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## Neglected ocular surface care in critical care medicine: An observational study

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## ABSTRACT

**Aim:** To study the prevalence of lagophthalmos and its related complications among the unconscious patients admitted in the intensive care units (ICU)/wards of a tertiary care centre.

**Methods:** Cross-sectional observational study.

**Results:** A total of 87 unconscious patients were included. 44 were children and 43 were adults. The overall median age of patients was 16 years (range: 9 days- 85 years). 53/87 (60.91%) showed signs of lagophthalmos, among which 56.60% (30/53) were children and 43.40% (23/53) were adults. There was no significant difference in the exposure patterns between children and adults ( $p = 0.25$ ). Exposure related manifestations (conjunctival/corneal) were found in 49/87 patients (56.32%). The most common conjunctival manifestation was chemosis, occurring in 28/53 patients (52.83%). Corneal exposure was seen in 31/53 patients (58.49%), of which fragile epithelium was the commonest finding (32.08%). Only 17/31 (54.83%) cornea exposed eyes were taped, of which 15 were sub-optimal. 6 patients were unnecessarily taped. Signs of infection were noted in 8/53 eyes (15.09%).

**Conclusion:** Optimal eye care in unconscious patients can avert the development of exposure-related complications and subsequent ocular morbidity. Adoption and implementation of systematic protocols can help improve the standard of care.

## 1. Introduction

The eyes are a window to the body system. The exceptional ability of the eyes to directly display its vasculature helps in diagnosis of various systemic angiopathies such as diabetes, hypertension, vasculitis, etc. Also, the optic nerve being a direct continuation of the central nervous system, guides in prompt diagnosis of dangerous disorders like raised intracranial tension and demyelinating diseases. Collagen vascular disorders and systemic infections also have significant ocular manifestations that can hint a timely diagnosis. Monitoring of pupillary size and reactions is an invincible study tool for all intensivists. While these diagnostic opportunities are being utilized to the fullest, the return reward of care to the eyes have not been reciprocal. The ocular apparatus is more often looked at as a diagnostic aid.

Ocular surface disorders (OSD) have been observed in nearly 60% of critically ill patients [1]. The unconscious patients are at high risk for

OSD, and their manifestations are preventable. Though the neglected ocular surface care in the critical care setting is a known problem, it is frequently under-appreciated, especially in the developing countries where the doctor-to-patient ratio and nurse-to-patient ratio is sub-optimal. Also, data on exposure keratopathy in the paediatric setting is limited at present [2,3]. Therefore, this study was undertaken to assess the differential patterns of ocular surface exposure & related complications in the paediatric and adult intensive care setting of a tertiary care hospital.

## 2. Methods

This was a cross-sectional observational study assessing the ocular surface health of unconscious patients who were admitted in the adult and paediatric wards/intensive care units (ICU) of a tertiary care centre. A written informed consent was obtained from the guardian of

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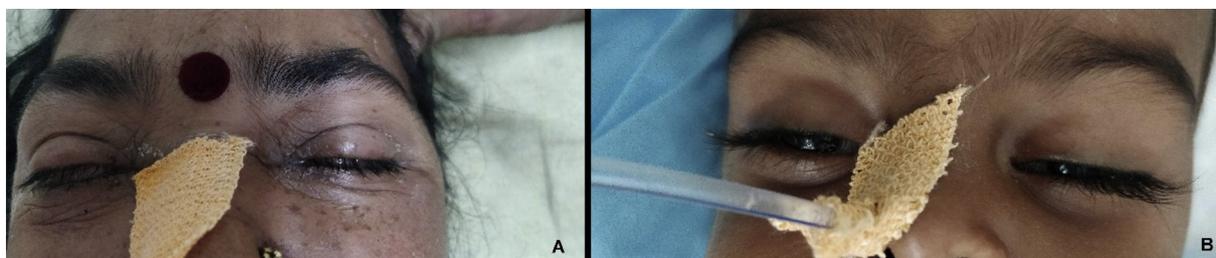
E-mail address: [sharathy2012@gmail.com](mailto:sharathy2012@gmail.com) (H. Selvan).

<sup>1</sup> The manuscript has been read and approved by all the authors. The requirements for authorship have been met by each of them, and all the authors believe that this manuscript represents their honest work. This work has not been published elsewhere. It was presented as a free paper in the Delhi Ophthalmological Society conference, 2019, India.

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**Fig. 1.** Showing A. grade-1 exposure (only conjunctiva visible) B. grade-2 exposure (any amount of cornea visible).

**Table 1**

The distribution of the various exposure-related conjunctival and corneal manifestations.

