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RESEARCH ARTICLE

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Development of the Critically Ill Patient Eye Assessment Scale: A study of validity and reliability

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Abstract

Background: Eye care and assessment of the eye are critical for intensive care patients to prevent ocular complications like dry eye and corneal abrasion. However, there is no measurement tool developed for intensive care patients that examines the risks of ocular complications.

Aim: This study aims to develop a valid and reliable tool, the Critically Ill Patient Eye Assessment Scale (CIPEAS), for assessing the risk of ocular complications and determining the frequency of eye care.

Study design: This study is an instrument development study. This methodological study was conducted with 151 intensive care patients in Turkey between March 2022 and March 2023. Data were collected with the Patient Information Form and the CIPEAS. The data were evaluated using SPSS 23 statistical software. AMOS 21 was used to verify the structure obtained with CFA. Exploration and confirmatory factor analyses were performed to determine the scale's factorial structure.

Results: As a result of exploratory factor analysis, a six-item scale consisting of a single dimension was obtained, explaining 59.993% of the total variance. The fit indices of the scale were found to be $\chi^2/SD = 2.653$, GFI = 0.954, RMSEA = 0.075, NFI = 0.949 and CFI = 0.967. Cronbach's alpha of the scale was found to be 0.862.

Conclusion: The CIPEAS was found to be a valid and reliable assessment tool.

Relevance to Clinical Practice: The Critically Ill Patient Eye Assessment Scale is a valid and reliable tool for Turkish society for assessing the risk of ocular complications. It is recommended for various national and international studies with different patients in intensive care units.

KEYWORDS

eye care, intensive care patients, nursing care, reliability, validity

1 | INTRODUCTION

Intensive care unit (ICU) patients face numerous complications because of changes in their state of consciousness and treatment practices. One of them is ocular complications, which develop

Elif Sözeri Öztürk and Kamile Kirca are at present address different from where the work was conducted

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because of changes in the protective mechanisms of the eye.[1,2] Keratoconjunctivitis sicca (dry eye syndrome), corneal epitheliopathy, superficial corneal abrasions, chemosis, conjunctivitis, keratitis, corneal ulcers and corneal perforations are some of the complications.[3,4] It is known that various risk factors affect the development of these complications. The patient's age, level of consciousness, administration of sedation, whether they are on ventilator support and pre-existing health conditions are some of the risk factors.[1,4–6]

It was determined that factors such as long-term hospitalization and sedation increase the risk of developing corneal damage. Corneal damage rates vary between 3.3% and 22% in ICU patients, and this rate reaches 60% in patients with sedation for more than 48 h.[3,4,7] In their study conducted with ICU patients in Turkey, Öncül and Yektaş[8] concluded that dry eye developed in almost one out of every three patients in the ICU, and the rate of development was higher in patients who were treated with mechanical ventilators and sedated. It is stated that ocular surface disorders in ICU patients usually occur within 48 h to a week after the patient's hospitalization. Oh et al.[6] determined that eye problems developed in ICU patients an average of 6.8 days after admission to the ICU. Intensive care nurses primarily strive to stabilize the patient's vital body functions. Therefore, eye care is often neglected, which increases the risk of developing ocular complications.[1,7] In terms of nursing care practices, eye care is often considered less significant compared with other care applications, and eye consultation is requested only when the complications become visibly apparent.[9] Therefore, the issue of providing eye care and detecting ophthalmological problems among nurses remains in the background.[10,11] However, with the protocols and guidelines developed in this regard, the risk of developing ocular complications in ICU patients can be reduced.[4]

