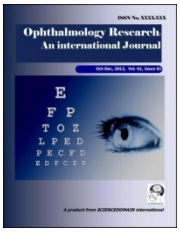

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Risk Factors for the Development of Inpatient Exposure Keratitis

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Authors' contributions

This work was carried out in collaboration between all authors. Authors BL and PA designed the study and wrote the protocol. Author BL performed data collection and analysis and wrote the manuscript. Authors TL, KF, HF and PA contributed to manuscript review and revision. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Purpose: To identify the risk factors for inpatient exposure keratitis and make possible the development of improved educational tools for providers.
Methods: Retrospective chart review of inpatient ophthalmology consults at a major New York City teaching hospital, identifying patients with exposure keratitis. Patients included were seen by the ophthalmology consult service over a 3 year period and had exposure keratitis severe enough to require active treatment.
Results: The four most common risk factors were sedation and mechanical ventilation (22/61, 36%), facial nerve palsy (10/61, 16%), nocturnal lagophthalmos (7/61,11%) and cicatricial or post-surgical lid changes (5/61,8%).Inpatient location was identifiable in 59 cases. 31% (18/59) of cases came from the physical therapy and rehabilitation floors and 24% (14/59) from the intensive care units. There were significantly more exposure keratitis cases identified during the 1st Half of the Academic Year, July through December, (45/61,74%) than the 2nd Half of the Academic year, January through June. (16/61, 26%) [*P*=0.03].
Conclusions: Sedation and mechanical ventilation, facial nerve palsy, nocturnal lagophthalmos, and cicatricial or post-surgical lid changes are the most common risk factors for inpatient exposure keratitis. Further study of the role of the primary team in preventing exposure keratitis is needed, and comprehensive efforts should be undertaken to reduce the incidence of this disease.

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Keywords: Exposure keratitis; corneal opacification; ophthalmology consult; corneal perforation.

1. INTRODUCTION

Exposure keratitis, sometimes also referred to as exposure keratopathy, is a potentially vision-threatening disease in which failure of the eyelids to fully close (lagophthalmos) allows for increased evaporation of the protective tear film from the ocular surface and subsequent dessication and breakdown of the corneal epithelium. Severe exposure keratitis may cause progressive stromal thinning, ulceration, scarring and neovascularization, and even corneal perforation [1]. Numerous conditions that may lead to exposure keratitis have been described, such as Bell's Palsy [2], cicatricial ectropion [3], chronic sedation associated with mechanical ventilation [4], and nocturnal lagophthalmos [5]. In the inpatient setting, particular attention has been focused on mechanically ventilated patients, and the propensity for infectious bacterial keratitis caused by respiratory pathogens has been well documented [6-8]. However, the incidence of exposure keratitis in hospitalized patients, and the relative contributions of the various potential risk factors to the development of exposure keratitis in the inpatient setting are less well known. The goal of this study was to review cases of exposure keratitis seen by the inpatient ophthalmology consult service at a tertiary care hospital, and identify risk factors leading to development of the condition. With improved knowledge of these risk factors, advances in prevention and detection of this sight-threatening disease may be made.

2. METHODS

We conducted a retrospective review of hospitalized patients with exposure keratitis seen by the Department of Ophthalmology at the Mount Sinai School of Medicine from 2008 through 2011. Approval for conduct of the study was obtained from the Institutional Review Board of the Medical School. Patients with exposure keratitis were identified through review of the consult records of the ophthalmology house staff consult service. All patients meeting the criteria were included from the beginning of October 2008 until the end of September 2011, at which point the data collection phase of the study terminated. Exposure was defined as failure to keep the eyelids adequately apposed, resulting in increased tear film evaporation and corneal epithelial abnormalities. Inclusion criteria were exposure with resultant keratitis severe enough to require treatment with lubrication, antibiotics, occlusive dressing, moisture chamber goggles, and/or tarsorrhaphy. Exclusion criteria were: acute post-operative corneal abrasion, dry eye syndrome without mention of exposure, and patients with exposure without keratitis. Patients seen in the emergency department or the outpatient setting were also excluded.

