Incidence of corneal injury in intensive care: a cohort study

Incidência de lesão de córnea em terapia intensiva: um estudo de coorte

Incidencia de lesión en la córnea en terapia intensiva: un estudio de cohorte

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Abstract

Objective: To identify the incidence of corneal injury in patients hospitalized in the Intensive Care Unit and associate the main risk factors with the occurrence of corneal injury in patients hospitalized in the Intensive Care Unit.

Methods: This is a prospective cohort study, in which 40 patients admitted to the Intensive Care Unit were included, from December 2019 to February 2020. Data analysis was descriptive and inferential, using statistical tests and effect measures.

Results: The sample consisted of 40 patients. Corneal injury developed in 20% (n=8) of participants and is significantly associated with the following factors: length of stay from two to seven days (70%; n=28), Glasgow < 13 (50%; n= 7), use of sedatives (33.3%; n=8), use of bronchodilators (36.8%; n=7), use of tracheostomy (TCT) (50%; n=6) and invasive mechanical ventilation (IMV) (58.3%; n=7), blinking less than five times (61.5%; n=8), partial eyelid closure (38.9%; n=7), hyperemia (34.8%; n=8), eyelid edema (41.2%; n=7), conjunctival edema (50%; n=7) and dryness (50%; n=5).

Conclusion: Patients admitted to the Intensive Care Unit are exposed to several risk factors for developing corneal injury, with emphasis on mechanical ventilation and Glasgow less than 13, requiring the implementation of prophylactic measures for corneal injury, through the control and mitigation of risk factors and patient exposure.

Resumo

Objetivo: Identificar a incidência de lesão de córnea em pacientes internados na unidade de terapia intensiva e associar os principais fatores de risco com a ocorrência de lesão de córnea em pacientes internados na unidade de terapia intensiva.

Métodos: Estudo de coorte prospectivo, no qual foram incluídos 40 pacientes internados na unidade de terapia intensiva, no período de dezembro de 2019 a fevereiro de 2020. A análise de dados ocorreu de forma descritiva e inferencial, por testes estatísticos e medidas de efeito.

Resultados: A amostra foi composta por 40 pacientes. A lesão de córnea se desenvolveu em 20% (n=8) dos participantes e está significativamente associada aos seguintes fatores: tempo de internação de dois a sete dias (70%; n=28), Glasgow < 13 (50%; n=7), uso de sedativo (33,3%; n=8),uso de broncodilatador (36,8%; n=7), uso de Traqueostomia (TQT) (50%; n=6) e Ventilação Mecânica Invasiva (VMI) (58,3%; n=7), o piscar menos de cinco vezes (61,5%; n=8), o fechamento parcial da pálpebra(38,9%;n=7), a hiperemia (34,8%; n=8), o edema palpebral(41,2%; n=7), o edema conjuntival (50%; n=7) e o ressecamento(50%; n=5).

Conclusão: O paciente internado em unidade de terapia intensiva está exposto a diversos fatores de risco para

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o desenvolvimento de lesão na córnea, com destaque para ventilação mecânica e Glasgow menor que 13 sendo necessária a implementação de medidas profiláticas para lesão de córnea, mediante o controle e mitigação dos fatores de risco e exposição do paciente.

Resumen

Objetivo: Identificar la incidencia de lesión en la córnea en pacientes internados en una unidad de cuidados intensivos y asociar los principales factores de riesgo con los episodios de lesión de córnea en pacientes internados en una unidad de cuidados intensivos.

Métodos: Estudio de cohorte prospectivo, en el que se incluyeron 40 pacientes internados en una unidad de cuidados intensivos, en el período de diciembre de 2019 a febrero de 2020. El análisis de los datos se realizó de forma descriptiva e inferencial, mediante pruebas estadísticas y medidas de efecto.

Resultados: La muestra estuvo compuesta por 40 pacientes. La lesión en la córnea se presentó en el 20 % (n=8) de los participantes y está significativamente asociada a los siguientes factores: tiempo de internación de dos a siete días (70 %; n=28), Glasgow < 13 (50 %; n=7), uso de sedante (33,3 %; n=8), uso de broncodilatador (36,8 %; n=7), uso de traqueotomía (TQT) (50 %; n=6) y ventilación mecánica invasiva (VMI) (58,3 %; n=7), parpadear menos de cinco veces (61,5 %; n=8), cierre parcial del párpado (38,9 %; n=7), hiperemia (34,8 %; n=8), edema palpebral (41,2 %; n=7), edema conjuntival (50 %; n=7) y resecamiento (50 %; n=5).