In a study conducted by Narmawala and Jani[7] over 5 months with ICU patients, a decrease ranging from 43.8% to 33% was observed in exposure keratopathy, particularly after providing training to health professionals, including nurses, to reduce risks related to eye health, and the importance of creating an eye health algorithm for patients was emphasized. Demirel et al.[10] concluded that corneal damage was reduced in ICU patients with the training given to health professionals. In the ICU, the cost of treatment increases with complications that develop because of improper or disruptive eye care, and the workload of the medical team responsible for care and treatment increases. Therefore, it is necessary to prevent complications before they develop. To prevent complications, the risk of complications should be determined. According to the risk situation, having a careful and correctly applied intervention protocol can prevent the vast majority of ocular complications.[4] Although there are very limited studies on ICU patients and eye care, it is evident that the existing studies generally focus on the practices and knowledge level of nurses about eye care.[1,12–16]

The ICU nurse plays a significant role in preventing and monitoring eye problems. However, the issue of how and how often eye care practices should be performed is not clear. The risk level and frequency of care needs of patients for ocular complications, which is a common risk for ICU patients, may vary. Therefore, there is a need for measurement tools that can evaluate patients objectively to determine the risk of ocular complications that may arise from the differences between the individual characteristics of the patients and their clinical conditions. When the relevant literature is examined, there is no measurement tool developed for ICU patients that examines the risks of ocular complications. The development of such a measurement tool will not only identify ICU patients at risk for potential ocular complications but will also facilitate the planning of eye care interventions, ultimately enhancing the overall quality of care.

What is known about the topic

- Intensive care patients constitute a risk group in terms of developing ocular complications.
- There is no valid and reliable measurement tool in the literature to evaluate the risk of ocular complications.

What this paper adds

- The CIPEAS is a valid, reliable measurement tool with efficient psychometric characteristics for determining the risk of ocular complications in patients in intensive care.
- It is recommended to use and test the CIPEAS with different national and international samples.

1.1 | Aims and research questions

This study was carried out to develop a valid and reliable measurement tool for the assessment of the risk of ocular complications in ICU patients. The study sought answers to the following questions:

- Is the scale developed for the assessment of ocular complication risk in the ICU a valid scale?
- Is the scale developed for the assessment of ocular complication risk in the ICU a reliable scale?

2 | METHOD

2.1 | Design

The study was designed methodologically. This study was carried out to develop a valid and reliable measurement tool for the assessment of the risk of ocular complications in ICU patients.

2.2 | Setting and sample

The study was conducted between March 2022 and March 2023, with researchers visiting patients daily from 8:00 to 16:00 throughout

the period from admission to discharge from the ICU. The study population consisted of patients receiving treatment in the ICUs at Bilecik Training and Research Hospital. The sample of the study consisted of 151 patients who met the inclusion criteria from the determined population. In scale development studies, it is generally recommended to include 5–10 times the number of items in the draft scale in the sample size calculation.[17,18] In this study, the data collection process was completed with a total of 151 patients included in the study.

2.2.1 | Inclusion criteria

- Receiving care and treatment in the ICUs of Bilecik Training and Research Hospital.
- Being over the age of 18.
- Having spent more than 48 h in the unit, as ocular surface disorders usually occur within 48 h to 1 week.
- Not having primary ocular disease.
- Volunteering to participate in the study (obtaining consent from the conscious patients themselves or from the relatives of the unconscious or sedated patients).

2.2.2 | Exclusion criteria

- Being under the age of 18.
- Spending less than 48 h in the unit.
- Having primary ocular disease.
- Refusing to participate in the study (not permitted by the patient's relative).

2.3 | Data collection tools

The study data were collected using the Patient Introductory Information Form and the Critically Ill Patient Eye Assessment Scale (CIPEAS) developed following the purpose of the study.