Conjunctival		
s.no	manifestations	n (%)
1	Normal	4 (7.55%)
2	Dry	13 (24.53%)
3	Chemosis	28 (52.83%)
4	congestion	8 (15.09%)
	<b>Total</b>	<b>53 (100%)</b>
Corneal		
s. no	Manifestations	n (%)
1	Not exposed	22 (41.51%)
2	Exposed but normal	5 (9.43%)
3	Fragile epithelium	17 (32.08%)
4	White lesion (infiltrate/opacity)	9 (16.98%)
	<b>Total</b>	<b>53 (100%)</b>

each patient. The study adhered to the tenets of declaration of Helsinki.

When an ophthalmic consultation for expert opinion was received, the examining ophthalmologist (one of two observers), in addition to those patients for whom opinion was sought, also screened the nearby unconscious patients. Both paediatric and adult patients were included. All patients were unconscious, and some were under ventilatory support. Records of those under assisted breathing showed that they had received sedatives and muscle relaxants dosed as per their body weight.

All eyes were assessed for lagophthalmos, and were graded as complete lid closure (grade 0), incomplete lid closure with visible conjunctiva (grade-1) (Fig. 1A) and incomplete lid closure with visible cornea (grade-2) (Fig. 1B) [4].

In the presence of exposure, on bed-side torch light examination, it was noted if the conjunctiva was normal, or was dry, had chemosis, and congestion. For cornea, it was noted if cornea was normal, or had exposure keratopathy in the form of dull reflex suggestive of fragile epithelium/ epithelial defect, or a white lesion in the inferior cornea which could be infiltrates/opacity. In the presence of associated redness, mucopurulent discharge, sticky lids and matting of lashes, ocular surface infection was suspected clinically.

When any amount of exposure was present, the management undertaken was reviewed. If found sub-optimal, appropriate changes were advised and the attending staff were educated about the fallacies, in accordance to the Intensive Care Society-The Royal College of Ophthalmologists guidelines [4]. If management had not been started, the ophthalmologist advised treatment accordingly.

All patients except two showed a bilaterally symmetric picture, and hence one eye per patient was included for the analysis. Statistical analysis was done using Stata 12.0 software. Categorical values were summarised as frequency (%) and quantitative values were summarized as mean  $\pm$  standard deviation, or median (range) if non-normally distributed. The qualitative variables were compared using Chi-square/ Fisher's exact test. A p-value of  $< 0.05$  was considered statistically

significant.

### 3. Results

A total of 87 unconscious patients were included. Both eyes of all 87 patients were observed, and all were found to be symmetrical except for two, who showed asymmetric uniocular exposure keratopathy. One of them had undergone ipsilateral craniotomy while the other had ipsilateral facial nerve palsy. 44 were children and 43 were adults. The overall median age of patients was 16 years (range: 9 days- 85 years), with median age of children being 3.5 years (range: 9 days-16 years) and median age of adults being 34 years (range: 18–85 years). 52/87 patients showed signs of active exposure and one patient showed sign of previous exposure (dense white lesion in lower 1/3rd cornea, but currently no lagophthalmos), thereby computing a total of 53/87 (60.91%) exposure overall. Of them, 56.60% (30/53) were children and 43.40% (23/53) were adults. There was no significant difference in the exposure patterns between children and adults ( $p = 0.25$ ).

