

Bedside Assessment of Ophthalmic Manifestations in Neurocritical Care: A Study in Tertiary Care Hospital**Maheshkumar Rajpura**

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Received: 25-07-2024 / Revised: 23-08-2024 / Accepted: 26-09-2024

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Conflict of interest: Nil

Abstract:

Background: This study aimed to investigate the incidence of Ocular Surface Disorders (OSDs)—including Dry Eye Disease, Chemosis, and Exposure Keratitis—among patients admitted to the Neurocritical Care Unit (NCC). The research also sought to assess the correlation between these disorders, the length of hospitalization in the NCC, and the Glasgow Coma Score (GCS). The heightened risk of developing OSDs in the NCC environment, particularly among patients with pre-existing neurological impairments, can lead to serious complications such as dry eye disease, chemosis, corneal abrasions, and infectious keratitis. These conditions can ultimately result in corneal opacities and perforations, significantly impacting visual acuity and overall quality of life.

Methods: This observational cross-sectional study was conducted from February to May 2022, examining the ocular health of all patients admitted to the NCC unit. The study assessed the presence of conjunctivitis, chemosis, keratitis, and dry eyes in relation to various factors, including: Duration of stay in the NCC, Glasgow Coma Score (GCS), Lagophthalmos (inability to close the eyelids fully), Adherence to prescribed eye care protocols in the NCC, Use of mechanical ventilation. A total of 100 subjects participated over the four-month period, with a mean age of 51.92 ± 18.73 years (age range: 17 to 89 years), including 70% males and 30% females (gender ratio of 2.33).

Results: The study findings revealed the following incidences of ocular conditions: Conjunctival Hyperemia: 26 eyes (13%) Chemosis: 23 eyes (11.5%) Severe Dry Eye Disease: 41 eyes (20.5%) Statistically significant associations were observed between: GCS (p-value <0.001), Keratitis (p-value 0.0035), Dry Eyes (Chi-Square Test notably, the incidence of dry eyes was significantly higher among patients with a prolonged stay of ≥ 10 days (p-value 0.003).

Conclusions: The study highlights the necessity for meticulous eye care and structured protocols in Neurocritical Care Units to mitigate the risk of long-term ocular complications, such as exposure keratitis. Given the increased susceptibility of NCC patients to these conditions, proactive measures are essential to ensure optimal ocular health and prevent serious visual impairments. Implementing standardized eye care practices can help enhance patient outcomes and preserve quality of life in this vulnerable population.

Keywords: Dry eyes, keratitis, lagophthalmos, neurocritical care, Glasgow Coma Scale, ocular surface disorder.

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Introduction

In the medical community, there is a strong belief that the eyes can reveal a wealth of information about a patient's overall health and underlying ailments. However, ophthalmologic examinations are frequently overlooked in critical care settings.[1] This oversight can hinder the timely diagnosis and management of various conditions. Scholars in the field of neuro-ophthalmology have emphasized the importance of recognizing specific ocular signs as a means to facilitate rapid decision-making regarding critical diagnoses. Eye examinations can provide valuable insights into neurological function and systemic health, allowing clinicians to identify potential complications early and initiate appropriate

interventions. Integrating thorough ocular assessments into routine critical care protocols can significantly enhance patient management, improving outcomes by addressing ocular health alongside other medical concerns.[2] By prioritizing ophthalmologic evaluations, healthcare professionals can ensure that patients receive comprehensive care that acknowledges the interconnectedness of visual health and overall well-being. Research has consistently shown that patients in intensive care units (ICUs) face an increased risk of developing ocular conditions such as dry eye disease, chemosis, conjunctivitis, and keratitis.[3] These issues often arise due to compromised ocular defense mechanisms,

including inadequate eyelid closure, diminished tear production, and heightened susceptibility to pathogenic microorganisms. In the high-pressure environment of the ICU, the primary focus of the medical staff is typically on life-threatening conditions, which can lead to the neglect of meticulous eye care. Important interventions, such as the regular application of lubricating eye drops and ointments, as well as timely ophthalmic consultations for suspected infections (e.g., those presenting with clinically evident mucopurulent discharge), may be overlooked.[4] This lack of attention to ocular health can result in the missed diagnosis of serious ocular pathologies. Such neglect can lead to significant complications, including keratitis, which may progress to corneal opacities and even perforation.[5] These outcomes can severely impair visual acuity and compromise the overall quality of life for patients. To prevent these serious complications, it is crucial to integrate structured eye care protocols within ICU practices. This includes routine assessments of ocular health, appropriate use of lubricants, and prompt referral to ophthalmology when necessary. By prioritizing eye care in the ICU, healthcare providers can help mitigate the risk of long-term ocular complications and enhance patient outcomes.[6]

