Chapter 6

Ocular Complications in Pediatric Intensive Care Units: Clinical Features and Care Considerations

Elem Kocaçal[1]

Abstract

Ocular complications represent a frequently overlooked yet clinically significant problem in pediatric intensive care units (PICUs). Critically ill children are particularly vulnerable to ocular surface disorders due to factors such as mechanical ventilation, sedation, neuromuscular blockade, decreased level of consciousness, and prolonged length of stay. Disruption of physiological protective mechanisms—including tear production, blinking, and complete eyelid closure—predisposes this population to exposure keratopathy, corneal injury, and infectious complications, which may result in long-term visual impairment if not promptly identified and managed. This book chapter provides a comprehensive overview of ocular complications in pediatric intensive care units, focusing on their pathophysiology, prevalence, risk factors, and clinical consequences. Current evidence demonstrates that ocular surface disorders in PICUs are common but largely preventable through early recognition and systematic care. Particular emphasis is placed on lagophthalmos as a key pathophysiological mechanism and modifiable risk factor. The chapter further reviews preventive and protective strategies, highlighting the superiority of moisture chamber applications over isolated use of lubricants and other traditional methods. A central component of this chapter is the role of nursing care in the assessment, prevention, and management of ocular complications. Structured ocular assessment, nurse-led fluorescein screening, and risk-based monitoring are discussed as essential elements of safe care. In addition, the integration of NANDA-I nursing diagnoses, NIC interventions, and NOC outcomes is presented as a framework for delivering standardized, evidence-based, and measurable eye care in pediatric intensive care settings. Finally, the chapter emphasizes

1 İzmir Demokrasi Üniversitesi Faculty of Health Sciences, Department of Nursing, İzmir/Türkiye; ORCID ID: 0000-0001-8771-5786; elem.kocacal@hotmail.com

https://doi.org/10.58830/ozgur.pub1126.c4582

the importance of nurse education, standardized protocols, and quality improvement initiatives in reducing preventable ocular complications. Strengthening nursing leadership in ocular care is proposed as a key strategy for enhancing patient safety and preserving visual health in critically ill children.

1. Introduction

Children admitted to pediatric intensive care units (PICUs) are exposed to a wide range of life-threatening conditions and advanced therapeutic interventions, often resulting in multisystem involvement. Factors such as sedation, mechanical ventilation, the use of neuromuscular blocking agents, sepsis, and neurological disorders may reduce the level of consciousness and compromise the body's physiological protective mechanisms (Niemi et al., 2020; Tork et al., 2022). Under normal circumstances, the ocular surface is protected by adequate tear production, regular blinking, and complete eyelid closure. In critically ill pediatric patients, however, disruption of these mechanisms may lead to drying of the corneal epithelium and the development of various ocular surface disorders, most notably exposure keratopathy (Pech-Lugo et al., 2025). The risk appears to be particularly pronounced in children receiving mechanical ventilation and continuous sedation (Niemi et al., 2020).

2. Ocular Complications in Pediatric Intensive Care Units

Ocular complications observed in children admitted to pediatric intensive care units (PICUs) primarily arise from the disruption of the eye's physiological protective mechanisms. Sedation, mechanical ventilation, the use of neuromuscular blocking agents, and reduced levels of consciousness suppress the blink reflex, impair eyelid closure, and decrease tear secretion (Niemi et al., 2020; Tork et al., 2022). As a result, the ocular surface becomes vulnerable to desiccation, which may subsequently lead to the development of various ocular disorders.

Exposure keratopathy is the most frequently reported ocular surface disorder among pediatric intensive care patients. It is characterized by punctate epithelial defects of the cornea, typically beginning in the inferior third, and may demonstrate a progressive course if left untreated (Pech-Lugo et al., 2025). In the absence of timely intervention, exposure keratopathy can advance to sterile or infectious corneal ulcers and, in rare cases, corneal perforation. Reported prevalence rates in PICUs range from 10% to 57%, with significantly higher rates among mechanically ventilated children (Niemi et al., 2020; Pech-Lugo et al., 2025). In the study conducted by