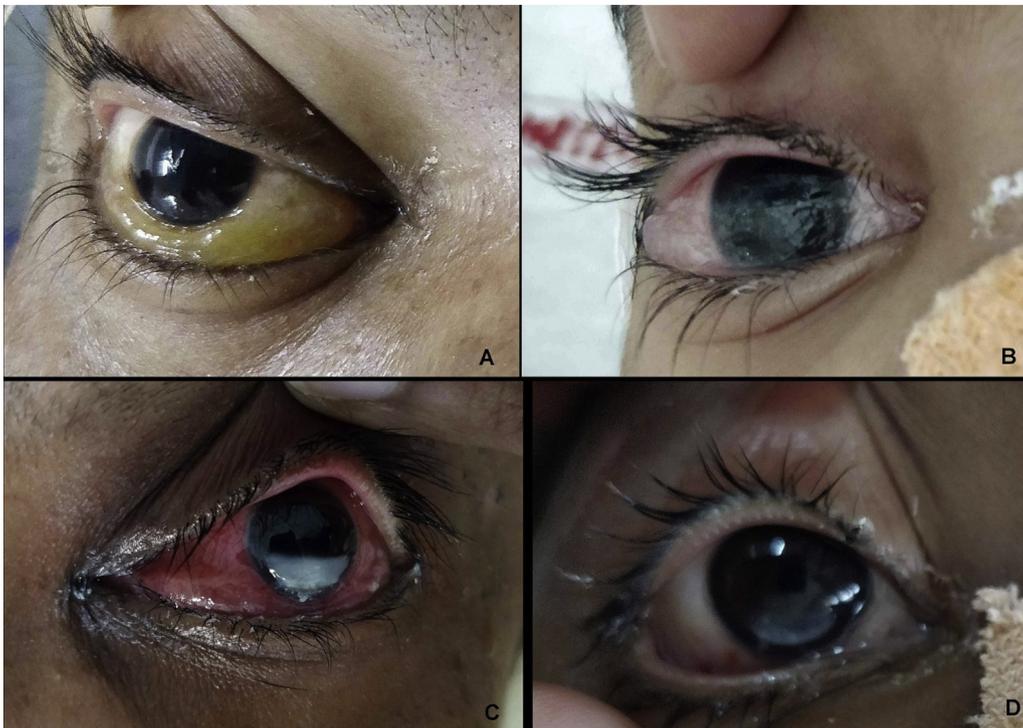
Exposure related manifestations (conjunctival/corneal) were found in 49/87 patients, accounting to 56.32%. The distribution of the various exposure-related conjunctival and corneal manifestations have been summarised in Table 1.

The most common conjunctival manifestation was chemosis (52.83%) (Fig. 2A). Thirty-one patients showed grade-2 (corneal) exposure (58.49%), of which fragile epithelium was the commonest finding (Fig. 2B), followed by white lesion (Fig. 2C). Clinical signs of infection were noted in 8/53 eyes overall (15.09%) (Fig. 2D). Four of these eight infected eyes had remained patched.

Of the overall 87 patients, expert ophthalmic opinion was sought for 41 patients (47.13%), and rest 46 (52.87%) were opportunistically screened. Of the 41 consultations received, 18 (43.90%) were for exposure related complaints. While 26 patients were found to have some form of corneal insult, consultation regarding it was sought only for 9 (34.61%). Among the remaining 17 patients, opinion regarding some other finding was sought for 10, while for 7 others, it was not sought at all.

Of 8 patients who showed signs of infection, only 4 were identified by the bed-in-charge resident and ophthalmologist opinion sought. Of the rest 4, two were picked up on opportunistic screening and for the other two, consultation regarding a different diagnostic clue was sought, not realizing/ ignoring the presence of ocular surface infection.

There were 31 cases of active corneal exposure, however, only 17 of these patients' eyes were taped (54.83%); the rest 45.16% remained untaped. Ironically, even among the 17 patients, 15 were sub-optimally taped (88.23%) (Fig. 3). On the other hand, a total of 25 patients were taped, among which 6 tapings were unnecessary, having no signs of corneal exposure. All these 6 precautiously taped eyes were of children, one child aged 2 months, rest were all over 2 years. Of the overall 25 taped eyes, only 4 were optimally done (all four were adult patients). Two eyes which were properly taped and opinions weren't sought for, were left undisturbed.



**Fig. 2.** A. chemosis B. chemosis with fragile corneal epithelium (dull reflex) C. congestion and corneal white lesion (likely infiltrate) D. signs of infection (boggy conjunctiva, mucopurulent discharge and matting of lashes). The patient also shows an inferior white corneal lesion.

#### 4. Discussion

Under the critical care system, most of the physicians' efforts are focussed towards life-saving interventions, as a result of which, other body tissues receive low priority. Ocular surface health is pivotal, especially in the critical care scenario, where voluntary blinking and tear film dynamics are grossly altered. In addition, the use of sedatives and muscle relaxants worsen the situation by inhibiting active contraction of orbicularis oculi. Also, the critically ill patients are prone for fluid imbalance and increased vascular permeability that increases the tendency for conjunctival chemosis and lagophthalmos [5]. When positive pressure ventilation is given, it may also add on to the chemosis by resisting venous return from the eye. Other contributory factors such as high flow oxygen through face masks and nebulizers enhance surface

vaporisation, and repeated tracheal suctioning (especially when done from head end) leads to aerolization and direct inoculation of pathogens onto the ocular surface [5]. These, along with the inability of the patient to express his/her ocular discomfort, makes it all the more the reason for the treating physician and the attending nurse to understand their responsibility and provide meticulous care for this vulnerable organ. In fact, it has been suggested that ocular prophylaxis for exposure keratopathy should be instituted in the same manner as it is done for deep vein thrombosis in ICU patients [6].