Conclusión: Los pacientes internados en una unidad de cuidados intensivos están expuestos a diversos factores de riesgo para contraer lesión en la córnea, con énfasis en la ventilación mecánica y Glasgow menor a 13, para lo cual es necesario implementar medidas profilácticas para lesión en la córnea mediante el control y mitigación de los factores de riesgo y exposición de los pacientes.

Introduction

The dynamics of intensive care settings can lead to the prioritization of specific, immediate and complex care to critically ill patients, due to other basic but essential care.[1] When severity does not pose an imminent risk to life, care may occur less frequently or not be evidenced, and may even be suppressed, as is the case with eye care for critically ill patients.

The lack of ocular prophylactic therapy makes critically ill patients susceptible to important alterations that lead to a high incidence of corneal injury in intensive care.[2] In a Brazilian cohort, in which 254 patients were included, 59.4% of patients admitted to an Intensive Care Unit (ICU) had corneal injury.[3]

As well as corneal injury, other ocular alterations also have a high incidence in critically ill patients. A study revealed that more than 70% of the 106 patients assessed developed ocular hyperemia.[4] Another study indicated lagophthalmia as the main ocular alteration in the ICU.[3] In a cohort, conducted in intensive care, it was demonstrated that blinking less than five times per minute substantially increased the chances of developing a corneal injury.[4] Such conditions are directly related to lubrication, maintenance and eye protection mechanisms, which are sometimes compromised in critically ill patients.[5-7]

Other risk factors for corneal injury, such as the use of an orotracheal tube (OTT), tracheostomy (TCT), mechanical ventilation (MV), high end-expiratory pressure (PEEP), use of sedatives, muscle blockers, antihypertensive angiostensin-converting enzyme (ACE) inhibitors, antibiotics, anesthetics, vasoconstrictors, benzodiazepines, in addition to surgeries, volume loss, are strongly associated with the appearance of ocular alterations.[4,5,7] Hence, critically ill patients are constantly vulnerable to eye damage and ophthalmic adverse events.

The losses generated in patients' physical, emotional and social scope are considerable, since the ocular impairment can prolong length of hospitalization and cause more serious complications, such as vision loss, postponing hospital discharge and directly affecting their daily and work activities.[1,5]

If the corneal injury problem is not identified early, the event, although preventable, will continue to occur. Implementation of control measures, through simple and effective strategies, such as risk factor assessment, eye inspection, eye hygiene and the use of lubricating eye drops, can control the incidence rates of this event and promote care free of ophthalmic damage. This situation is aggravated, since the injury to the cornea can remain silent in the case of critically ill patients. Therefore, the urgency of traceability regarding the possibility of developing a corneal injury is emphasized, through the identification of risk factors.

By producing a scope of knowledge about risk factors for corneal injury, this study intends to support nursing care, planning and implementation of

screening, control and prevention measures for this condition. Considering that the nursing team directly assists patients 24 hours a day, it is strategic that professionals have knowledge capable of controlling risk factors and managing potential adverse events.

Considering corneal injury as a prevalent, current and relevant problem that manifests significant repercussions for patients who occupy an ICU bed, this study aims to: identify the incidence of corneal injury in patients hospitalized in the ICU and associate the main risk factors with the occurrence of corneal injury in patients hospitalized in the ICU.

Methods

This research was guided by the STROBE Statement - Checklist of items that should be included in reports of cohort studies. This is a cohort study carried out in a private hospital with the Joint Commission International (JCI) seal of accreditation par excellence, located in the city of Rio de Janeiro. Currently, the ICU, located on the second floor of the hospital, has eight active beds, mostly represented by elderly patients, with some previous respiratory impairment, such as asthma and Chronic Obstructive Pulmonary Disease (COPD), arising from the emergency. The unit also receives patients transferred from other institutions and other sectors of the hospital. The sample calculation was 40 patients, which generated 454 observations with a maximum error of 5% and a confidence level of 95%, based on population size in the last three months prior to the survey. It is noteworthy that the observations were made on subsequent days throughout the hospitalization period. The cohort was conducted from December 2019 to February 2020.