Pech-Lugo et al. (2025), exposure keratopathy developed in 56.8% of pediatric patients, with lagophthalmos identified as the strongest associated risk factor. Keratopathy and corneal abrasions may develop as a progression of exposure keratopathy or as a consequence of mechanical trauma. Ocular surface dryness, impaired eyelid closure, and insufficient lubrication are among the primary contributing factors (Niemi et al., 2020). Niemi et al. (2020) reported that at least one ocular surface disorder was identified in 32.2% of children during their stay in the PICU; however, following the implementation of a standardized eye care protocol, this rate decreased markedly to 8.6%. Conjunctivitis and chemosis represent other commonly encountered ocular complications in pediatric intensive care patients. Prolonged mechanical ventilation, high oxygen flow, infections, and fluid imbalance have been implicated in the development of these conditions (Tork et al., 2022). In the study by Pech-Lugo et al. (2025), chemosis was shown to be significantly associated with the development of exposure keratopathy, underscoring its clinical relevance in critically ill children. Ocular surface disorders developing during childhood may result in more severe long-term consequences compared with those observed in adults. Corneal scarring and opacity can compromise the visual axis and contribute to the development of amblyopia (Pech-Lugo et al., 2025). For this reason, early recognition and prevention of ocular complications in pediatric intensive care patients are of critical importance.

Recent studies indicate that the majority of ocular complications in PICUs are largely preventable and that regular assessment combined with appropriate care strategies can significantly reduce their incidence (Cardozo et al., 2020; Sevgi et al., 2024).

3. Etiology and Risk Factors of Ocular Complications

Ocular complications developing in pediatric intensive care units are generally characterized by a multifactorial etiology, emerging in relation to patient-specific factors, therapeutic interventions, and care processes. Critical illness, reduced levels of consciousness, and life-sustaining interventions disrupt the eye's natural protective mechanisms, thereby creating a predisposition to ocular surface disorders (Niemi et al., 2020; Pech-Lugo et al., 2025). Sedation represents one of the primary risk factors for the development of ocular complications in pediatric intensive care patients. Sedative agents suppress the blink reflex and interfere with complete eyelid closure, frequently leading to the development of lagophthalmos (Tork et al., 2022). Pech-Lugo et al. (2025) reported that all children who developed

exposure keratopathy were under sedation and that prolonged duration of sedation was associated with a significant increase in complication risk.

A reduced level of consciousness further limits children's ability to express ocular discomfort, delaying the recognition of early ocular surface lesions. This challenge may result in delayed diagnosis and treatment of ocular complications, particularly in pediatric patients who are unable to communicate symptoms effectively (Niemi et al., 2020). Mechanical ventilation is among the risk factors most strongly associated with ocular surface disorders in pediatric intensive care patients. Positive pressure ventilation reduces the tone of the orbicularis oculi muscle, impairs eyelid closure, and contributes to corneal exposure (Pech-Lugo et al., 2025). The use of neuromuscular blocking agents further accentuates these effects. Niemi et al. (2020) reported significantly higher rates of ocular surface disorders among children receiving neuromuscular blockers. Similarly, Pech-Lugo et al. (2025) observed that exposure keratopathy developed in all patients who were administered neuromuscular blocking agents.

Lagophthalmos constitutes one of the most critical pathophysiological mechanisms underlying ocular complications in pediatric intensive care settings. Incomplete eyelid closure exposes the cornea to the external environment and accelerates evaporation of the tear film (Tork et al., 2022). A strong association between the presence of lagophthalmos and the development of exposure keratopathy has been consistently reported in the literature. In the study by Pech-Lugo et al. (2025), exposure keratopathy developed in 86.9% of children with lagophthalmos, with a reported 13-fold increase in risk. These findings underscore the importance of regular eyelid assessment in pediatric intensive care practice. Chemosis is frequently observed in intensive care patients, particularly in the presence of fluid overload, infection, and impaired venous return. Conjunctival edema further compromises eyelid closure, thereby exacerbating vulnerability of the ocular surface (Pech-Lugo et al., 2025). Sepsis and systemic inflammatory responses are associated with microcirculatory impairment and reduced ocular surface perfusion, which may diminish healing capacity and promote progression of existing lesions (Niemi et al., 2020).

Prolonged length of stay in the pediatric intensive care unit is considered an independent risk factor for the development of ocular complications. Pech-Lugo et al. (2025) reported significantly longer PICU stays among children who developed exposure keratopathy. Extended hospitalization, accompanied by sustained exposure to sedation and mechanical ventilation, may render ocular surface damage increasingly unavoidable over time.

