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Nursing Interventions for Preventing Exposure Keratopathy in Sedated and Mechanically Ventilated Patients

Alruwaili, Hala Musaad M[1], Nazlaha Nayir Laili Alanzi[2], Alsaidan, Aishah Falah Z[3], Abeer Ghazi Ghathyan Alruwaili[4], Alsharari, Hissah Nafea M[5], Bushra Rashid Salim Al-Balawi[6], Seham Sayyar Muflih Al-Ruwaili[7], Fahdah Awad Mashuj Alanazi[8], Feryal Mahrous Saleh Alamri[9], Saad Obaid Awadh Alzarea[10]

[1] Nursing Specialist – Al Jouf Health Cluster, Ministry of Health, Sakaka, Al Jouf Region, Saudi Arabia.
Email: Halatk0133@gmail.com
[2] Nursing Specialist – Public Health Department (Occupational Health), Al-Qurayyat General Hospital, Al Jouf Health Cluster, Ministry of Health, Al Qurayyat, Al Jouf Region, Saudi Arabia.
Email: Nazlaha@moh.gov.sa
[3] Nursing Technician – Al-Gharb Health Center, Al Jouf Health Cluster, Ministry of Health, Dumat Al-Jandal, Al Jouf Region, Saudi Arabia.
Email: afalsaidan@moh.gov.sa
[4] Nursing Technician – Mental Health Hospital, Al Jouf Health Cluster, Ministry of Health, Al Qurayyat, Al Jouf Region, Saudi Arabia.
Email: agalrwaili@moh.gov.sa
[5] Nursing Technician – Hasidah Primary Health Care Center, Al Jouf Health Cluster, Ministry of Health, Al Qurayyat, Al Jouf Region, Saudi Arabia.
Email: hnalsharari@moh.gov.sa
[6] Nursing Technician – Al-Qurayyat General Hospital, Al Jouf Health Cluster, Ministry of Health, Al Qurayyat, Al Jouf Region, Saudi Arabia.
Email: Wed8040@gmail.com
[7] Nursing Technician – Prince Mutaib bin Abdulaziz Hospital, Al Jouf Health Cluster, Ministry of Health, Sakaka, Al Jouf Region, Saudi Arabia.
Email: sealrwily@moh.gov.sa
[8] Nursing Technician – Al-Gharbi Primary Health Care Center, Al Jouf Health Cluster, Ministry of Health, Al Qurayyat, Al Jouf Region, Saudi Arabia.
Email: faenzi@moh.gov.sa
[9] Nursing Technician – Madinah Health Cluster, Ministry of Health, Madinah, Madinah Region, Saudi Arabia.
Email: Foofah3@gmail.com
[10] Nursing – Dumat Al-Jandal General Hospital, Al Jouf Health Cluster, Ministry of Health, Dumat Al-Jandal, Al Jouf Region, Saudi Arabia.
Email: soalzarea@moh.gov.sa

ABSTRACT: Sedated and mechanically ventilated patients in intensive care units are at substantial risk for exposure keratopathy, a corneal injury resulting from incomplete eyelid

closure that leaves the ocular surface unprotected and vulnerable to desiccation, microbial colonization, and ulceration. Sedation impairs the protective blink reflex and eyelid muscle tone, while mechanical ventilation, neuromuscular blockade, and fluid shifts further compromise eyelid function, often leading to lagophthalmos and reduced tear production. Because patients are frequently unable to communicate ocular discomfort, this condition is easily overlooked and may progress to microbial keratitis, corneal perforation, and permanent visual impairment. Consequently, systematic ocular assessment is a fundamental nursing responsibility: nurses should perform regular eye examinations documenting eyelid closure, corneal clarity, conjunctival integrity, and the presence of secretions or erythema, using tools such as the fluorescein test when available, and should escalate any signs of corneal damage promptly.Evidence-based nursing interventions for prevention center on maintaining a moist, protected ocular surface and include a tiered approach based on individual risk. Simple measures such as meticulous eye hygiene, frequent gentle cleansing of secretions, and head elevation to reduce edema and venous congestion form the foundation of care. For patients with incomplete eyelid closure, eyelid taping and protective coverings such as polyethylene film or gauze secured with tape help preserve moisture, while instillation of artificial tears or lubricating ointments at scheduled intervals maintains surface hydration. More advanced interventions include the use of moisture chamber devices and, in high-risk cases, passive eyelid closure achieved through taping or botulinum toxin administration under medical direction. Nurses must also incorporate eye care into routine ICU bundles, document interventions and outcomes consistently, and educate the multidisciplinary team about early recognition of ocular complications, thereby reducing the incidence of preventable vision loss in this vulnerable population.