Patients over 18 years of age admitted to the ICU during the data collection period and who did not present previous corneal injury, assessed using the 1% Sodium Fluorescein Test,[8,9] who remained in the unit for more than 48 hours, considering this is the minimum time for the appearance of the referred injury, were included The 1% Sodium Fluorescein Test was performed daily by a trained intensive care nurse and an ophthalmologist (gold standard), lasting approximately four to five minutes. A nurse performed the test and, in the presence of any alteration, an ophthalmologist performed a new test. Under dim light, a drop of 1% sodium fluorescein was instilled into each eye, and after 1 minute the patients' cornea was assessed with the aid of an ophthalmoscope under cobalt light. The data were recorded in the data collection instrument.

In order to detect the risk factors: hyperemia, eyelid edema, chemosis (observation of conjunctival edema), eye blinking less than five times per minute and ocular dryness, a physical examination of the eye was performed at the bedside, with emphasis on inspection and palpation for the following findings: presence of dilated vessels, abnormal accumulation of fluid in the eyelid region, observation of conjunctival edema, number of times patients blinked in a period of one minute (with the aid of a stopwatch) and tear film disruption (through the 1% sodium fluorescein test), respectively. These observations, performed daily, were guided by the data collection instrument. The data collection instrument was based on scientific evidence considering the main risk factors for corneal injury in the ICU, being didactically organized into three chunks: sociodemographic data, data extracted from medical records and direct observation of patients at the bedside.[1,3,7] Thus, a database was created using Microsoft Excel® 2007, and subsequently submitted to descriptive analysis using the Statistical Package for Social Science (SPSS), version 22.0.

In order to characterize patients, a descriptive analysis of results of the variables was performed using frequency distributions with the proportions of interest and calculation of appropriate statistics for quantitative variables (hospital stay, length of ICU stay, time to appearance of corneal injury, age, Richmond agitation and sedation scale (RASS), Glasgow coma scale (Glasgow), room temperature), i.e. minimum, maximum, mean, median, standard deviation and coefficient of variation (CV). The distribution variability of a quantitative variable was considered low if <0.20; moderate if 0.20≤ <0.40;

and high if ≥0.40. Sedated patients have a diminished and eventually latent blink due to pharmacological sedation. However, this condition does not prevent the observation of the palpebral reflex count (eyeblink rhythm). The institutional protocol recommends the application of RASS together with the Glasgow Coma Scale (Glasgow) for the assessment of ICU patients, due to the profile of neurological impairment of these patients.

The prevalence and incidence of risk factors, as well as the incidence of corneal injury, were estimated individually using absolute and relative frequency. The hypothesis of normal distribution was verified by the Shapiro-Wilk test. In all quantitative variables, the hypothesis of normality was rejected, and for ordinal variables, the comparison of two independent groups was performed using the non-parametric Mann-Whitney test. More than two independent groups were compared by Analysis of Variance (ANOVA), in the case of normality, or by the Kruskall-Wallis test, in case the variable did not follow a normal distribution in at least one of the groups. To verify the association between two qualitative variables (gender, origin, main complaint, main diagnosis, previous disease, presence of respiratory infection, drug therapy, organ failure, hyperemia, eyelid edema, eyelid closure, eye blinking, ocular exposure area, conjunctival edema, loss of eyelid muscle tone, non-invasive ventilation, nasal catheter, macronebulization, invasive mechanical ventilation (IMV), endotracheal tube (ETT), TCT and OTT fixation), including the association of corneal injury with qualitative factors, the chi-square test or Fisher's exact test was used in cases of inconclusive chi-square. The statistical measure used to estimate the risk was the Odds Ratio (OR). All discussions about the significance tests were performed considering a maximum significance level of 5% ($p<0.05$).

The analysis of survival time until corneal injury was investigated by the Survival analysis curve, mean and median of survival time estimated by the Kaplan Meier method. The research participants were instructed about the purpose of the study and signed the Informed Consent Form, and if they had any incapacity or liability, the legal guardian signed it. The study met the ethical criteria for research involving human beings, approved under Opinion 3,523,713 of 08/21/2019 and CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 13942519.0.0000.5238).