2.3.1 | Patient introductory information form

The form was prepared in line with the literature to obtain information about the sociodemographic and clinical characteristics of the patients participating in the study. The form includes questions such as age, gender, diagnosis, treatments, date of admission to the ICU and sedation status of the patients.[1,4,5,16,19]

2.3.2 | Critically Ill Patient Eye Assessment Scale

The scale, which was developed to assess the eyes of ICU patients, consists of six items. While preparing the scale, researchers with intensive care experience conducted a comprehensive literature review to identify parameters influencing eye care in ICU patients, and a scale item pool including 11 items was created.[1–5,16,19] The scale was designed as a four-point Likert-type scale, scored within the range of 1–4 points, and structured as a single dimension. Each parameter was evaluated separately as Normal = 1 point, Mild = 2 points, Moderate = 3 points and Severe = 4 points. There are no reverse-scored items on the scale. The sum of the scores obtained for each parameter gives the total CIPEAS score. The score that can be taken from the scale varies between 6 and 24. CIPEAS indicates that 6 points = no risk, 7–12 points = light risk, 13–18 points = moderate risk and 19–24 points = serious risk. The higher the total score obtained from CIPEAS, the higher the risk of developing ocular complications.

2.4 | Data collection process

The data were collected in three phases.

1. Creation of scale items: The parameters of CIPEAS were prepared based on the literature and researchers' observations during their experiences in intensive care nursing.[1–5,9,17,19] Expert opinion: After the scale items were created, expert opinions were taken by 11 specialists (4 intensive care nurses, 1 ophthalmology specialist, 2 intensive care physicians and 4 academic nurses). Experts evaluated the scale items in terms of comprehensibility, purposefulness, distinctiveness and cultural appropriateness, and expressed their opinions. Expert opinions were evaluated on a four-point Likert-type scale with the items 'very suitable (4)', 'appropriate but minor changes are required (3)', 'the item needs to be made appropriate (2)' and 'not suitable (1)' and a form was used to enable them to write their opinions and suggestions regarding each item. In line with the evaluations, the content validity was determined according to the Davis technique. According to this technique, the content validity ratio for an item is determined by dividing the number of experts who selected '3' or '4' by the total number of experts, and a value >0.80 is considered sufficient.[20] In our study, the status of the items was evaluated according to their validity rate in line with expert opinions. After the necessary improvements were made to the items in line with the recommendations of the experts, the content validity of the scale was examined. The scale content validity rate was found to be 0.967.
2. Implementation: A pilot study was conducted by applying CIPEAS to 10 patients with similar (homogeneous) characteristics to the sample group. Data collection forms were filled in by the researcher in approximately 20 min.

2.5 | Data analysis

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to provide evidence for the construct validity of the scale. For EFA, the study data were analysed using the

SPSS 23.0 statistical software package. Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were applied to determine whether the data were suitable for principal components analysis. SPSS AMOS 21.0 statistical software was used for CFA, and the suitability of the model revealed in EFA was checked. Chi-square goodness (χ^2), root mean square error of approximation (RMSEA), incremental fit index (IFI), comparative fit index (CFI), and goodness-of-fit index (GFI) values were used to evaluate this fit. Cronbach's alpha coefficient was calculated for the reliability of the scale.

2.6 | Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. After the approval of the Bilecik Şeyh Edebali University Non-Interventional Clinical Research Ethics Committee (10.03.2022, E-10333602-050.01.04-82 972), institutional permission was obtained from the hospital for conducting the study. Consent was obtained from the patients or their relatives. All patients were included in the study voluntarily.

3 | RESULTS

The mean age of the patients included in the study was 73.95 ± 12.54 years. It was determined that 56.3% of the patients included in the study were male, and 56.3% were over 74 years old. It was determined that 23.8% of the patients were in the ICU because of general condition disorder and 21.9% because of pulmonary oedema. While 52.3% of the patients received mechanical ventilator support, the mean APACHE II and Glasgow coma scores were 22.75 ± 8.44 and 10.35 ± 2.5, respectively.

The findings on the psychometric properties of the CIPEAS are presented below.

3.1 | Validity analysis of the CIPEAS

3.1.1 | Content validity

The content validity index (CVI) was calculated to determine the content validity of the developed scale. According to expert opinions, the vast majority of items were rated as 'highly suitable' and 'extremely suitable'. When the expert opinions were analysed, the CVI for the scale was found to be 0.967. CVIs are expected to be above 0.80.[21] With a significance level of $\alpha = 0.05$ and considering the opinions of 11 experts, the CVI was determined to be 0.967.