4. Pathophysiology of Ocular Complications

Ocular complications observed in pediatric intensive care patients develop through a multistep pathophysiological process that arises from disruption of the eye's physiological protective systems. Under normal conditions, the ocular surface is protected from external insults by the tear film, regular blinking, complete eyelid closure, and the integrity of the corneal epithelium. In the intensive care setting, however, these mechanisms are reported to be substantially impaired, rendering the ocular surface vulnerable to injury (Tork et al., 2022; Niemi et al., 2020). The tear film is a dynamic structure composed of lipid, aqueous, and mucin layers, playing a critical role in maintaining corneal hydration, preserving optical clarity, and protecting against microorganisms. In intensive care patients, sedation, mechanical ventilation, and oxygen therapy reduce tear production while simultaneously increasing the rate of tear evaporation (Pech-Lugo et al., 2025). Disruption of tear film stability leads to corneal surface dryness and the formation of micro–surface defects, representing the initial stage in the development of exposure keratopathy. Studies have demonstrated that tear film integrity may deteriorate rapidly in children admitted to intensive care units, with damage beginning within the first 24–48 hours of hospitalization (Niemi et al., 2020; Tork et al., 2022).

The blink reflex is a fundamental protective mechanism that ensures uniform distribution of the tear film across the corneal surface and facilitates the removal of foreign particles. Sedative and analgesic medications markedly reduce blink frequency through central nervous system suppression (Pech-Lugo et al., 2025). Decreased blinking prevents adequate renewal of the tear film and prolongs corneal exposure. In pediatric patients, whose corneal epithelium is inherently more fragile, this mechanism may accelerate the development of ocular surface damage (Tork et al., 2022). Lagophthalmos represents one of the principal pathophysiological triggers of ocular complications in intensive care settings. Sedation, neuromuscular blocking agents, and facial or periorbital edema reduce the tone of the orbicularis oculi muscle, thereby preventing complete eyelid closure (Niemi et al., 2020). Persistent eyelid opening exposes the cornea to ambient air, leading to epithelial erosion, particularly in the inferior corneal region. Pech-Lugo et al. (2025) reported that the presence of lagophthalmos increased the risk of exposure keratopathy by 13-fold, highlighting the combined contribution of mechanical injury and desiccation in the pathogenesis of corneal damage. Loss of tear film protection and sustained mechanical exposure compromise corneal epithelial integrity, resulting in superficial punctate epithelial erosions. As these lesions progress, larger epithelial defects, stromal involvement,

and infectious keratitis may develop (Pech-Lugo et al., 2025). In pediatric patients, the clinical significance of corneal injury extends beyond the acute phase. Corneal scarring, particularly when it involves the visual axis, increases the risk of amblyopia and permanent visual impairment (Pech-Lugo et al., 2025; Tork et al., 2022).

In pediatric intensive care patients, sepsis, systemic inflammation, and immune suppression reduce the ocular surface's resistance to infection. Disruption of corneal epithelial integrity creates a portal of entry for microorganisms, thereby increasing the risk of microbial keratitis (Niemi et al., 2020). In addition, prolonged antibiotic exposure and contact with hospital flora may predispose patients to ocular infections caused by resistant pathogens. For this reason, preservation of ocular surface integrity is essential not only for preventing local complications but also for reducing the risk of broader systemic consequences (Tork et al., 2022).

5. Prevalence and Clinical Significance of Ocular Complications in Pediatric Intensive Care

Although ocular complications occur more frequently than is often assumed in pediatric intensive care units, they may remain overshadowed by life-threatening clinical conditions and therefore go unrecognized in routine practice. The literature reports that the prevalence of ocular surface disorders among intensive care patients ranges from 10% to 57%, with markedly higher rates observed in pediatric populations, particularly in the presence of sedation and mechanical ventilation (Niemi et al., 2020; Pech-Lugo et al., 2025).