2.1 Data Collection, Variables of Interest and Statistical Analysis

Patients with exposure keratitis were identified through review of ophthalmology consult service notes, and the following data concerning the patients were collected. Patient age and gender, duration (in days) of hospitalization at the time the consult was initiated, patient race and ethnicity, inpatient location of the consult (categorized as intensive care unit, physical therapy and rehabilitation floor, post-intensive care "step down" unit, or general medical and surgical floor), and the academic quarter of the consult (First Quarter-July to September, Second Quarter - October to December, Third Quarter-January to March, Fourth Quarter-April to June).Information on academic quarter was collected in order to explore for changes in the incidence of exposure keratitis as the experience level of house staff increased

throughout the academic year. The total number of ophthalmology consults placed for any reason by inpatient physicians was also recorded, in order to identify any trends in the overall utilization of ophthalmology services. In addition, the following information concerning the keratitis was collected: Unilateral or bilateral disease, presence of a secondary bacterial or fungal keratitis, results of corneal microbial culture if performed, and the underlying etiology or etiologies of exposure (sedation and mechanical ventilation, cranial nerve seven palsy, altered mental status without intubation or sedation, simple nocturnal lagophthalmos in the absence of other eyelid or neurologic pathology, neuromuscular conditions such as Guillan-Barre Syndrome or myasthenia gravis, post-surgical eyelid changes or cicatricial ectropion of the eyelids, and proptosis caused by thyroid eye disease or other conditions). Statistical analysis of the data was performed using Microsoft Office Excel (Microsoft Corporation, Redmond Washington).Two tailed T-tests were run with a p-value of <0.05 as the threshold for statistical significance.

3. RESULTS

3.1 Characteristics of the Patient Population

Baseline characteristics of the study population are outlined in Table 1. 61 inpatients with exposure keratitis were identified. The average age was 61 (Standard Deviation+/-14.6), with an average length of stay of 15 days (Standard Deviation+/-15.7) and a median length of stay of 11 days (Interquartile Range 3-22) prior to the consult. 57% (35/61) of the patients were male. 30 out of 61, or 49%, of patients had bilateral disease. Information on race and ethnicity was available in 40 out of 61 consult notes reviewed. 55% (22/40) of patients were Caucasian, 27.5% (11/40) were Hispanic, 10% (4/40) Asian, and 7.5% (3/40) percent were African American. Table 2 outlines results of positive corneal cultures sent for patients with exposure-related corneal ulcers. There were 6 positive corneal cultures, 3 of which were for pseudomonal species, 2 for coagulase-negative staphylococcal species, and 1 for Yeast (*Candida albicans*).

Table 1. Baseline characteristics of the inpatient exposure keratitis population

Patient characterisics	Result
Total Patients (n)	61
Mean Age (yrs+/-SD*)	61 (+/-14.6)
Median Age (yrs & IQR†)	64 (52.8-71)
Mean Duration of Admission at time of consult (days+/-SD*)	15 (+/-15.7)
Median Duration of Admission at time of consult (days & IQR†)	11 (3-22)
Patients with bilateral disease (%)	49
Male (%)	57
Caucasian (%)	55
Hispanic (%)	27.5
Asian (%)	10
African American (%)	7.5

** Standard deviation. † Interquartile range*

3.2 Identification of Risk Factors

Risk factors identified for exposure keratitis are shown in Fig. 1. The three most common risk factors were sedation and mechanical ventilation (22/61,36%), facial nerve palsy (10/61,

16%), and nocturnal lagophthalmos (7/61,11%). Cicatricial or post surgical lid changes (5/61,8%), neuromuscular conditions such as Guillan-Barre or myasthenia gravis (4/61, 7%), altered mental status (4/61,7%), and proptosis and/or thyroid eye disease (3/61, 5%) were also identified. The etiology of the remaining cases was either not readily identifiable from the consult note or did not fall clearly into one of the above categories (6/61, 10%). Inpatient location was identifiable in 59 cases and is outlined in Fig. 2. 31% (18/59) of cases came from the physical therapy and rehabilitation floors and 24% (14/59) from the intensive care units. 40% (24/59) of cases came from the general medical or surgical wards, and 5% (3/59) from step down units.

Table 2. Results of cultures for corneal ulcers

Culture results	n
Culture-Negative Ulcer	3
Pseudomonas species	3
Coagulase-negative staph species	2
Candida albicans	1