INTRODUCTION

Exposure keratopathy is an acquired disorder of the ocular surface that develops when the cornea remains exposed to the environment for a prolonged period, usually because the eyelids fail to close completely or because the protective blink reflex is lost. In intensive care units, this condition is both common and clinically important, yet it is frequently overshadowed by more dramatic organ-support priorities. Patients who are sedated, paralyzed, mechanically ventilated, or neurologically impaired are unable to blink, cannot report ocular pain or visual change, and often cannot close their eyes adequately; as a result, the corneal epithelium becomes desiccated, erodes, and may progress to ulceration, infection, or perforation. Ocular surface protection is therefore a core nursing responsibility rather than an optional comfort measure, because the consequences of neglect may persist long after the acute illness has resolved [1]. The intensive care environment itself contributes to the problem. Dry air from ventilators and air-conditioning, reduced tear production, fluid shifts, positive-pressure ventilation, and the frequent use of sedatives and neuromuscular blocking agents all interact to impair the normal protective mechanisms of the eye. At the same time, ocular care is often informal, inconsistently documented, and dependent on individual nurse initiative rather than standardized policy, which means that patients at highest risk may receive the least reliable protection. This gap is important because exposure keratopathy is largely preventable through simple, low-cost nursing measures that can be delivered at the bedside [2]. The prevention of exposure keratopathy requires a systematic approach that combines risk assessment, scheduled lubrication, mechanical protection of the eyelids, moisture-chamber therapy in high-risk patients, staff education, and audit of practice [3].

Epidemiology and Clinical Significance

Ocular surface disorders are among the most under-recognized complications of critical illness. A systematic review of studies published between 2020 and 2025 reported that the incidence of ocular surface disorders in intensive care unit patients ranged from 20% to 60%, with exposure keratopathy specifically occurring in approximately 23% of cases. A meta-analysis of 23 observational studies involving 3,519 subjects estimated the pooled prevalence of exposure keratopathy at 34.0% and the pooled incidence at 23.0% [3]. These figures are not confined to adult intensive care; similar patterns have been described in pediatric intensive care units, where exposure keratopathy has been reported in approximately one fifth to one quarter of patients [4]. The clinical spectrum ranges from punctate epithelial erosions and corneal abrasions to microbial keratitis, stromal thinning,

and corneal perforation. Because sedated patients cannot report foreign-body sensation, pain, photophobia, or blurred vision, corneal damage may progress silently unless nurses actively inspect the eyes. A scoping review of risk factors and preventive measures emphasized that ocular complications are often preventable when risk is identified early and when preventive care is embedded in routine nursing practice [5]. The clinical significance of exposure keratopathy therefore extends beyond immediate ocular discomfort; it includes prolonged hospital stay, additional ophthalmology consultation, antimicrobial therapy, and the risk of permanent visual impairment [6].