Although studies examining the prevalence of ocular surface disorders in pediatric intensive care patients remain limited, available evidence consistently points to a high-risk patient population. In a prospective cohort study conducted by Niemi et al. (2020), ocular surface disorders were identified in 15% of sedated and intubated children at the time of initial assessment following admission to the intensive care unit. With repeated evaluations during hospitalization, this rate increased to 32.2%. Similarly, in a prospective study by Pech-Lugo et al. (2025), exposure keratopathy developed in 56.8% of children admitted to the pediatric intensive care unit. This figure represents one of the highest prevalence rates reported in pediatric populations and has been attributed to the high frequency of mechanical ventilation and prolonged sedation in this setting. Mechanical ventilation is considered one of the strongest determinants of ocular complication development in pediatric intensive care patients. In the study by Pech-

Lugo et al. (2025), 86.1% of children who developed exposure keratopathy were receiving mechanical ventilation, and the risk was reported to be approximately sevenfold higher among ventilated patients. The presence of sedation further exerts a substantial influence on prevalence rates. In the same study, all children who developed exposure keratopathy (100%) were under sedation, and increasing duration of sedation was associated with both a higher frequency and greater severity of ocular lesions (Pech-Lugo et al., 2025). These findings suggest that sedation is not merely a coexisting condition but represents a direct pathophysiological risk factor for ocular surface injury.

Lagophthalmos is regarded as a critical intermediate mechanism in the development of ocular complications among pediatric intensive care patients. Pech-Lugo et al. (2025) reported that exposure keratopathy developed in 78.4% of children with identified lagophthalmos, highlighting its strong predictive value. Although chemosis occurs less frequently, its presence constitutes an important risk factor for progression of ocular surface damage. Chemosis further compromises eyelid closure and increases corneal exposure, thereby exacerbating vulnerability of the ocular surface (Niemi et al., 2020). The clinical significance of ocular complications in pediatric intensive care patients extends beyond acute ocular surface lesions. Progressive corneal injury, scarring, and involvement of the visual axis may result in long-term outcomes such as amblyopia, refractive errors, and permanent visual impairment (Pech-Lugo et al., 2025). Ongoing maturation of the visual system during childhood represents a key factor distinguishing pediatric patients from adults. Consequently, even ocular lesions that appear transient in the intensive care setting may exert lasting effects on a child's neurodevelopmental and functional outcomes (Tork et al., 2022). Moreover, delayed recognition or failure to identify ocular complications may increase the risk of infection, prolong hospital stay, and contribute to higher care-related costs (Niemi et al., 2020). Collectively, these findings underscore that ocular care in pediatric intensive care units represents a critical clinical priority rather than a neglectable aspect of care.

6. Approaches to the Prevention of Ocular Complications

Prevention of ocular complications in pediatric intensive care units requires systematic and evidence-based care approaches, particularly during periods of sedation and mechanical ventilation when physiological protective mechanisms are compromised. Although various strategies aimed at preventing ocular surface injury have been described in the literature,

notable differences exist in their reported effectiveness (Niemi et al., 2020; Tork et al., 2022).

6.1. Eyelid Closure–Based Interventions

Interventions aimed at promoting eyelid closure represent one of the fundamental strategies for reducing corneal exposure. Commonly used methods include eyelid taping, gauze applications, and moisture chamber techniques. Eyelid taping is frequently preferred in the presence of lagophthalmos; however, improper application may result in eyelash loss, skin irritation, and eyelid trauma. In addition, the inability to directly observe whether complete eyelid closure has been achieved constitutes an important limitation of this method (Tork et al., 2022). Gauze applications, on the other hand, are often insufficient in maintaining adequate corneal hydration and demonstrate limited effectiveness in preventing ocular surface dryness.

6.2. Polyethylene Cover (Moisture Chamber) Application

Current evidence indicates that the use of a polyethylene cover to create a moisture chamber is among the most effective methods for preventing ocular surface complications. By establishing a closed microenvironment around the eye, the polyethylene cover reduces tear evaporation and helps maintain corneal hydration (Niemi et al., 2020). In the study by Niemi et al. (2020), implementation of a dynamic eye care protocol incorporating a polyethylene cover and regular fluorescein assessment reduced the incidence of ocular surface disorders to as low as 8.6%, a rate markedly lower than those reported for other preventive methods. Similarly, Cardozo et al. (2020) reported that the polyethylene cover constituted a key component of a structured eye care protocol implemented in pediatric intensive care units, resulting in a significant reduction in corneal lesions. Collectively, these findings suggest that the polyethylene cover should be regarded not merely as an adjunctive measure but as a central preventive strategy.