Results

Of the 40 patients, 47.5% (n=19) were female and 52.5% (n=21) were male, with a predominant age range between 70 and 90 years (65.0%; n=26). With the majority coming from the emergency sector (77.5%; n=31), they remain from two to seven days in the ICU (70.0%; n=28), under an average temperature greater than 20°C and less than 23°C (70.0%; n=28), presenting as main comorbidities vascular disease (60.0%; n=24) or heart disease (52.5%; n=21), Glasgow greater than 13 (65%; n=26) and initial RASS value 0 (77.5%; n=31). All major complaints or diagnoses had a frequency of less than 50%. Most were using antimicrobials (70.0%; n=28), antihypertensives (70%; n=28), sedatives (60.0%; n=24) and diuretics (52.5%; n=21) and were under ventilatory support (92.5%; n=37). Regarding the risk factors observed during the follow-up of ICU patients, according to Table 1, the occurrence of ocular hyperemia was typical, which occurred in 57.5% (n=23) of patients. Other changes also found were partial eyelid closure (45%; n=18), eyelid edema (42.5%; n=17), conjunctival edema (35%; n=14), blinking less than five times a minute (32.5%; n=13) and local dryness (25%; n=10). Corneal injury, the main outcome of this study, affected 20% (n=8) of patients.

Table 1. Risk factors for corneal injury identified in patients admitted to an Intensive Care Unit

Risk factors observed in the follow-up period	af(rf) n(%)
Ocular hyperemia	23(57.5)
Partial eyelid closure	18(45.0)
Eyelid edema	17(42.5)
Conjunctival edema	14(35.0)
Blinking less than 5 times per minute	13(32.5)
Dryness	10(25.0)

af – Absolute frequency; rf– Relative frequency

Regarding risk factors, data from Table 2 showed the following factors significantly associated with corneal injury, such as blinking less than five times, partial eyelid closure, hyperemia, eyelid edema, conjunctival edema, dryness, Glasgow < 13, use of sedative, use of bronchodilator, use of TCT device and use of IMV.

Table 2. Presentation of association tests between the variables of interest and corneal injury

Risk factor	Factor frequency n=40 f(%)	Corneal injury in the group where the factor is absent f(%)	Corneal injury in the group where the factor is present f(%)	p-value
Moderate or severe injury (Glasgow < 13)	14(35.0)	1(3.8)	7(50.0)	0.001*
Medication administered during the observation period				
Antibiotics	28(70.0)	1(8.3)	7(25.0)	0.396[a]
Antihypertensives	28(70.0)	3(25.0)	5(17.9)	0.677[a]
Sedatives	24(60.0)	0(0.0)	8(33.3)	0.013[a]
Diuretics	21(52.5)	6(31.6)	2(9.5)	0.120[a]
Bronchodilators	19(47.5)	1(4.8)	7(36.8)	0.017[a]
Tricyclic antidepressants	16(40.0)	3(12.5)	5(31.2)	0.229[a]
Vitamins	13(32.5)	4(14.8)	4(30.8)	0.400[b]
Use of TCT	12(30.0)	2(7.1)	6(50.0)	0.005[a]
Respiratory support				
Nasal cannula	18(45.0)	7(31.8)	1(5.6)	0.054[a]
Macronebulization	15(37.5)	4(16.4)	4(26.7)	0.444[a]
Invasive mechanical ventilation	12(30.0)	1(3.6)	7(58.3)	<0.001[a]
Ocular changes				
Blinking less than 5 times	13(32.5)	0(0.0)	8(61.5)	<0.001[a]
Partial eyelid closure	18(45.0)	1(4.5)	7(38.9)	0.014[a]
Hyperemia	23(57.5)	0(0.0)	8(34.8)	0.013[a]
Eyelid edema	17(42.5)	1(4.3)	7(41.2)	0.006[a]
Conjunctival edema	14(35.0)	1(3.8)	7(50.0)	0.001[a]
Dryness	10(25.0)	3(10.0)	5(50.0)	0.015[a]

[a]Fisher's exact test; [b]Chi-square test

It is observed that patients with corneal injury presented significantly lower Glasgow than patients without corneal injury and that the length of hospitalization factor was associated with the appearance of corneal injury, as evidenced in Table 3. To investigate factors associated with corneal injury, only relevant factors with frequencies greater than 20% were considered in the overall sample. Corneal injury was significantly associated with the following factors: moderate or severe injury according to Glasgow less than 13, use of sedative, bronchodilator, TCT and IMV device, blinking less than five times per minute, partial eyelid closure, hyperemia, edema palpebral edema, conjunctival edema and dryness.

