with a simple corneal abrasion, what aspects of the prior series of topical anesthetic benefit and harm questions differ by age?

Patient Management Recommendations

Level A recommendations. None specified.

Level B recommendations. None specified.

Level C recommendations. Avoid topical anesthetics in children or adolescents, as there is no evidence of their benefit or potential harms (Consensus recommendation).

Evidentiary Summary

There have been no studies in children or adolescents, and none of our case reports or case series included children. There are insufficient data to speculate as to whether the risk of corneal toxicity with topical anesthetics might be higher in children than in adults (*Insufficient quality of evidence*. Strong consensus: 10/10 strongly agree).

DISCUSSION

In this review of the literature, we found incomplete evidence to fully inform our chosen questions. However, it is noteworthy that in the available case reports, case series, and studies of topical anesthetics in both ED and photorefractive keratectomy settings, no patients were identified who experienced serious or permanent harm with short-term exposure to topical anesthetics. This context forms the basis for these consensus guidelines for the short-term use of topical anesthetics as administered in accordance with a strict protocol (Figure 3) and with careful patient instructions (Figure 4).^{17,18}

We wish to estimate the benefits and harms of the analgesia described, while acknowledging the limitations of the underlying literature. The best available source with a binary assessment of benefit is the randomized controlled trial from Shipman et al.¹⁴ Assuming that substantial relief is a final numerical rating scale of 2 or less, which occurred in 51/56 (91%) participants for tetracaine and 3/55 (6%) for placebo, the number needed to treat is 1.2. The best available source to approximate safety is the observational report of Waldman,¹⁷ which reported an estimated 1,524

patients with no serious or permanent adverse outcomes (0%, 95% CI 0% to 0.24%). Given no measurable harm, a number needed to treat would be infinite; thus, an accurate number cannot be calculated.

After the completion of our guidelines, but before submission for publication, a related Cochrane review was published.³⁹ Their conclusion of being “very uncertain” about safety might appear contrary to our findings; however, the discrepancy is readily explained by the differential methodology and scope of our 2 systematic reviews. The Cochrane review was exclusively limited to randomized, controlled trials—a choice aligned with their primary objective of assessing efficacy. Their abstract reports that their secondary safety conclusion was based on 5 randomized controlled trials with only 156 total topical anesthetic patients. No clinically relevant adverse events were observed; however, such a small sampling cannot be expected to reliably identify a potentially rare adverse event, thus precluding a confident assessment.

In contrast, the primary focus of our review was safety, and, accordingly, we chose a more comprehensive search strategy. We included not just the pertinent randomized controlled trials as did Cochrane, but also the multiple large observational series and many case reports—literature formats much more likely to identify uncommon adverse events. To establish the full context of topical anesthetic-related toxicity, we searched regardless of setting, treatment duration, or underlying corneal diagnosis. Our evidentiary sample included more than 3,000 topical anesthetic patients—19 times that of the Cochrane review. In addition, we studied patients both with and without toxicity. Indeed, it was this substantially larger, observational and case report body of data that permitted us to establish our key finding that, regardless of setting, no patients were identified in the published literature who experienced serious or permanent harm on exposure to topical anesthetics of 4 days or less. The Cochrane review could not similarly identify or consider this finding based on their chosen restriction to just the limited sample of randomized controlled trials. Our search strategy, in contrast, permitted us to appraise and incorporate all the available clinical evidence regarding safety for our summaries and recommendations.

A further consideration is that the Cochrane review was written solely by individuals from a single specialty, in this case ophthalmology. The *National Guideline Clearinghouse of the Agency for Healthcare Research and Quality* recommends that workgroups creating clinical guidelines “include persons from all relevant professional

groups” and should be “multidisciplinary and balanced.”³⁰ Emergency physicians—the end users for these guidelines—see and treat a high volume of unselected corneal abrasions, whereas the lesser subset of these patients ultimately seen by ophthalmologists skews toward those with more complicated conditions, with impressions regarding safety colored by such referral bias. The Cochrane review was also limited in that it did not include, as we did, an assessment of patient preferences, as is recommended by the Institute of Medicine and SIGN.^{28,29}

As with any situation of incomplete evidence, more rigorous studies with a greater cumulative sample sizes are needed. We encourage investigators to create research registries for topical anesthetic use as we describe. We recommend an update to these guidelines in 10 years unless material changes in the underlying literature occur before then.

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