Previous research has primarily concentrated on the incidence of ocular surface disorders (OSDs) within the ICU, often focusing on critically ill patients receiving neuromuscular blockade. However, our study aims to fill a gap by specifically assessing the manifestations of ocular disorders and the eye care provided to patients in the Neurocritical Care Unit (NCC) [7]. Patients in the NCC represent a unique population, as they frequently present with a wide spectrum of diseases, including vascular pathologies, trauma, and infections. This demographic is particularly relevant for our study because they tend to exhibit a higher incidence of lagophthalmos (inability to fully close the eyelids) and often experience prolonged hospital stays. These factors contribute to an increased risk of developing conditions such as dry eye disease, chemosis, and exposure keratitis, particularly in the context of potentially neglected eye care. By focusing on the specific needs and conditions of patients in the NCC, our research aims to shed light on the ocular health challenges they face and the adequacy of the eye care provided. The findings will help underscore the importance of implementing structured eye care protocols in the NCC setting, ensuring that these vulnerable patients receive comprehensive ocular assessments and interventions to mitigate the risks of long-term ocular complications.[8]

Prolonged admissions in the Neurocritical Care Unit (NCC), particularly those exceeding seven days, trigger a cascade of biochemical, cellular, and

microbial events that can lead to significant inflammation, hypoxia, and the development of ocular surface disorders (OSDs).[9] This phenomenon necessitates thorough investigation, as many patients admitted to the NCC typically have a poorer prognosis and require extended hospital stays. Understanding the underlying mechanisms that contribute to the development of OSDs during prolonged admissions is critical. Factors such as reduced eyelid closure due to neuromuscular impairment, decreased tear production, and increased exposure to pathogens can exacerbate these conditions. Additionally, the inflammatory response triggered by underlying illnesses and prolonged mechanical ventilation can further compromise ocular health.[10] A better comprehension of these processes is essential for improving patient outcomes in the NCC. By identifying risk factors and mechanisms associated with OSD development in this population, healthcare providers can implement more effective preventive and therapeutic strategies. These may include structured eye care protocols, regular ocular assessments, and timely interventions to address complications. Ultimately, enhancing our understanding of how prolonged admissions impact ocular health can lead to improved management and quality of life for patients in neurocritical care settings.[11]

Methods

In this observational cross-sectional study conducted at Swaminarayan Institute of Medical Sciences and Research, a tertiary-level hospital located in Kalol, Ahmedabad. The ocular health of all patients admitted to the Neurocritical Care Unit (NCC) was systematically examined. The focus was on identifying conditions such as conjunctivitis, chemosis, keratitis, and dry eyes. The study aimed to correlate the incidence of these ocular disorders with various factors, including the length of stay in the NCC, Glasgow Coma Score (GCS), presence of lagophthalmos, adherence to appropriate eye care protocols, and the use of mechanical ventilation. A total of 100 subjects were evaluated over the four-month study period. The cohort had a mean age of 51.92 ± 18.73 years, with ages ranging from 17 to 89 years. The gender distribution was predominantly male, comprising 70% of the participants, while females accounted for 30%, resulting in a gender ratio of 2.33. This comprehensive examination of ocular health in the NCC setting provides valuable insights into the prevalence of ocular surface disorders and emphasizes the need for structured eye care protocols tailored to the specific needs of this vulnerable patient population. The findings will help inform best practices and potentially guide future research aimed at improving ocular health outcomes in critically ill patients. In our study, all patients admitted to the Neurocritical Care Unit

(NCC) who consented to participate were included, along with their attendants in cases where patients were unconscious. This approach ensured that we gathered comprehensive data while respecting the autonomy of the participants.