Table 3. Odds Ratio (OR) of risk factors associated with corneal injury

Risk factor	Factor frequency n=40 f(%)	Corneal injury in the group where the factor is absent f(%)	Corneal injury in the group where the factor is present f(%)	p-value	(95%) CI	OR
Glasgow< 13	14(35.0)	1(3.8)	7(50.0)	0.001[a]	2.6-289.79	25
Sedatives	24(60.0)	0(0.0)	8(33.3)	0.013[a]	-	-
Bronchodilators	19(47.5)	1(4.8)	7(36.8)	0.017[a]	2.2-197.8	11.7
Use of TCT	12(30.0)	2(7.1)	6(50.0)	0.005[a]	2.1-81.0	13
IMV	12(30.0)	1(3.6)	7(58.3)	<0.001[a]	3.8-377.9	37.8
Blinking less than 5 times per minute	13(32.5)	0(0.0)	8(61.5)	<0.001[a]	-	-
Partial eyelid closure	18(45.0)	1(4.5)	7(38.9)	0.014[a]	1.4-122.9	13.4
Hyperemia	23(57.5)	0(0.0)	8(34.8)	0.013[a]	-	-
Eyelid edema	17(42.5)	1(4.3)	7(41.2)	0.006[a]	1.7-142.5	15.4
Conjunctival edema	14(35.0)	1(3.8)	7(50.0)	0.001[a]	2.6-238.0	25.0
Dryness	10(25.0)	3(10.0)	5(50.0)	0.015[b]	1.3-50.3	9.0

[a]Fisher's exact test; [b]Chi-square test; IC – Confidence Interval; OR – Odds Ratio

Length of hospitalization was associated with corneal injury. It can be observed that two days after admission, 100% of patients had no corneal injuries. After five days, it was estimated that 94.1% of patients did not present this type of injury. At 44 days in the ICU, it has been estimated that 53.0% of ICU patients survive without corneal injury, and so on, to the point where, at 65 days in the ICU, only 13.2% of patients survive without corneal injury. This finding can be identified in Chart 1 by the Kaplan-Meier survival curve until the development of corneal injury.

Discussion

The present study made it possible to identify factors associated with corneal injury in 20% of patients admitted to the ICU. Patients' clinical and therapeutic conditions were presented as risk factors for injury appearance, especially Glasgow <13, use of sedative, use of bronchodilator, use of TCT

Chart 1. Kaplan-Meier survival curve to corneal injury

N	Time t(days)	Status	Cumulative survival ratio over time		Cumulative number of cases of corneal injury at time t	Remaining number of cases
			Estimate (%)	Standard error		
1	2.000	0	100	.	0	39
23	4.000	0	100	.	0	17
24	5.000	1	94.1	0.057	1	16
28	6.000	1	86.9	0.087	2	12
32	12.000	1	77.2	0.120	3	8
34	21.000	1	66.2	0.145	4	6
36	44.000	1	53.0	0.166	5	4
37	60.000	1	39.7	0.169	6	3
38	63.000	1	.	.	7	2
39	63.000	1	13.2	0.122	8	1
40	65.000	0	13.2	0.122.	8	0

device and use of IMV, which was also found in studies by other authors.[3,4,7,10]

The incidence of corneal injury was significantly higher in the subgroup that used a bronchodilator (p-value=0.017). In the group that did not use bronchodilators, the incidence was 4.8%. In the group that used bronchodilators, corneal injury occurred significantly more frequently in 36.8% of cases. It is estimated that the chance of a patient who uses a bronchodilator to have a corneal injury is 11.7 times greater than a patient who does not use such a drug. In a Brazilian cohort of 254 patients, bronchodilator use was configured as a strong association for this type of injury.[3]