Risk Factors in Sedated and Mechanically Ventilated Patients

The risk of exposure keratopathy in the intensive care unit is multifactorial, but sedation and mechanical ventilation are central contributors. Mechanical ventilation, particularly when it requires deep sedation and neuromuscular blockade, eliminates spontaneous blinking and impairs eyelid closure, and the incidence of exposure keratopathy in this population has been reported to be as high as 56%. Lagophthalmos, defined as incomplete eyelid closure, is the most direct mechanism of corneal exposure, and its severity correlates closely with the depth of sedation or paralysis. Chemosis, resulting from fluid resuscitation and positive-pressure ventilation, further prevents the eyelids from closing over the globe. Positive end-expiratory pressure and prone positioning add gravitational and venous-congestive burdens that exacerbate conjunctival edema and ocular surface exposure [6]. An expert consensus on prevention and management of exposure keratopathy emphasizes that risk stratification should guide the intensity of prophylaxis, with the highest level of protection reserved for patients who are deeply sedated, paralyzed, or unable to close the eyes [7]. A systematic review of interventions for critically ill, sedated, and mechanically ventilated patients identified compromised blinking, eyelid closure, and sedation as key modifiable targets for nursing prevention [8].

Table 1 summarizes the principal risk factors and their implications for nursing assessment.

Table 1. Principal Risk Factors for Exposure Keratopathy in Sedated, Mechanically Ventilated Patients

Risk Factor	Mechanism	Nursing Implication
Deep sedation	Suppression of blink reflex and orbicularis oculi tone; lagophthalmos	Assess sedation depth and eyelid closure at every shift; anticipate prophylaxis in deeply sedated patients
Neuromuscular blockade	Paralysis of eyelid musculature; absent protective closure	Prioritize ointment-based lubrication and mechanical closure support
Mechanical ventilation with positive end-expiratory pressure	Venous congestion, chemosis, reduced eyelid apposition	Inspect for chemosis; elevate the head of the bed when not contraindicated; avoid direct globe pressure
Lagophthalmos	Direct corneal exposure and tear-film evaporation	Grade eyelid closure; escalate from lubrication to moisture chamber or taping
Chemosis	Conjunctival edema preventing eyelid closure	Differentiate from infection; protect the exposed surface and reassess frequently
Prone positioning	Facial and orbital edema; direct pressure on the globe; reduced access to the eyes	Re-lubricate before each turn; maintain a neutral head position; avoid ocular compression
Prolonged intensive care stay and low Glasgow Coma Scale score	Cumulative exposure and reduced protective reflexes	Integrate eye care into the daily routine; document findings and escalate abnormal findings

Pathophysiology of Corneal Injury

The healthy ocular surface is maintained by a balanced tear film, regular blinking, and competent eyelid closure. Sedation and neuromuscular blockade disrupt all three mechanisms. Reduced or absent blinking prevents the meibomian glands from releasing lipid into the tear film, accelerating evaporation of the aqueous layer. Incomplete eyelid closure exposes the inferior

cornea, particularly during prolonged immobility, and the dry intensive care environment further increases evaporative loss. The resulting epithelial desiccation produces punctate erosions that may coalesce into frank epithelial defects. If exposure persists, stromal inflammation, thinning, and microbial invasion can ensue, with potentially sight-threatening consequences [6]. This cascade explains why single interventions are often insufficient: effective prevention must address both lubrication and the physical barrier that prevents evaporation. The pathophysiology also explains why patients with chemosis, lagophthalmos, and deep sedation require more intensive prophylaxis than patients who retain partial blink function and eyelid competence [7].

Assessment and Monitoring of the Ocular Surface

Prevention begins with structured assessment. All intensive care patients should undergo an ocular risk assessment on admission, and mechanically ventilated patients should be reassessed at intervals of two to four hours. The assessment should include inspection of eyelid closure, documentation of lagophthalmos severity, evaluation for chemosis, and examination of corneal clarity under a bright light. Fluorescein staining with cobalt-blue illumination can detect epithelial defects before they become clinically obvious, and trained intensive care clinicians can perform this screening feasibly when ophthalmology access is limited [6]. Nurses should also record ocular history, including pre-existing dry eye, contact lens use, and previous ocular surgery, because these factors increase vulnerability and require individualized prophylaxis. A simple grading system for eyelid closure, ranging from complete closure to visible cornea, can guide escalation from routine lubrication to mechanical closure or moisture-chamber protection. Documentation of eye findings at every shift transforms ocular care from an informal, memory-dependent task into an auditable patient-safety process [2].