This study showed a prevalence of 61% lagophthalmos and 56% lagophthalmos related manifestations, of which 30% were exposure keratopathy and 9% showed clinical signs of infection. These are close to the previously reported numbers [1,7], however, these percentages are huge, and require active intervention to curtail them. Saritas et al



**Fig. 3.** Pairs of images showing improper methods of eye taping and resulting manifestations. A&B: Case-1. (A) shows inadequately closed eyes with vertical taping which on opening (B) show exposure keratopathy. C&D: Case-2. (C) shows a dry gauze applied over the eyes, which on opening (D) revealed grade-2 exposure with lashes abrading the cornea. Both the children's eyes were not entirely closed before taping.

studied 40 ICU patients and showed 56% to manifest hyperemia, 36% muco-purulent discharge and 15% corneal staining [1]. A meta-analysis showed that 20–42% of ICU patients developed exposure keratopathy [5]. Being a preventable cause, this problem requires wider realization among the intensivists. The present practice patterns need more refinement. Despite the well-known guidelines given by the Intensive Care Society and The Royal College of Ophthalmologists [4], it was noted that there was no uniformity and standardization in the practice patterns followed. The importance of these protocols is underappreciated.

A simple test of flashing a pen torch and observing the reflection of light from the cornea can help pick up early signs of exposure keratopathy. A more simple understanding of this scenario could be, ‘no dull reflex = no problem!’. In fact, torch light examination for pupillary reflexes is periodically carried out in every ICU, however, the overlying ocular surface is frequently overlooked. Presence of redness associated with copious discharge, stickiness of lids and matting of eyelashes may suggest associated infection.

An 8 hourly assessment of the ocular surface can massively reduce OSD [8,9]. With dissemination and execution of simplified, standardized algorithms, exposure related keratopathy and infections can be significantly curtailed, improving the standard of care of ICUs [10,11]. This could prevent permanent corneal scarring and low vision that may compromise the quality of rest of the patient’s life after survival. Other uncommon ocular conditions that an intensivist should be aware of include herpetic keratitis and endophthalmitis, however, these are relatively rare, and none were encountered during this study.

This study showed that children manifested marginally higher exposure-related manifestations as compared to that of the adults. This may be due to the use of warmers and higher temperature settings used in the paediatric ICUs and ward. Therefore, the need for parallel augmented ocular care in paediatric setting should be stressed upon. Moreover, though many eyes were taped, they were inadequate to serve the purpose (Fig. 4). Hartford et al on the contrary showed lesser prevalence of exposure keratopathy in paediatric ICUs as compared to medical and neurological ICU [2].

For grade-2 exposure, lubrication and closure of eyes, ensuring that all lashes face out, should be ensured before horizontal taping [10]. The

**Table 2**

Do’s and don’ts for prevention of exposure keratopathy and related manifestations [4,8,12].

**Do’s:**

- Grade 0 (closed lids): No treatment
- Grade 1 (conjunctival exposure): 4-hly ointment lubrication
- Grade 2 (corneal exposure): Ointment lubrication + lid taping
  - A. Clean lids off the previous dried ointment
  - B. Check for corneal clarity and red eye
  - C. Pull lower eyelid to form a pouch and instil lubricating ointment directly into the lower fornix
  - D. Manually close the upper lid to oppose the lower lid with direction of lashes facing out
  - E. Apply micropore horizontally across the lids to seal them (transparent tape preferable)
  - F. Seek ophthalmologist opinion in case of doubt/red eye/sticky eye /loss of corneal clarity

**Don’ts:**

- A. Unnecessary taping
- B. Taping in suspicion of infection
- C. Avoid gauzes (can predispose to corneal abrasions)
- D. Head end suctioning
- E. Touching of ointment applicator nozzle
- F. Hand application of ointment
- G. Normal saline irrigation of eyes (increases rates of OSD and cross-infection)



Fig. 5. Demonstrating horizontal taping of lids after ensuring complete closure and lashes facing out.