The incidence of corneal injury was also associated with the use of TCT device (p-value=0.005), with an incidence of 7.1% in patients who used this device. The chance of developing a corneal injury increased substantially when using TCT, being 13.0 times higher when compared to patients who do not use a device, corroborating the findings identified in the literature.[7,11]

For the group under IMV, the incidence of corneal injury was significantly higher (p-value<0.001). In the group that did not use IMV, the incidence of corneal injury was only 3.6%. In the group that used IMV at some point, corneal injury occurred significantly more frequently in 58.3% of cases. Patients using IMV are 37.8 times more likely to develop this type of injury. This finding corroborates the literature that identifies mechanical ventilation as one of the highest risk factors for the development of eye injuries in the ICU. Mechanically ventilated patients have a high propensity to develop corneal injury. For all patients using mechanical ventilation or sedated, preventive measures should be adopted for corneal injury.[12-14]

Tracheostomized patients using IMV are under sedation for the most part, which reduces ocular lubrication. End-expiratory pressure (PEEP) above physiological values can increase eye pressure, damaging the cornea. Another factor that contributes to ocular damage is the fixation of the tube too tight, as it hinders venous return and leads to eyelid/conjunctival edema. Moreover, they are patients who need to be aspirated, sometimes in an open system, which promotes bacterial translocation, where microorganisms through the aspirated content can be transported from the respiratory tract mucosa to another mucosa, leading to deposition in the ocular mucosa when not protected, resulting in an inflammatory/infectious process.[7,11,12]

It should be noted that intensive care patients sometimes have a compromised eyelid corneal reflex, significantly contributing to ocular changes. Eyelid edema can lead to impaired eyelid closure and, consequently, eye exposure, which makes it more vulnerable to eye damage. In a cohort of 254 ICU patients, patients were 1.86 times more likely to develop punctate corneal injuries when compared to patients without edema.[11] Chemosis, in addition to preventing complete eyelid closure, also makes lubrication difficult, contributing to the occurrence of ocular damage. Its incidence ranges from 9 to 80% of ICU patients.[12]

In the present study, eyelid and conjunctival edema (chemosis) increased, respectively, 15.4 and 25 times the chance of a patient presenting corneal

injury. These ocular changes are configured as strong risk factors for corneal injury. It is believed that the absence of a bundle to prevent ocular changes may have contributed to this finding. Prevention measures for corneal injury should be adopted since the implemented therapy itself, such as the use of endotracheal fixator and pronation, favors the appearance of eyelid edema and chemosis.[2,11]

Lagophthalmia is an alteration that also interferes with ocular protection and lubrication mechanisms, making it more susceptible to ophthalmic diseases. Ocular exposure leads to an acceleration in the process of tear film evaporation, which is one of the causes of ocular dryness.[2] A study with 230 patients identified an incidence of lagophthalmia of 49.2%, 53% with ocular dryness, and 54.3% evolved with corneal injury. Lagophthalmia was the main contributor to changes in the ocular surface, and dryness was an important factor for the appearance of corneal changes.[1]

The use of sedation, neuromuscular blockers and routinely used medications in intensive care can also lead to lagophthalmia. In this study, logophthalmos was related to the development of corneal injuries, with 13.4 times more chances of developing the injury when compared to patients with complete eyelid closure. Thus, performing ocular assessment and using occluders that perform passive eyelid closure are simple measures that have positive outcomes and a reduction in the incidence of corneal injury. Another ocular alteration that is one of the main risk factors for the development of injuries on the ocular surface is dryness. In intensive care settings, sometimes there is a disorder in the mechanisms responsible for lubrication and ocular protection, compromising the tear film, and, consequently, enabling the appearance of a corneal injury.[1-3]