6.3. Use of Artificial Tears and Ocular Lubricants

Artificial tears and ophthalmic lubricants are widely used to support ocular surface hydration. However, their effectiveness is highly dependent on application frequency and continuity of care. In sedated pediatric patients, insufficient or irregular application has been shown to limit their ability to prevent corneal dryness (Pech-Lugo et al., 2025). Moreover, evidence suggests that lubricant use alone may be inadequate in preventing exposure

keratopathy in patients with incomplete eyelid closure; therefore, combined use with mechanical closure methods is recommended (Niemi et al., 2020).

6.4. Combined Approaches and Current Evidence

Recent studies emphasize that no single intervention is sufficient for all patients and that combined protocols incorporating moisture chambers, lubricant use, and regular ocular assessment represent the most effective preventive approach. In a quasi-experimental study conducted by Tork et al. (2022), structured eye care protocol training for nurses led to significant improvements in both knowledge and practice, accompanied by a parallel reduction in ocular surface disorders. Pech-Lugo et al. (2025) further highlight that, despite the absence of a universally accepted standard protocol, risk-based and structured approaches significantly reduce both the incidence and recovery time of exposure keratopathy. Notably, the current literature does not provide strong evidence supporting the superiority of any alternative method over the polyethylene cover.

6.5. Implications for Nursing Practice

Intensive care nurses play a pivotal role in the planning, implementation, and evaluation of ocular care. Correct application of the polyethylene cover, continuous monitoring of eyelid integrity, and timely administration of ocular lubricants constitute core components of nursing practice in pediatric intensive care units (Tork et al., 2022). In this context, adoption of evidence-based protocols and enhancement of nurses' competence in ocular care should be regarded as critical strategies for preventing ocular complications in pediatric intensive care settings (Cardozo et al., 2020; Niemi et al., 2020).

7. Assessment and Diagnosis of Ocular Complications: The Nursing Role

Early identification of ocular complications in pediatric intensive care units is critical for preventing irreversible visual impairment. Interventions such as sedation, mechanical ventilation, and neuromuscular blockade suppress protective ocular mechanisms in pediatric patients, thereby facilitating rapid development of ocular surface injury. For this reason, systematic ocular assessment should be regarded as an integral component of routine intensive care practice (Niemi et al., 2020; Pech-Lugo et al., 2025). Clinical assessment of the ocular surface should include evaluation of eyelid closure, tear presence, conjunctival edema (chemosis), corneal integrity, and signs of infection. The literature consistently identifies lagophthalmos as one of the strongest predictors of exposure keratopathy (Pech-Lugo et al.,

2025). Niemi et al. (2020) emphasized that failure to regularly monitor eyelid closure may result in ocular surface disorders being overlooked. By observing eyelid integrity and degree of closure during each shift, nurses can identify high-risk patients at an early stage. This approach is considered a fundamental step in preventing the progression of advanced corneal lesions (Tork et al., 2022). Although various classification systems are available for assessing lagophthalmos, scales based on the degree of eyelid opening are most commonly used in clinical practice. In the study by Pech-Lugo et al. (2025), eyelid closure was evaluated using a five-point scale, and the presence of lagophthalmos was associated with a 13-fold increase in the risk of developing exposure keratopathy. Application of such scales does not require advanced ophthalmic equipment and can be performed safely by nurses when appropriate training is provided. This reinforces the role of nurses not only as care providers but also as key clinical risk assessors within the intensive care team (Tork et al., 2022).

Fluorescein staining is widely regarded as one of the gold-standard methods for evaluating corneal epithelial integrity. This technique enables early detection of microerosions and abrasions on the corneal surface. Niemi et al. (2020) reported that regular fluorescein-based corneal examinations incorporated into a dynamic eye care protocol in the PICU were effective in preventing progression of ocular surface disorders. When conducted within an appropriate training framework and protocol, fluorescein application represents an assessment method that can be performed by nurses. Vilchez-Rodriguez et al. (2025) demonstrated that nurse-led fluorescein screening facilitated early diagnosis and enabled more targeted ophthalmology consultations. Although the Schirmer test allows quantitative assessment of tear production, its applicability in pediatric intensive care settings is limited. In sedated children, the test may be poorly tolerated, and results may not accurately reflect the clinical condition of the ocular surface. Consequently, the literature suggests that the Schirmer test should be considered a supportive rather than a routine assessment tool in PICUs (Pech-Lugo et al., 2025). In contrast, clinical observation of tear presence and ocular surface moisture is more feasible and sustainable within nursing practice (Tork et al., 2022).