3.1.2 | Construct validity

In construct validity, the assessment involves determining how well a measurement instrument, which aims to measure a phenomenon that is theoretically described but challenging to directly observe, achieves its purpose and accurately measures the intended phenomenon.[22]

3.2 | Exploratory and CFA

Before exploratory factor analysis, the KMO test was applied to determine whether the sample size was suitable for factor analysis. As a result of the analysis, the KMO value was determined to be 0.848. Based on this result, it was concluded that the sample size is 'sufficient' for conducting factor analysis. While values between 0.5 and 1.0 are considered acceptable, values below 0.5 are an indication that factor analysis is not suitable for the dataset in question.[23] In addition, when the results of Bartlett's test of sphericity were examined, it was determined that the chi-square value obtained was acceptable ($\chi^2(15) = 457.920$, $p < .05$).

In the EFA conducted to reveal the factor pattern of the scale, five items were removed from the scale because of their low factor load, and the remaining six items were collected in a single dimension (Figure 1). These factors explain 59.993% of the total variance. In single-factor patterns, it is considered sufficient for the explained variance to be above 40%.[24]

When the correlations between the variables were examined, the factor loads of the items were above 0.40 and all correlation relationships were significant. Because factor loads ranged from 0.013 to 0.299, the other five items were excluded from the scale.

According to the CFA, the six items constituting the scale were associated with a single-dimensional scale structure. The fit indices calculated for the scale were $\chi^2/SD = 2.653$, GFI = 0.954, RMSEA = 0.075, NFI = 0.949 and CFI = 0.967 (Table 1).

The mean values of the scores the scale parameters are given in Table 2. Accordingly, the critically ill patients' Glasgow Coma Scale mean score is 2.86 ± 1.04, breathing pattern mean score is 2.70 ± 1.17, duration of mechanical ventilation mean score is 1.48 ± 0.99, blinking frequency mean score is 2.72 ± 1.22, eyelid blink hygiene mean score is 1.68 ± 0.59 and Ramsay sedation mean score is 1.76 ± 0.88.

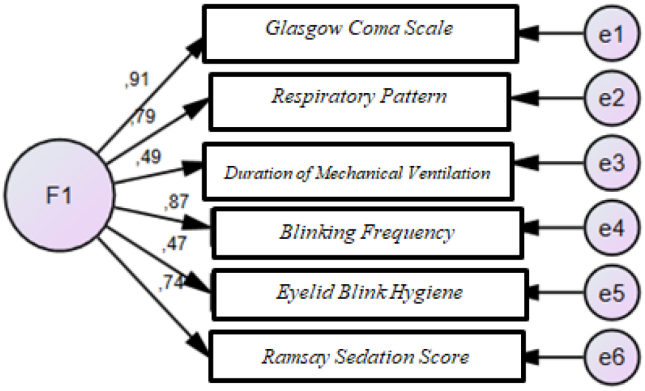

FIGURE 1 Model for single-factor confirmatory factor analysis of the scale.

TABLE 1 Results on the measurement model of the scale.

Factors	Expressions	Factor loadings	SE	*t* Values	*p* Values
F1	Glasgow Coma Scale	0.911	–	–	–
	Breathing pattern	0.787	0.076	12.423	***
	Duration of mechanical Ventilation	0.487	0.079	6.292	***
	Blinking frequency	0.872	0.074	14.951	***
	Eyelid blink hygiene	0.470	0.048	6.032	***
	Ramsay sedation score	0.740	0.065	11.202	***

***$p < .05$.

TABLE 2 Descriptive statistics of items.