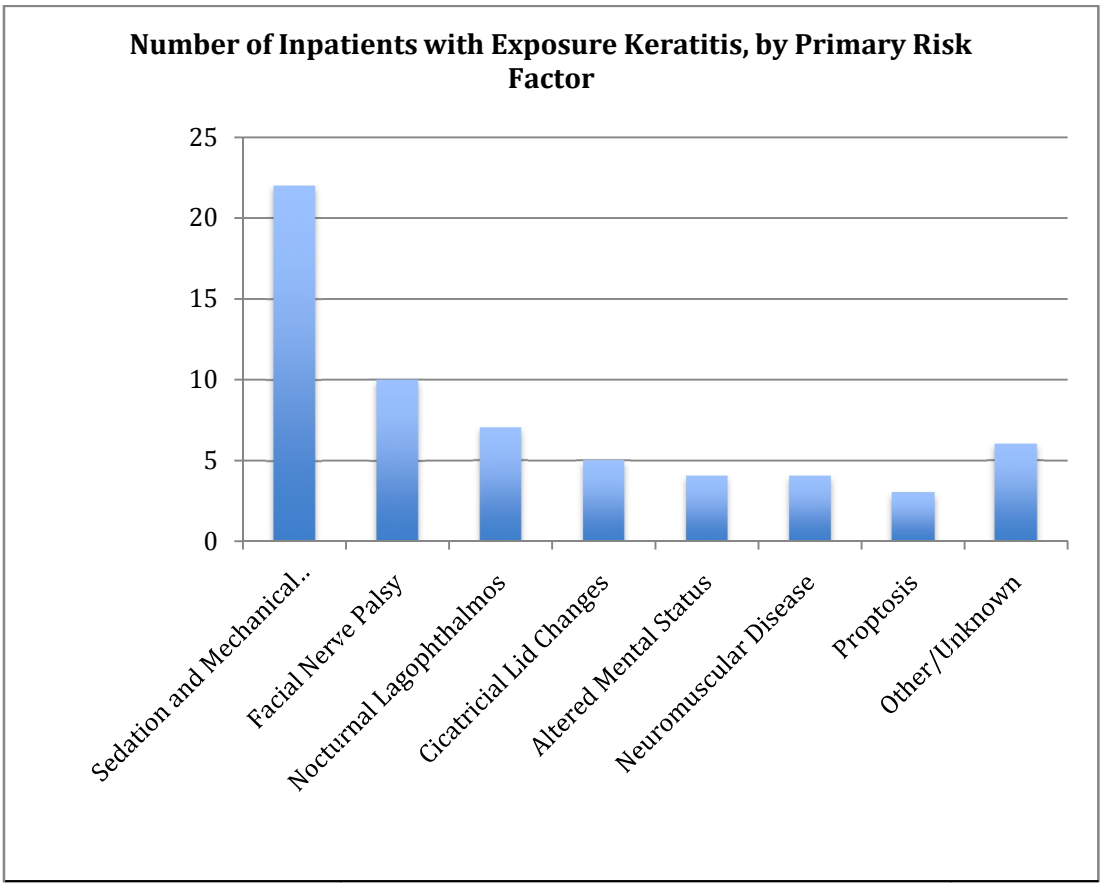

Fig. 1. Number of inpatients with exposure keratitis, by primary risk factor

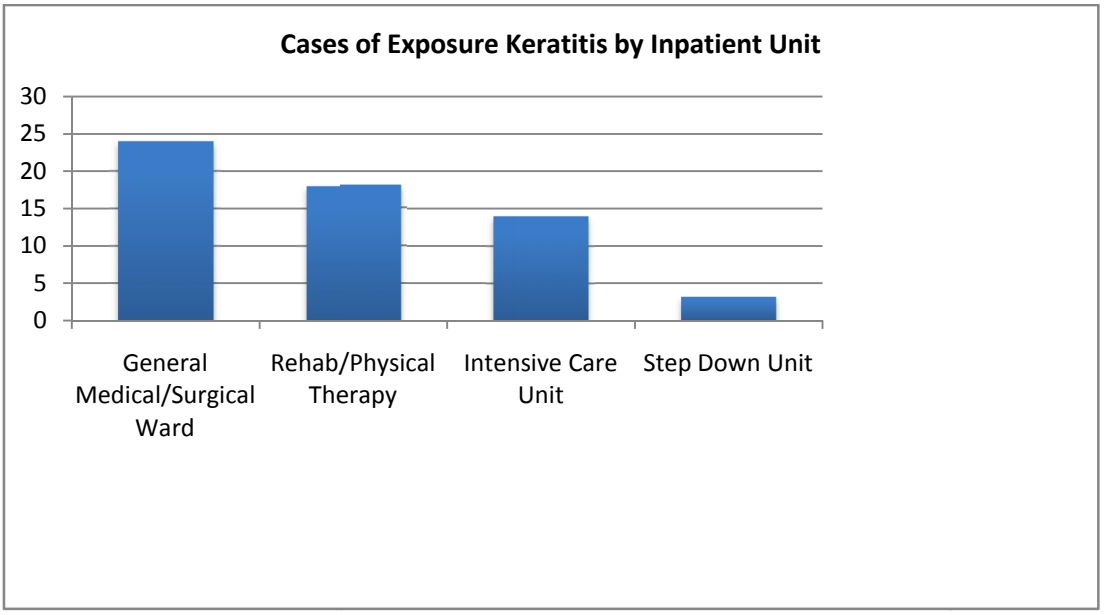

Fig. 2. Cases of exposure keratitis by inpatient unit

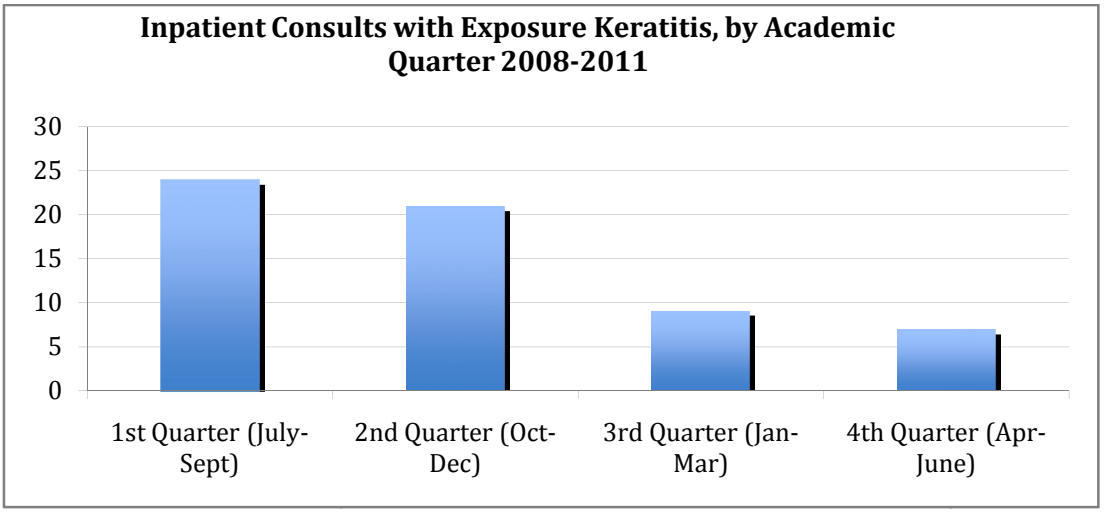

Fig. 3. Inpatient consults with exposure keratitis, by academic quarter, 2008-2011

An analysis of the academic quarter in which the exposure keratitis cases were seen was performed and is shown in Fig. 3 Over the 3 year period, 39% (24/61) of cases developed during the 1st Quarter of the Academic calendar (July to September), 36% (21/61) during Q2 (October to December), 15% (9/61) during Q3 (January to March), and 11% (7/61) during Q4 (April to June). There were significantly more exposure keratitis cases identified during the 1st Half of the Academic Year, July through December, (45/61, 74%) than the 2nd Half of the Academic year, January through June (16/61, 26%) [*P*=0.03]. Over the 3 year period, there was no statistically significant difference in the total number of inpatient consults placed in the 1st half of the Academic Year versus the 2nd Half. There were 722 consults

placed during the 1st half, and 674 placed during the 2nd half of the Academic Calendar [*P*=0.35].

4. DISCUSSION

Similar to decubitus ulcers, exposure keratitis is an avoidable complication of both critical and chronic illness that has not been uncommon in the inpatient setting. Serious sequelae such as central corneal opacification and perforation have a devastating impact on vision and quality of life, and add significantly to the cost of hospitalization. Our study adds to the body of literature that demonstrates intensive care patients are at high risk for exposure keratitis. Examinations by ophthalmologists making weekly rounds in the ICU setting have found an incidence of keratitis as high as 42-50% [9,10]. We also found a high incidence of exposure keratitis among the chronically ill patients typically under care of the rehabilitation and physical therapy units. Since these units typically receive patients who have been transferred from acute-care floors, our study design does not allow us to definitively conclude how many of these cases developed while on the rehabilitation units themselves. However, our findings do highlight the need for practitioners on these units to maintain a high level of awareness for patients developing signs of exposure. The median length of stay was 11 days at the time of the consult identifying exposure keratitis, highlighting the fact that once corneal exposure develops, keratitis may ensue relatively rapidly.