Current evidence highlights the central role of intensive care nurses in the early diagnosis of ocular complications. Cardozo et al. (2020) reported a significant reduction in corneal lesions following implementation of nurse-focused education and structured assessment protocols. Regular assessment by nurses, systematic documentation of findings, and timely referral in high-risk situations enhance the effectiveness of multidisciplinary care. In this context, integration of ocular assessment competencies into nursing

education programs represents a key strategy for improving patient safety in pediatric intensive care units (Tork et al., 2022; Niemi et al., 2020).

8. The Relationship Between NANDA-I, NIC, and NOC in Eye Care in Pediatric Intensive Care Units

Preservation of ocular surface integrity in children admitted to intensive care units represents a fundamental responsibility of nursing care. Considering factors such as sedation, mechanical ventilation, neuromuscular blockade, reduced level of consciousness, and lagophthalmos, a structured and standardized approach to eye care is essential in this patient population. Within this framework, NANDA-I nursing diagnoses, Nursing Interventions Classification (NIC) interventions, and Nursing Outcomes Classification (NOC) outcomes enable systematic and evidence-based planning, implementation, and evaluation of ocular care.

In the NANDA-I 2024–2026 classification, the nursing diagnoses directly associated with ocular complications in pediatric intensive care patients include the following:

- Risk for Dry Eye: Refers to the risk of ocular surface dryness associated with decreased tear production, suppression of the blink reflex, and inadequate eyelid closure.
- Risk for Corneal Injury: Describes the risk of disruption to corneal epithelial integrity resulting from lagophthalmos, mechanical ventilation, sedation, and exposure of the ocular surface to environmental factors.
- Risk for Impaired Tissue Integrity: A diagnosis applicable to tissues at risk of damage due to pressure, dryness, and infection, including the ocular surface and cornea.

These diagnoses constitute the foundation for preventive nursing approaches to eye care in pediatric intensive care settings (Herdman et al., 2024).

Within the NIC classification, the primary interventions directly related to the diagnoses outlined above and included in recent editions are as follows (Bulechek et al., 2023):

- Eye Care: Encompasses regular assessment of the eyes, observation of eyelid closure, cleansing of secretions, and monitoring for signs of infection.

- Dry Eye Prevention: Includes interventions aimed at maintaining ocular surface hydration, appropriate use of lubricants, and reduction of environmental dryness.
- Risk Prevention: Dry Eye: Focuses on early identification of risk factors for dry eye development and systematic implementation of preventive care measures.
- Eye Irrigation: Involves cleansing of the ocular surface with sterile solutions when indicated to remove irritants and secretions.

When implemented in combination with preventive strategies such as polyethylene cover (moisture chamber) application, artificial tear use, and eyelid closure techniques, these interventions have been shown to be effective in reducing corneal damage. In the study by Niemi et al. (2020), implementation of a structured NIC-based eye care protocol reduced the incidence of ocular surface disorders from 15% to 8.6%. Similarly, Tork et al. (2022) demonstrated that nurse education combined with protocol-based practice significantly decreased corneal injury rates.

The effectiveness of NIC interventions is monitored and evaluated through NOC outcomes. Key NOC indicators related to eye care in pediatric intensive care units include:

- Dry Eye Severity: Allows assessment of the clinical severity of ocular surface dryness and monitoring of changes throughout the care process.
- Risk Control: Dry Eye: Evaluates the effectiveness of implemented nursing interventions in preventing the development of dry eye.
- Tissue Integrity: Skin and Mucous Membranes: Assesses preservation of mucosal integrity, including the cornea and conjunctiva.

Cardozo et al. (2020) reported that nursing care monitored using NOC indicators was effective and sustainable in protecting ocular health in pediatric intensive care settings.

Integrated use of NANDA-I, NIC, and NOC classifications ensures that eye care in pediatric intensive care units is delivered as a structured, measurable, and systematic process rather than as an incidental aspect of care. The literature consistently demonstrates that nurse-led protocols and standardized care approaches significantly reduce both the incidence and severity of ocular surface disorders (Moorhead et al., 2023; Niemi et al., 2020; Vilchez-Rodriguez et al., 2025; Tork et al., 2022). In this context, planning eye care based on NANDA-I diagnoses, implementing appropriate

NIC interventions, and evaluating outcomes using NOC indicators emerges as a key strategy for enhancing patient safety and improving quality of care in pediatric intensive care units.