To maintain the integrity of the study and eliminate confounding factors, we implemented specific exclusion criteria. Patients were excluded if they had ocular injuries or conditions that could influence ocular health. A history of pre-existing dry eyes or the use of lubricating eye drops, which could skew the results related to dry eye disease. Pre-existing corneal opacities secondary to trauma or keratitis, as these conditions might independently affect the study outcomes. A history of prosthetic eye use, orbital implant use, keratoplasty, refractive surgeries, or contact lens use, which could introduce additional variables affecting ocular surface health. By carefully selecting our study population and excluding individuals with these specific conditions, we aimed to ensure that our findings accurately reflect the incidence and severity of ocular surface disorders in the NCC setting, independent of other ocular pathologies. This methodological rigor enhances the reliability of our results and contributes to a clearer understanding of ocular health in critically ill patients.

In our study, a thorough ocular examination was performed on all participants to assess various ocular conditions. The examination utilized a torchlight to evaluate the following: Lagophthalmos: The inability to fully close the eyelids, which can lead to exposure-related ocular issues. Conjunctival congestion: Redness and inflammation of the conjunctiva, which can indicate infection or irritation. Discharge: The presence of any ocular discharge, which can help differentiate between conjunctivitis and other conditions. Pupillary light reflex: Assessment of the pupillary response to light to check for neurological involvement or other pathologies.

To identify keratitis, we applied fluorescein sodium ophthalmic strips to the cornea. After instillation, we examined the cornea under cobalt blue light using a direct or indirect ophthalmoscope. This method allowed for the visualization of corneal epithelial injuries, as the injured areas stained bright green, indicating keratitis. Conjunctivitis was diagnosed based on clinical findings such as the presence of purulent or mucopurulent discharge, Chemosis: Swelling of the conjunctiva, redness: Observed during the examination, indicating inflammation of the conjunctiva.

This comprehensive examination protocol enabled us to accurately identify and classify ocular surface disorders among the patients in the Neurocritical Care Unit, facilitating a better understanding of

their ocular health status and guiding appropriate interventions. In our study, Schirmer's test was employed as a diagnostic tool to assess dry eyes among the patients in the Neurocritical Care Unit. Less than 5 mm: Pathological, indicating severe dry eye disease. 5–14 mm: Suspicious for dry eye, suggesting the need for further evaluation or management. Greater than 15 mm: Considered normal, indicating adequate tear production.

Patients with a reading of less than 15 mm were classified as having dry eye disease, allowing us to identify and address this condition among patients in the NCC, who are often at increased risk due to factors such as prolonged hospitalization and mechanical ventilation. This information was crucial for guiding interventions aimed at preserving ocular health and preventing complications associated with dry eye disease. GCS was one of the scoring systems used in NCC to assess the neurocritical status. It helped us understand the severity of the disease and the risk of mortality by computing a score between 3 and 15 based on various measurements. In the presence of infectious signs and symptoms, like discharge, chemosis, or redness, broad-spectrum antibiotic eye drops were advised. In cases with dry eye disease, lagophthalmos, and exposure keratitis, appropriate management protocols, including lid taping and lubricants, were recommended.

Results

A comprehensive assessment of 100 subjects, with ages ranging from 17 to 89 years (mean age of 51.92 ± 18.73), and a gender distribution of 70% males to 30% females (yielding a gender ratio of 2.33), noteworthy findings emerged regarding ocular surface disorders (OSDs) among patients in the Neurocritical Care Unit (NCC). 18% of subjects exhibited indicative signs of infection, characterized by the presence of mucopurulent, purulent, or watery discharge, alongside eyelash matting. Conjunctival Congestion Observed in 26 individuals (13%), chemosis noted in 23 individuals (11.5%), discharge documented in 14 individuals (7%). These findings underscore the prevalence of ocular surface disorders in critically ill patients and highlight the necessity for vigilant eye care protocols in the NCC setting to mitigate complications and enhance patient outcomes (Table 1).

The findings regarding the prevalence of lagophthalmos and its relationship with ocular surface disorders (OSDs) among patients in the Neurocritical Care Unit (NCC) provide crucial insights into the ocular health challenges faced by this vulnerable population. Lagophthalmos found in 19 eyes (9.5%). Progression to exposure keratitis occurred in 14 eyes (6.5%) among those with lagophthalmos. Prevalence of dry eye among

patients with lagophthalmos was 89.47%. A significant negative correlation was observed between declining GCS and increased susceptibility to OSDs ($P < 0.001$). Prolonged hospital stays were significantly associated with increased severity of dry eyes. Length of stay exceeding 10 days ($P = 0.003$) (two-sample proportion test), length of stay less than 5 days: Showed scant evidence of dry eye disease ($P = 0.0401$, two-sample proportion test). For patients with a stay ranging from 5 to 10 days, the proportion of those developing dry eyes versus those who did not showed no significant disparity (Table 1 and 2).