Nursing Interventions for Prevention

Ocular Lubrication: Drops, Gels, and Ointments

Ocular lubrication is the foundational nursing intervention for corneal protection. Preservative-free artificial tears provide temporary moisture, but their effect is short-lived, particularly in the presence of lagophthalmos and high evaporative demand. Ointments and gels, by contrast, form a more persistent lipid-based barrier that maintains corneal hydration for longer periods. A systematic review of interventions for critically ill, sedated, and mechanically ventilated patients found that the risk of corneal injury in the lubricants group was 66% lower than in the eye-taping-alone group. The same review concluded that ocular lubrication, preferably in gel or ointment form, is among the most effective interventions for patients with compromised blinking and eyelid closure [8]. A randomized clinical trial comparing simple eye ointment, polyethylene cover, and eyelid taping found that polyethylene cover was the most effective method, followed by simple eye ointment and eyelid taping [9]. A risk-stratified protocol implemented in medical and neurologic intensive care units prescribed artificial tears every six hours for low-risk patients, artificial tears every six hours plus nightly ointment for mechanically ventilated patients without lagophthalmos, and artificial tear ointment every six hours plus a moisture-chamber dressing for high-risk patients with lagophthalmos, absent blink reflex, or deep sedation. This approach reduced exposure keratopathy incidence from 60.0% to 15.0% in the medical intensive care unit and from 47.8% to 5.0% in the neurologic intensive care unit [3]. Ointments should be applied gently, without touching the cornea, and the eyelids should be inspected for retained lubricant, skin irritation, and adequacy of closure.

Eyelid Closure and Taping

Eyelid taping is a simple mechanical method of maintaining corneal coverage, but its effectiveness depends on whether lubrication is used concurrently. Eyelid taping without lubrication may still permit corneal dryness, whereas combining closure with a lubricant addresses both the evaporative and mechanical components of exposure. In the randomized trial comparing simple eye ointment, polyethylene cover, and eyelid taping, taping was less effective than polyethylene cover and simple ointment when used as a single intervention [9]. Taping must be performed without exerting pressure on the globe, using hypoallergenic tape, and the eyelids should be inspected regularly for skin integrity and adequate closure. In patients with severe chemosis or facial edema, tape alone may be insufficient, and a moisture chamber or membrane dressing may be required. The nursing goal is not simply to close the eyelids but to restore a protected, humid ocular surface while avoiding pressure-induced corneal injury or skin breakdown [8].

Moisture Chambers and Polyethylene Covers

Moisture chambers, most commonly constructed from polyethylene film or a transparent membrane dressing, create a humid microenvironment over the eye that reduces evaporative loss while allowing visual inspection of the cornea. A meta-analysis of seven randomized trials found that moisture chambers reduced the incidence of corneal damage compared with lubrication

alone. In subgroup analysis, the advantage was significant versus lubricating drops but not versus lubricating ointments, suggesting that ointment-based lubrication and moisture chambers offer comparable protection when used appropriately [10]. A more recent systematic review and meta-analysis reported that the risk of corneal injury in the polyethylene-chamber group was 68% lower than in the eye-ointment group [11]. Polyethylene covers have therefore been described as the most effective single protective intervention in several reviews, although the certainty of evidence varies. Practical considerations include securing the cover without tension on the eyelid skin, changing it according to infection-prevention policy, and using single-patient materials to reduce cross-contamination. Table 2 summarizes the comparative evidence for the main nursing interventions.

Table 2. Comparative Evidence for Nursing Interventions to Prevent Exposure Keratopathy