9. The Role of Nurses, Education, and the Importance of Standardized Protocols

Nurses play a pivotal role in the prevention and early detection of ocular complications in children admitted to pediatric intensive care units. Due to mechanical ventilation, deep sedation, neuromuscular blockade, and altered levels of consciousness, these patients are often deprived of protective ocular reflexes. Consequently, assessment, protection, and ongoing monitoring of the ocular surface largely fall within the scope of nursing care (Niemi et al., 2020; Tork et al., 2022). During routine care activities, nurses are uniquely positioned to regularly evaluate parameters such as eyelid closure, conjunctival hyperemia, ocular dryness, presence of secretions, and corneal integrity. Use of structured risk assessment tools enables early identification of high-risk patients and timely initiation of appropriate preventive interventions (Vilchez-Rodriguez et al., 2025). This approach allows ocular complications to be controlled before reaching advanced stages, thereby reducing the need for ophthalmology consultation and minimizing the risk of permanent damage.

The literature demonstrates that structured educational programs for nurses significantly improve the quality of eye care practices. Quasi-experimental studies conducted in pediatric intensive care settings report that theoretical and practical eye care training leads to improvements in nurses' knowledge and skills, increased adherence to protocols, and a reduction in the incidence of keratopathy (Tork et al., 2022). Similarly, Sevgi et al. (2024) showed that implementation of a quality improvement program combining nurse education, visual reminders, and digital documentation systems resulted in substantial standardization of eye care practices within the intensive care unit. Development and implementation of standardized eye care protocols ensure that care is delivered in an evidence-based manner rather than being dependent on individual experience. Although national and international guidelines include recommendations for ocular care, these guidelines are often insufficiently translated into routine clinical practice (Sevgi et al., 2024). Integration of protocols into electronic health record systems facilitates systematic documentation of assessments and interventions, thereby enhancing traceability and continuity of care. Quality improvement initiatives—particularly those employing systematic methods such as the Plan–Do–Study–Act (PDSA) cycle—have been shown

to support sustainable improvements in eye care practices. When led by nurses, such initiatives enhance team awareness and strengthen patient safety culture (Sevgi et al., 2024). Given that ocular complications in pediatric intensive care patients may affect long-term visual function and quality of life, the preventive role of nursing care in this domain becomes even more critical (Pech-Lugo et al., 2025). In summary, preservation of ocular health in critically ill children requires an approach in which nurses take an active role, supported by education and structured through standardized protocols. This approach should be regarded as a fundamental patient safety strategy for reducing preventable ocular complications.

10. Conclusion and Recommendations

Children admitted to pediatric intensive care units represent a highly vulnerable population with respect to ocular surface disorders due to multiple risk factors, including mechanical ventilation, sedation, neuromuscular blockade, decreased level of consciousness, and prolonged hospitalization. High incidence rates reported in the literature indicate that exposure keratopathy and related corneal injuries constitute a clinically significant patient safety concern that should not be overlooked (Niemi et al., 2020; Pech-Lugo et al., 2025). The studies reviewed in this chapter consistently demonstrate that ocular complications are largely preventable and that systematic eye care interventions implemented at an early stage significantly reduce both lesion development and recovery time. In particular, early identification of lagophthalmos, combined with appropriate humidification and mechanical protection strategies, emerges as a cornerstone for preserving ocular health in pediatric intensive care patients (Vilchez et al., 2024; Vilchez-Rodriguez et al., 2025).

Evidence-based findings indicate that application of a polyethylene cover (moisture chamber) provides more effective protection of the ocular surface compared with other methods and offers longer-lasting and more stable hydration than lubricant drops used alone (Niemi et al., 2020; Tork et al., 2022). Nevertheless, individualized assessment of each patient's risk profile remains essential, and preventive interventions should be tailored accordingly. Within this framework, the role of nursing care is decisive. By integrating ocular assessment into routine daily care, nurses can identify at-risk patients at an early stage and initiate appropriate interventions in a timely manner. Nursing diagnoses such as Risk for Dry Eye and Risk for Corneal Injury, included in the NANDA-I 2024–2026 classification, provide a structured basis for systematic management of ocular health in pediatric intensive care patients. Corresponding NIC interventions—such as Eye Care and Dry