	Minimum	Maximum	Mean	SD
Glasgow Coma Scale	1.00	4.00	2.86	1.04
Breathing pattern	1.00	4.00	2.70	1.17
Duration of mechanical ventilation	1.00	4.00	1.48	0.99
Blinking frequency	1.00	4.00	2.72	1.22
Eyelid blink hygiene	1.00	3.00	1.68	0.59
Ramsay sedation score	1.00	4.00	1.76	0.88

TABLE 3 Inter-item correlation matrix.

Expressions	Glasgow Coma Scale	Breathing pattern	Duration of mechanical ventilation	Blinking frequency	Eyelid blink hygiene	Ramsay sedation score
Glasgow Coma Scale	1.000	0.706	0.424	0.801	0.430	0.679
Breathing pattern		1.000	0.543	0.683	0.296	0.587
Duration of mechanical ventilation			1.000	0.390	0.250	0.294
Blinking frequency				1.000	0.416	0.636
Eyelid blink hygiene					1.000	0.412
Ramsay sedation score						1.000

TABLE 4 Item total statistics.

Expressions	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's alpha if item deleted
Glasgow Coma Scale	5.3642	14.313	0.825	0.723	0.806
Breathing pattern	5.5298	14.064	0.761	0.618	0.819
Duration of mechanical ventilation	6.7550	17.186	0.479	0.311	0.869
Blinking frequency	5.5166	13.518	0.784	0.683	0.814
Eyelid blink hygiene	6.5497	19.409	0.442	0.234	0.873
Ramsay sedation score	6.4437	16.008	0.680	0.517	0.836

3.3 | Reliability analysis of the CIPEAS

When the reliability of the scale was evaluated, it was found to be 0.862 for the overall scale, indicating a good degree of reliability. Cronbach's alpha values >0.60 indicate that the scales used are reliable. This shows that the internal consistency of the scale used in the study is good.

Inter-item correlation results are given in Table 3. It can be seen that the inter-item correlation coefficient varies between 0.250 and 0.801. Inter-item correlation values of 0.20 and lower indicate weak correlation. There is no value lower than 0.2 in the table.

Scale Mean if Item Deleted, Scale Variance if Item Deleted, Corrected Item-Total Correlation, Squared Multiple Correlation and Cronbach's Alpha if Item Deleted values of the items are presented in

Table 4. The total score correlation of all items in the scale is higher than 0.40. Additionally, in the scale we developed, if an item is removed from the scale, there is no change in the alpha coefficient that will affect the reliability.

4 | DISCUSSION

Patients admitted to the ICU need constant supervision and complex and professional care. Care services are mainly aimed at vital organs such as the respiratory, cardiovascular and nervous systems. However, patients in the ICU are exposed to conditions such as dry eyes, corneal epithelial ulcers and loss of blink reflexes, which can ultimately lead to the spread of infection, corneal perforation and even complications such as vision loss.[5] Ocular surface disease is prevalent in the intensive care population, and corneal epithelial defects develop in 20%–42% of the patients.[4]

The use of guidelines is recommended for the protection of the eye and the prevention of eye-related complications in ICU patients.[4,5] To carry out eye care practices effectively in ICU patients, it is necessary to evaluate the factors that will affect eye health and the risk status of the patients. ICU nurses play a significant role in assessing and maintaining patients' eye health in critical situations.[4,7] This study was planned because there is no assessment tool used for this purpose in the literature. Below, the findings regarding the validity and reliability of the CIPEAS are discussed.

The two most important and basic features that should be evaluated in a good assessment tool are validity and reliability. Validity is related to what a tool measures and how well it does it.[25] Content validity, one of the types of validity, is the degree to which a measurement tool has a sample of items suitable for the measured structure. This is a crucial procedure in scale development. The CVI is the most widely used index in quantitative evaluation.[26] As a result of the opinions received from 11 experts, the CVI of the scale developed in our study was found to be 0.967. It was stated that the acceptable CVI value should be at least 0.78 in studies where opinions are obtained from at least nine experts.[27] It can be stated that the CVI value of the scale is at the desired level.