The results from the Mann–Whitney U test indicate a significant association between Glasgow Coma Score (GCS) and the development of ocular surface disorders (OSDs) among patients in the Neurocritical Care Unit (NCC).

In our study, 13% (26 out of 200 eyes) exhibited conjunctival hyperemia and congestion. This finding highlights the need for heightened vigilance among ICU personnel when encountering patients with red, adhesive eyes, as these symptoms may indicate conjunctivitis.

The presence of conjunctival hyperemia necessitates immediate ophthalmologic consultation to evaluate and manage potential underlying conditions effectively. Our investigation

identified 18 patients displaying signs consistent with conjunctivitis, characterized by purulent or mucopurulent discharge, chemotic conjunctiva, and redness. A significant correlation was observed between dry eyes and the progression to keratitis within the Neurocritical Care Unit (NCC). Specifically, 11.71% (13 patients) with dry eyes developed keratitis ($P = 0.0035$, Chi-square test). If left untreated, this progression can lead to severe, permanent visual complications. Thus, addressing the seemingly minor concern of dry eyes is crucial for preventing the debilitating onset of keratitis. Our research also identified a significant association between lagophthalmos and keratitis, with 73.68% (14 out of 19) of patients with lagophthalmos also presenting with keratitis ($P < 0.001$). This correlation underscores the potential for impaired visual acuity and a diminished overall quality of life due to these ocular complications.

Among the 15 patients who required ophthalmic consultations, only 13 pursued this care. 2 patients who opted not to seek ophthalmic consultation demonstrated severe dry eyes, keratitis, and chemosis. In contrast, those who engaged with ophthalmic care exhibited either absent or moderate dry eyes, with no occurrences of keratitis. These findings highlight the critical need for rigorous ophthalmic monitoring and intervention within the NCC to prevent ocular complications and improve patient outcomes.

Table 1: Subjects variation according to various variables

Variables	Subcategory	Total (N=100)
Mechanical ventilation	Yes	26 (26%)
	No	74 (74%)
GCS	Mild	48 (48%)
	Moderate	25 (25%)
	Mean+SD	11.17+3.96
	Median (Min, Max)	12 (3, 15)
Eye care protocol	Optimal	3 (3%)
	Suboptimal	10 (10%)
	Not done	2 (2%)
Advised lubricants	No	44 (44%)
	Yes	56 (56%)
Advised taping	No	85 (85%)
	Yes	15 (15%)
Advised antibiotics	No	82 (82%)
	Yes	18 (18%)

Table 2: Distribution of subjects according to Ophthalmologic findings

Variables	Subcategory	Total (N=200 eyes)
Eyelids	Lid edema	14 (7%)
	Ptosis	4 (2%)
	Normal	182 (91%)
Conjunctival congestion	Not present	174 (87%)
	Present	26 (13%)
Chemosis	Not present	177 (88.5%)
	Present	23 (11.5%)
Discharge	Not present	186 (93%)

(mucopurulent/purulent)	Present	14 (7%)
	Present	14 (7%)
Pupillary reflex	Fixed/abnormal	57 (28.5%)
	RRRL	143 (71.5%)
Dry eyes (i.e., Schirmer's test results)	No	89 (44.5%)
	Mild	32 (16%)
	Moderate	38 (19%)
	Severe	41 (20.5%)

Discussion

The ophthalmic manifestations observed in our study are likely attributed to several interrelated factors present in the Neurocritical Care Unit (NCC). Underlying neurological disorders can impact ocular health and increase the risk of complications. The use of mechanical ventilation can interfere with natural eyelid closure and tear film stability, leading to dryness and exposure issues. Conditions like lagophthalmos can prevent proper eyelid function, exposing the cornea to environmental factors and increasing the risk of keratitis. Lack of comprehensive eye care protocols may result in missed opportunities for preventive measures, such as the administration of lubricating eye drops.[12] Prolonged hospitalization can exacerbate these issues, increasing the likelihood of developing ocular surface disorders. Neurocritical conditions encompass a diverse array of disorders such as vascular Conditions, infections, traumatic Injuries, autoimmune Disorders, metabolic Disorders, inflammatory conditions and neoplastic Condition.