While the overall number of inpatient consults remained relatively constant throughout the course of the academic year, the number of consults in which exposure keratitis was identified was significantly less in the second half of the academic year. This may mean that as new staff physicians developed more familiarity with the management of corneal exposure, they were more likely to start prophylactic treatment, eventually reducing the incidence of exposure keratitis. However, as with any retrospective review, caution is warranted when interpreting our data. We were able to identify all patients with exposure keratitis seen by the ophthalmology consult service during the period of interest, so there was no selection bias. However, we cannot exclude the influence of any referral bias. Given the study design, it is possible that as the academic year progressed, staff physicians became more comfortable recognizing and managing exposure keratitis, and were therefore less likely to feel a consult was warranted in these instances. However, if that is the case, then the increased level of comfort in dealing with exposure keratitis was not accompanied by a decrease in ophthalmology consults in general, as there was no significant decline in total consults throughout the year. Further study of this topic may identify if increased education and awareness of corneal exposure amongst staff physicians can reduce the incidence of keratitis.

Having better identified key risk factors for inpatient keratitis, a targeted educational program for inpatient healthcare providers caring for high-risk patients can be developed. This would incorporate a comprehensive review of known risk factors and a protocol for treatment strategies to prevent and treat keratitis. Treatment options would include lubricating drops, lubricating ointment, moisture chamber goggles, occlusive dressings, and other options for severe or progressive cases [9,11,12]. To our knowledge, no randomized control trial (RCT) comparing the efficacy of all commonly employed strategies has been completed, however one RCT comparing lubricating drops to polyethylene film found the film to be more effective than drops [11], and another RCT found no significant difference between polyethylene wrap and lubricating ointment [12]. A meta-analysis of three RCTs with 294 patients total found moisture chamber/occlusion to be superior to lubrication, however the studies analyzed utilized several different strategies for lubrication and creation of the moisture chamber [13].

5. CONCLUSION

In conclusion, exposure keratitis is a potentially vision-threatening condition that is not uncommon among inpatients. Mechanical ventilation with sedation, facial nerve palsy, nocturnal lagophthalmos, and cicatricial ectropion were the four most common underlying risk factors, and patients in intensive care and chronic-care settings were at risk. Further study of the role of the primary team in preventing exposure keratitis is needed, and comprehensive efforts should be undertaken to reduce the incidence of this disease.

CONSENT

The Institutional Review Board of the Icahn School of Medicine at Mount Sinai approved the research protocol including approval of waiver of consent.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Grey F, Carley F, Biswas S, Tromans C. Scleral contact lens management of bilateral exposure and neurotrophic keratopathy. Cont Lens Anterior Eye. 2012;35(6):288-91.
2. Rahman I, Sadiq SA. Ophthalmic management of facial nerve palsy: a review. Surv Ophthalmol. 2007;52(2):121-44.
3. Astori IP, Muller MJ, Pegg SP. Cicatricial, postburn ectropion and exposure keratitis. Burns. 1998;24(1):64-7.
4. Hernandez E, Mannis M. Superficial Keratopathy in Intensive Care Unit patients. Am J Ophthalmol. 1997;124:212–6.
5. Katz J, Kaufman HE. Corneal exposure during sleep (Nocturnal lagophthalmos). Arch Ophthalmol. 1977;95(3):449-53.
6. Hutton WL, Sexton RR. Atypical pseudomonas corneal ulcers in semicomatose patients. Am J Ophthalmol. 1972;73:37–9.
7. Ommeslag D, Colardyn F, De Laey JJ. Eye infections caused by respiratory pathogens in mechanically ventilated patients. Crit Care Med. 1987;15:80–1.
8. Parkin B, Turner A, Moore E, Cook S. Bacterial keratitis in the critically ill. Br J Ophthalmol. 1997;81(12):1060-3.
9. Ezra DG, Lewis G, Healy M, Coombes A. Preventing exposure keratopathy in the critically ill: A prospective study comparing eye care regimes. Br J Ophthalmol. 2005;89(8):1068-9.
10. Mercieca F, Suresh P, Morton A, et al. Ocular surface disease in intensive care unit patients Eye. 1999;13:231–6.
11. Cortese D, Capp L, McKinley S. Moisture chamber versus lubrication for the prevention of corneal epithelial breakdown. Am J Crit Care. 1995;4:425–8.

12. Koroloff N, Boots R, Lipman J, et al. A randomised controlled study of the efficacy of hypromellose and Lacri-Lube combination versus polyethylene/Cling wrap to prevent corneal epithelial breakdown in the semiconscious intensive care patient. Intensive Care Med. 2004;30:1122–6.
13. Rosenberg JB, Eisen LA. Eye care in the intensive care unit: Narrative review and meta-analysis. Crit Care Med. 2008;36(12):3151-5.

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