Intervention	Mechanism of Protection	Key Evidence	Practical Considerations
Preservative-free artificial tears	Rehydrates the ocular surface; supplements the aqueous tear layer	Effective for low-risk and moderate-risk patients; requires frequent administration	Short duration of action; use at scheduled intervals and before eyelid closure
Lubricating ointment or gel	Forms a lipid barrier that retards evaporation; longer contact time	66% lower risk of corneal injury versus taping alone in a systematic review [8]	Preferred for sedated and ventilated patients; may cause transient blurring
Eyelid taping	Mechanically maintains eyelid closure	Effective when combined with lubrication; inferior to polyethylene cover as a single method [9]	Avoid pressure on the globe; inspect skin and eyelid position regularly
Polyethylene moisture chamber	Creates a humid micro-environment; reduces evaporation; allows inspection	68% lower risk versus ointment alone in a meta-analysis [11]; significant reduction versus drops [10]	Secure without tension; follow infection-prevention policy for replacement
Multimodal bundle	Combines lubrication, closure, moisture protection, and staff education	Reduced corneal injury from 69.7% to 13.8% in high-risk patients [12]	Requires protocol, documentation, and audit; most effective overall strategy

Multimodal Care Bundles and Protocolized Eye Care

Single interventions rarely provide complete protection in the highest-risk patients. Multimodal nursing interventions that combine eyelid closure, ocular lubrication, moisture-chamber application, and staff education have been shown to reduce the incidence of corneal injury from 69.7% to 13.8% in high-risk intensive care patients [12]. Algorithm-based bundles incorporating eyelid-closure grading, hydroxypropyl methylcellulose gel, cleaning, and taping achieved a similar reduction in exposure keratopathy incidence. A two-phase quality-improvement study reported a decrease in exposure keratopathy from 21% to 2.6% after implementing a protocol that included eye lubrication every two hours, shift-based corneal checks, and membrane application for high-risk patients, with compliance exceeding 97% [3]. The key feature of successful bundles is not the complexity of the individual components but the consistency with which they are delivered. Simple, clearly written standards are associated with higher clinical compliance than elaborate, multi-step protocols, and the most effective bundles specify who performs eye care, how often it is performed, how risk is graded, and when escalation to ophthalmology is required [12].

Staff Education and Competency

Even the best-designed protocol will fail if nurses lack the knowledge, skills, and confidence to implement it. Intensive care nurses often report insufficient training in ocular care, absence of standardized protocols, and lack of evaluation metrics, resulting in reactive rather than proactive practice. A structured educational intervention in Spain found that a one-hour in-person educational session combining theoretical content, bedside demonstration, and visual materials reduced the incidence of ocular surface disorders from 76.3% to 38.3% and increased adherence to evidence-based ocular care from 80% to 93.8% [13]. Another pre–post study reported that audiovisual plus hands-on eye-care training reduced corneal pathology from 59% to 23% and ocular discharge from 44% to 19% [14]. A survey of adult intensive care unit nurses using the health belief model

found that perceived barriers, self-efficacy, and institutional norms influenced eye-care practices, reinforcing the need for supportive protocols rather than knowledge alone [15]. Education should not be a one-time event; periodic refresher training, integration of ocular assessment into daily rounds, and documentation of eye findings as a routine nursing metric help sustai n practice change [15].

Special Considerations: Prone Positioning and Deep Sedation

Prone positioning, increasingly used in the management of severe acute respiratory distress syndrome, presents distinctive ocular risks. Facial and periorbital edema, direct pressure on the globe, and restricted access to the eyes during prone sessions compound the effects of sedation and lagophthalmos. A cross-sectional study of 252 prone-ventilated patients found exposure keratopathy in 51.2%; independent risk factors included deeper sedation, higher positive end-expiratory pressure, longer prone-ventilation time, greater frequency of prone sessions, eyelid insufficiency, and ocular surface secretions [16]. A systematic review of ocular complications during prone positioning confirmed that ocular surface exposure and pressure-related injury are recurring hazards and recommended structured eye protection before, during, and after each prone session [17]. Nursing care during prone positioning should include ocular risk assessment before, during, and after each session; re-lubrication before every turn; maintenance of a neutral head position; and avoidance of any direct compression of the globe. For deeply sedated patients, best practice includes maintaining neutral head alignment, protecting the eyes with ointment and closure, and re-lubricating every four hours with reassessment at each turn [18]. Exposure keratopathy has also been described specifically in sedated and ventilated patients outside the prone position, reinforcing the need for universal prophylaxis rather than position-specific vigilance alone [19]. Pediatric patients require similar principles adapted to smaller anatomy and developmental needs, and exposure keratopathy in pediatric intensive care has been associated with prolonged ventilation and impaired eyelid closure [4].