Eye Prevention—and NOC outcomes—including Risk Control: Dry Eye and Dry Eye Severity—offer a robust framework for standardizing and evaluating nursing care (NANDA-I, 2024–2026; NIC; NOC; University of Iowa, 2024). Furthermore, structured educational programs for nurses and implementation of standardized eye care protocols have been shown to increase knowledge levels, promote consistency in practice, and reduce the incidence of ocular complications (Herdman et al., 2024; Tork et al., 2022; Sevgi et al., 2024). These findings underscore that eye care should not be left to individual initiative but should instead be embedded within an institutional approach supported by protocols, checklists, and ongoing education. In conclusion, preservation of ocular health in pediatric intensive care units is achievable through evidence-based and standardized care approaches implemented within a multidisciplinary framework and led primarily by nurses. Future multicenter and long-term studies are warranted to further elucidate the impact of these interventions on visual outcomes and quality of life. Nevertheless, current evidence clearly establishes ocular care as a fundamental and indispensable component of pediatric intensive care nursing practice.

References

1. Herdman, T. H., Kamitsuru, S., & Lopes, C. T. (Eds.). (2024). *NANDA International nursing diagnoses: Definitions & classification 2024–2026* (13th ed.). Thieme Medical Publishers..
2. Moorhead, S., Swanson, E., & Johnson, M. (2023). *Nursing outcomes classification (NOC): Measurement of health outcomes* (7th ed.). Elsevier.
3. Bulechek, G. M., Butcher, H. K., Dochterman, J. M., & Wagner, C. M. (2024). *Nursing interventions classification (NIC)* (8th ed.). Elsevier.
4. University of Iowa, College of Nursing, Center for Nursing Classification and Clinical Effectiveness. (2024). NIC & NOC fact sheet. https://nursing.uiowa.edu/cncce/facts
5. Wagner, C. M., Butcher, H. K., & Clarke, M. F. (2023). *Nursing interventions classification (NIC)* (8th ed.). Elsevier.
6. Cardozo, O., Paredes, M., Zaracho, Y., & Godoy, L. (2020). Impacto de una intervención sanitaria en los cuidados oculares en pacientes de la unidad de cuidados intensivos pediátricos. Pediatría (Asunción), 47(3), 145–150. https://doi.org/10.31698/ped.47032020005
7. Niemi, A., Geddie, B. E., Rajasekaran, S., Davis, A. T., VanDenBosch, N., Steenland, C., & Winters, J. W. (2020). Ocular surface disease in a PICU: Incidence and outcomes with a dynamic eye care protocol. Pediatric Critical Care Medicine, 21(4), 357–362. https://doi.org/10.1097/PCC.0000000000002200
8. Pech-Lugo, R. A., Vázquez-Cerón, A., Segura-López, F. K., & Dávila-Camargo, A. (2025). Frequency, risk factors and time to resolution of exposure keratopathy in patients in the Pediatric Intensive Care Unit. Archivos de la Sociedad Española de Oftalmología (English Edition), 100(1), 22–27. https://doi.org/10.1016/j.oftale.2024.10.011
9. Sevgi, M., Monachello, E., Yates, M., Lockington, D., & Cowan, R. (2024). Improving eye care in an intensive care unit. Journal of the Intensive Care Society, 25(3), 346–349. https://doi.org/10.1177/17511437241228587
10. Tork, H. M., Mohamed, R. A. E.-G., Elaasar, H. N., & El-Said, R. R. (2022). Effect of designed eye care protocol on nurses' knowledge and practices regarding prevention of ocular surface disorders among sedated and intubated children at pediatric intensive care unit. American Journal of Nursing Research, 10(2), 46–57. https://doi.org/10.12691/ajnr-10-2-2
11. Vilchez-Rodriguez, B., Marcos-López, M., Manzanal-Martín, I., González-Navarro, P., & López-Herce, J. (2025). Modification of an eye injury risk scale for critically ill children. Enfermería Intensiva (English Edition), 36(1), 100495. https://doi.org/10.1016/j.enfie.2025.100495
12. Wan, K., Lau, K. H., Wong, H. Y., et al. (2024). Fostering holistic eye care for children with special educational needs: An interprofessional education program bridging optometry and education. BMC Medical Education, 24, 1340. https://doi.org/10.1186/s12909-024-06350-w