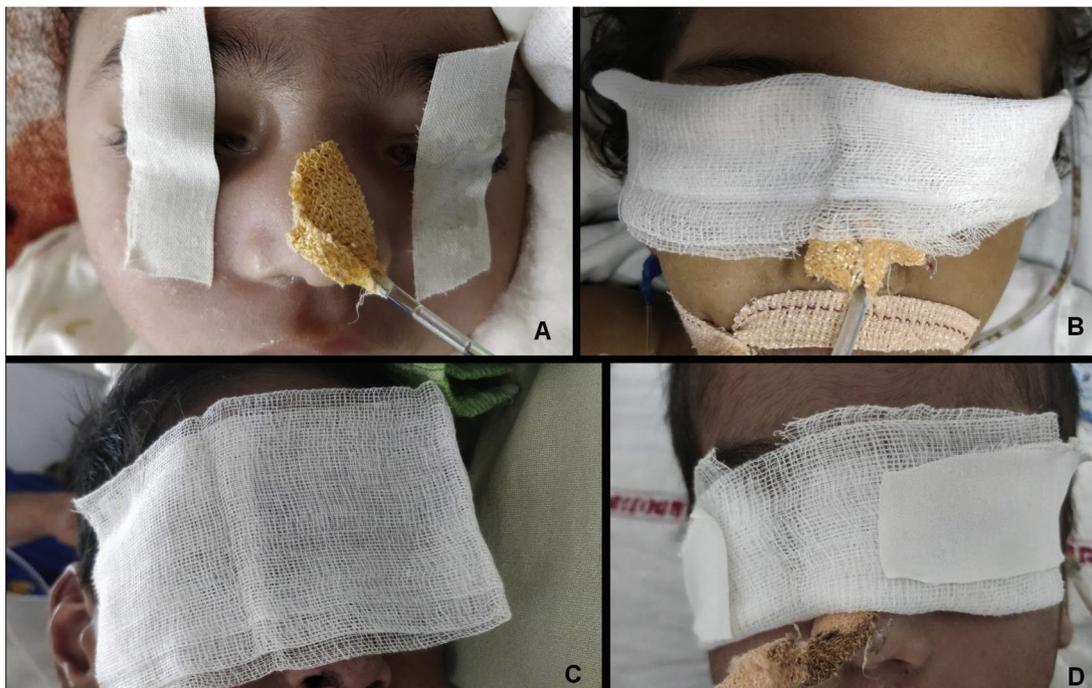


Fig. 4. Improper methods of taping. A. vertical taping. B, C, D. show dry gauze placed over eye.

steps for right method of taping have been elaborated in Table 2 and demonstrated in Fig. 5.

Of note is that an infected eye or that with copious secretions should not be covered [8]. Also, eyes with grade-1 exposure do not require taping, a regimen of 4-hly lubricating ointment is adequate. Unnecessary taping can be distressing to the relatives and lead to untoward skin irritation when repeatedly removed [4]. Therefore, it should only be undertaken when necessary, where benefits clearly outweigh the risks. In cases of ocular surface infection, chloramphenicol ointment is advisable.

Literature shows that 'closed-chamber' measures like moisture chambers, polyethylene covers and swimming goggles, are known to be superior to the traditional 'open-chamber' lubricating methods [5,8,13]. Nevertheless, they may not be universally available, and hence, a ratified adoption of the open-chamber methods may be a simple solution in this scenario. Also, other causes for OSD such as Stevens Johnson's syndrome, pemphigus, pemphigoid, Sjogren's syndrome, etc.. should be kept in mind while assessing ocular surface dryness and treated accordingly.

This study was mainly devised to ascertain the percentage of exposure and exposure-related complications among the unconscious patients admitted in the ICU/wards. However, in due course, it was realized that the existing eye care practices were not optimal. Therefore, this study intends to make aware the treating doctor and nurses that a simple torch light examination may suffice to clinically pick up the ocular danger signs and seek expert ophthalmic opinion when needed. The limitations include that a bed-side fluorescein staining and cobalt blue light examination to identify epithelial defects, and microbiological confirmation of clinically suspected infections could not be done. Therefore, strict classification into corneal infiltrates, epithelial defects and non-infective corneal opacity was not possible. Also, categorisation into ICU and ward patients could have yielded differential results. But on a qualitative note, it was eminent that the ophthalmic care provided in the ICU was better than in the wards, probably because of the presence of trained staff and individualized care delivered in the former. Also, the practices in paediatric setting required more refinement. Guidelines and oral instructions may alone not be adequate for practical purposes, and hence, short training sessions should be held periodically for every set of new staff. A study on the change in practice patterns after such training sessions will unravel the bygone benefits. Posters and consolidates of the standard protocol may be stuck in the wards and ICU for an easier reach. Better awareness and understanding of the issue may increase their compliance and eliminate the resistance to put the much needed measures into action.

In conclusion, optimal eye care in unconscious patients can avert development of exposure-related complications and subsequent ocular morbidity. Adoption of standardized protocols would be the key to inculcate such a change. As known, prevention is always better than cure.

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#### Declaration of Competing Interest

None declared for all authors.

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