Dry eyes are a significant ophthalmic manifestation observed in ICU patients, with reported prevalence rates ranging from 23% to 60% according to Hearne et al. In our study, we found a concerning 55.5% of subjects exhibited dry eyes, indicating an even higher prevalence in the Neurocritical Care Unit (NCC). Among the total of 111 dry eyes identified, severe dry eyes were noted in a striking 41 eyes (20.5%). Our findings also revealed a significant association between Glasgow Coma Scale (GCS) scores and the prevalence of dry eyes ($P < 0.001$).[13] Specifically, patients with lower GCS scores indicated a worse neurocritical prognosis, underscoring the relationship between neurocritical conditions and the prevalence of ocular surface disorders (OSDs).

Ramani et al. demonstrated significant microbial growth in conjunctival swabs collected from ICU patients, underscoring the importance of monitoring conjunctivitis in these settings. Our study corroborated this concern, revealing that 18% of patients exhibited signs and symptoms of conjunctivitis. Without timely intervention, conjunctivitis can rapidly spread among patients and staff, potentially leading to serious complications, including vision loss. This

highlights the necessity for vigilant ophthalmic assessments and prompt treatment in the Neurocritical Care Unit (NCC) to mitigate the risks associated with conjunctival infections.[14] Kam et al. highlighted a prevailing gap in understanding the crucial role of eyelid position in the development of exposure keratopathy and microbial keratitis. In contrast, our study findings shed light on a significant relationship between these conditions. Among the 19 patients affected by lagophthalmos, a remarkable 73.68% (14 patients) also exhibited keratitis, demonstrating a strong and statistically significant correlation ($P < 0.001$). These ocular complications can profoundly compromise visual acuity and diminish overall quality of life, reinforcing the need for vigilant monitoring and proactive management of patients at risk of lagophthalmos in the Neurocritical Care Unit (NCC).[15] Mechanical ventilation significantly contributed to the development of ophthalmic complications in our study. Positive pressure ventilation can lead to various issues, including orbital hemorrhage, eyelid injury, conjunctival edema, and facial nerve paralysis, all of which result in inadequate eyelid closure. Furthermore, the administration of neuromuscular blockers during endotracheal intubation disrupts the blink reflex, which is a vital protective mechanism for the eyes. [16] These concerns have been especially pertinent in the context of the coronavirus disease 2019 (COVID-19) pandemic, as underscored by studies from Ekici Gok et al [12]. and Imanaka et al.[13] The unique challenges posed by mechanical ventilation in critically ill patients necessitate enhanced eye care protocols to mitigate the risk of ocular surface disorders and preserve visual health.

The length of stay in the ICU significantly influences the prevalence and severity of dry eyes among patients. Our study revealed that patients with a length of stay of 10 days or more exhibited a higher incidence of dry eyes ($P = 0.003$). This finding is consistent with the observations made by Płaszewska-Żywko et al.,[3] indicating that prolonged exposure to the ICU environment exacerbates the severity of dry eyes and contributes to the overall morbidity experienced by critically ill patients. Additionally, a study by Imanaka et al.[13] highlighted that ocular surface disorders (OSDs) were present in 20% of patients who had

an ICU stay exceeding 7 days, further underscoring the need for vigilant eye care protocols in this vulnerable population. Numerous studies have demonstrated that the implementation of a simple, standardized protocol significantly enhances corneal health among patients in critical care settings. Such protocols have been associated with reduced pain, lower infection rates, and a decreased risk of long-term vision loss. Additionally, the use of polyethylene covers has been suggested as an effective strategy for preventing ocular surface disorders (OSDs).

Conclusion

As intensivists, neurologists, ophthalmologists, and paramedics, it is our critical responsibility to ensure that the ICU environment does not pose a risk to patient health. Our study provides compelling evidence of a significant correlation between admissions to the Neurocritical Care Unit (NCC) and the development of ocular surface disorders (OSDs). We strongly recommend the implementation of a comprehensive and standardized eye care protocol for all patients admitted to the NCC. Furthermore, healthcare professionals in the Neurocritical Care Unit (NCC) should receive education on the importance of eye care and the potential risks associated with neglecting proper ophthalmic management. Implementing training programs and clear guidelines is essential to ensure that caregivers and physicians are well-informed about the appropriate eye care protocols tailored to the unique environment of the NCC. By enhancing awareness and knowledge among healthcare providers, we can significantly improve the quality of care for patients and reduce the incidence of ocular surface disorders.

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