Implementation, Barriers, and Quality Improvement

Translating evidence into bedside practice requires attention to system-level barriers. High nurse workload, unfavorable patient-to-staff ratios, and competing clinical priorities often cause ocular care to be deprioritized. A rapid review of eye-care practices in intensive care units found that ocular care is frequently informal, inconsistently documented, and dependent on individual nurse initiative rather than standardized policy [20]. Embedding eye-care orders into the electronic medical record can improve adherence: one adult intensive care unit increased adherence to eye-exposure guidelines from 2% to 76% after integrating the bundle into the electronic record, and an electronic lubrication order set significantly increased lubrication administration among ventilated patients. An analysis of an ABCDE bundle-based eye-care strategy reported improved prevention of keratitis in critically ill patients when eye care was incorporated into daily sedation, delirium, and mobility routines [21]. A prophylactic eye-care protocol has also been shown to reduce exposure keratopathy in intensive care units when implemented as a standardized unit-level policy [22]. The broader literature on making a difference in eye care for critically ill patients emphasizes that simple, low-cost nursing measures can produce measurable ocular outcomes when they are consistently applied and audited [23]. Rapid reviews of eye-care practice repeatedly identify the absence of documentation and audit as a major gap, suggesting that quality improvement should begin with a minimum dataset for ocular assessment [24]. Systemic strategies that combine care bundles, staff training, and environmental optimization are therefore more likely to succeed than isolated educational sessions or single-product changes [25]. Quality-improvement metrics for ocular care include the proportion of ventilated or deeply sedated patients with a documented eye examination, the proportion of high-risk patients receiving prescribed prophylaxis, adherence to scheduled lubrication and closure, and the rate of exposure keratopathy or corneal injury per intensive care admission or ventilator day. These measures convert eye care from an optional bedside task into an auditable patient-safety process. Multidisciplinary collaboration among intensive care nurses, intensivists, and ophthalmologists is essential for risk stratification, timely escalation, and protocol review.

Table 3. Quality-Improvement Metrics for an Eye-Care Prevention Program

Metric	Numerator	Denominator	Purpose
Documented ocular risk assessment	Patients with a completed eye-risk assessment within 24 hours of admission	All intensive care admissions	Measures initial risk identification

Scheduled lubrication adherence	Prescribed lubrication doses actually administered	Prescribed lubrication doses	Measures fidelity to the prevention protocol
Eyelid closure assessment	Ventilated or sedated patients with documented eyelid closure each shift	All ventilated or sedated patients	Detects lagophthalmos and triggers escalation
Moisture-chamber use in high-risk patients	High-risk patients with a moisture chamber or equivalent protection	All patients with lagophthalmos or absent blink	Measures escalation of care
Exposure keratopathy incidence	New corneal epithelial defects or exposure keratopathy cases	Ventilator days or intensive care admissions	Measures patient outcome
Staff competency	Nurses who completed ocular care training and demonstrated practice	All intensive care nursing staff	Measures sustainability of education

CONCLUSION

Exposure keratopathy is a common, preventable, and potentially sight-threatening complication of sedation and mechanical ventilation. Its prevention rests on interventions that are simple, low-cost, and firmly within the scope of nursing practice: systematic ocular assessment, scheduled lubrication with preservative-free drops or ointment, mechanical support of eyelid closure, moisture-chamber protection for high-risk patients, and consistent implementation through multimodal care bundles and ongoing staff education. The evidence does not support reliance on any single measure in isolation; rather, the combination of lubrication and physical protection, delivered within a documented and auditable protocol, offers the greatest protection for patients who cannot protect their own eyes. Nurses are uniquely positioned to identify at-risk patients, initiate prophylaxis, detect early corneal changes, and escalate care before irreversible injury occurs. Integrating eye care into routine critical care practice is therefore not an additional burden but an essential expression of patient safety and holistic nursing care.

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