In patients who did not present dryness, the incidence of corneal injury was 10.0%. In the cases that presented dryness, 25% of the population studied, the injury occurred with a significantly higher frequency in 50.0% of cases. It is estimated that the chance of a patient with dryness having a corneal injury is 9.0 times higher compared to those without dryness. In a cohort of 206 intensive care patients, 78.6% had a decrease in tear film, 52.4% were diagnosed with ocular dryness and 47.6% had a nursing diagnosis of risk for dry eye.[7] Patients in this study were prescribed the use of lubricating eye drops four times a day, which may have contributed to a lower incidence of ocular dryness when compared to other studies. From which it can be inferred that the use of ocular lubricant is an effective measure in the fight against corneal injury. Corneal injury was also associated with blinking less than five times, in agreement with a study carried out in an ICU in Brazil, which identified a 45.46-fold increase in the chances of corneal injury in patients who blinked their eyes less than five times a minute.[3] The absence or deficiency in eye blinking makes the eye susceptible to environmental aggressions due not only to exposure, but to the deficit in ocular lubrication mechanisms. In the absence of protective measures, such as the use of ocular lubricant, ocular hygiene, application of occluders that allow complete eyelid closure, the cornea will be prone to injury. Patients who developed hyperemia had a significantly higher incidence of corneal injury (34.8%). Hyperemia, dilation of blood vessels that generates redness of the conjunctiva, varies from superficial to deep according to its extent, number of dilated vessels and hyperemic area.[6] This ocular alteration is a consequence of failures to maintain the mechanisms that lubricate the eyes.[6,13] In a cross-sectional study in the ICU, hyperemia was present in more than 70% of patients observed.[6] In the presence of hyperemia, the chances of ocular dryness increased by 2.94 times for the right eye and 3.2 times for the left eye in a cohort of 206 patients, where more than 50% of participants had hyperemic eye.[7]

According to the findings of this study, it is estimated that after 65 days in the ICU, only 13.2% of patients survive without corneal injury, that is, the length of stay is a determining factor for injury. A cohort study corroborates this finding, which showed a close relationship between the length of hospital stay and the appearance of ocular alterations, justified by the longer exposure to risk factors and neglected eye care.[7] The main risk factor for corneal injury in intensive care patients is the de-

ficiency or absence of eye lubrication.[7,8] Preventing dry eye is to mitigate the risk of corneal injury. All the factors that were associated with corneal injury in the present study are configured as changes that compromise lubrication, maintenance and ocular protection mechanisms. In this regard, regular implementation of strategies aimed at eye care, including continuing education of health professionals focused on modifiable risk factors for corneal injury, use of hypoallergenic tape for eyelid closure, application of artificial tears, use of lubricating gel/ointment and use of a humid chamber are fundamental in intensive care settings.[14-16]

From simple care, corneal injury can be prevented. In this sense, the nursing team role in bedside care should be considered, making it strategic that the mapping of risks for corneal injury, the implementation of protocols that advocate continuous assessments and the application of prevention and control measures are part of the Nursing Process. Like any cohort study, one of the limitations of this research was the financial cost and the loss of patients that made up the sample, whether due to death or hospital discharge.

Conclusion

Corneal injury, despite being a preventable event, had an incidence of 20%. Hyperemia, lagophthalmos, conjunctival edema, eyelid edema, eye blinking less than five times a minute and ocular dryness were risk factors for this type of injury. Furthermore, the therapy itself competes as a risk factor for corneal injury, considering Glasgow <13, use of sedatives and bronchodilators, use of TCT and IMV. The implementation of stabilization measures favors the development of ocular alterations, since, in different ways, they alter the physiological mechanisms of ocular maintenance and protection. The intervention of nursing team and other professionals is necessary in detecting risk factors as well as in early identification of the main ocular alterations that precede the corneal injury. The data make it clear that patients hospitalized in an intensive care unit are susceptible to the appearance of ocular alterations and that this impairment is due to multiple variables. Ocular changes detected in the early stages have a more favorable prognosis. Thus, it is suggested, in addition to the adoption of preventive measures, the performance of an interdisciplinary team in the follow-up of these patients with the implementation of care based on risk factors and control of intensive care settings. Therefore, nursing practice can provide for implementing care practices aimed at reducing risks related to the unwanted appearance of corneal injuries, and thus contain and mitigate the occurrence of adverse events and preventable incidents in intensive care settings.

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Collaborations

Santos QF, Stipp MAC, Góes FGB, Oliveira FA and Paes GO declare that they contributed to the study design, data analysis and interpretation, article writing, relevant critical review of the intellectual content and approval of the final version to be published.

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