The validity of the scale was tested using EFA and CFA. In our study, before the EFA, the KMO test was applied to determine whether the sample size was suitable for factor analysis. As a result of the analysis, the KMO value was determined to be 0.848. KMO values between 0.5 and 1.0 are considered acceptable.[28] Based on this result, it was concluded that the sample size is 'sufficient' for conducting factor analysis. The strength of the correlation can be measured with Bartlett's test of sphericity in SPSS.[27] In our study, when the results of Bartlett's test of sphericity were examined, the chi-square value obtained was acceptable ($\chi^2(15) = 457.920$, $p < .05$).

As a result of the EFA performed to reveal the factor pattern of the scale, a six-item scale consisting of a single dimension was obtained, explaining 59.993% of the total variance. It is accepted that the high variance explained is an indication that the relevant concept or structure is measured so well,[24] and in single-factor patterns, the explained variance above 40% is considered sufficient.[29] The fit indices used in CFA were χ^2, χ^2/SD, GFI, RMSEA, NFI and CFI.[30] In our study, the findings are as follows: $\chi^2/SD = 2.653$, $GFI = 0.954$, $RMSEA = 0.075$, $NFI = 0.949$ and $CFI = 0.967$. Acceptable values for fit indices are typically $3 < \chi^2/d < 5$, RMSEA <0.08, and GFI, NFI and CFI >0.90.[31,32] The results obtained show that the fit indices obtained from the scale are acceptable.

Reliability is related to the extent to which the measuring tool controls for random error.[22] In our study, Cronbach's alpha coefficient of the scale was found to be 0.862. Cronbach's alpha value was developed to provide a measure of the internal consistency of a test or scale, and it is expressed as a number between 0 and 1. Internal consistency refers to the extent to which all items in a test measure the same concept or structure, and are therefore related to the correlation of the items in the test to each other.[33] This shows that the internal consistency of the developed scale is good.

5 | LIMITATIONS

The limitations of the study are that the test–retest method cannot be applied because the daily assessment of the scale may be affected because of the change in the patients' conditions in the ICU and the study can only be generalized to the sample group. Another limitation is that there is no gold standard to evaluate ocular complications in intensive care patients, and the developed scale cannot be tested.

6 | IMPLICATIONS AND RECOMMENDATIONS FOR PRACTICE

ICU patients have a risk of developing ocular complications because of some risk factors such as level of consciousness, administration of sedation and whether they are on ventilator support. However, in terms of nursing care practices, eye care is often considered less significant compared with other care interventions, and eye consultation is requested only when the complications become visibly apparent. Therefore, the issue of detecting ophthalmological problems and providing eye care among nurses remains in the background. The CIPEAS is a valid and reliable measurement tool for Turkish society that will guide nurses in assessing ocular complications and deciding eye care in the ICU. It is believed that the CIPEAS will fill the gap regarding the assessment of the risk of ocular complications in ICUs. The development of such a measurement tool will not only identify ICU patients at risk for potential ocular complications but will also facilitate the planning of eye care interventions, ultimately enhancing the overall quality of care.

7 | CONCLUSION

Although eye care is often neglected in ICUs, intensive care patients constitute a risk group in terms of developing ocular complications.

However, there is no valid and reliable measurement tool in the literature to evaluate this risk. It is believed that the CIPEAS will fill the gap in this regard. It was concluded that the CIPEAS is a valid and reliable measurement tool in the evaluation of the eye in ICU patients, with its structure consisting of six items and a single dimension. It is considered that larger sample sizes and evaluation of validity and reliability in different intensive care patients may contribute to the usability of the scale. In addition, comparative and experimental studies on factors affecting eye care are recommended.

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DATA AVAILABILITY STATEMENT

Research data are not shared.

INFORMED CONSENT

Written approval was obtained from the Office of the Head Physician of the hospital and also from the participating patients' relatives.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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