Original Article

Development and Psychometric Properties of the Caring Behaviors of Operating Room Nurses Questionnaire during the COVID-19 Pandemic: A Mixed-Method Study

Reza Mohebbi Hozesorkhi[1], Saeed Babajani Vafsi[2], Mojgan Mohammadimehr[3], Mohammad Hassan Kazemi-Galougahi[4], Abbas Ebadi[5], Mahboobeh Afzal[6]

[1]Master of Perioperative Nursing, Aja University of Medical Sciences, Tehran, Iran, [2]Department of Operating Room Technology, Faculty of Paramedical Sciences, Aja University of Medical Sciences, Tehran, Iran, [3]Associated Professor, Department of Laboratory Sciences, Faculty of Paramedicine, Aja University of Medical Sciences, Tehran, Iran, [4]Department of Social Medicine, Faculty of Medicine, Aja University of Medical Sciences, Tehran, Iran, [5]Behavioral Sciences Research Center, Life Style institute, Baqiyatallah University of Medical Sciences, Tehran, IR Iran- Nursing Faculty, Baqiyatallah University of Medical Sciences, Tehran, IR Iran, [6]Department of Emergency Medicine, School of Paramedical, Aja University of Medical Sciences, Tehran, Iran

Address for correspondence:
Dr. Mahboobeh Afzal, Department of Emergency Medicine, School of Paramedical, Aja University of Medical Sciences, Tehran, Iran.
E-mail: afzal1391@yahoo.com

Access this article online

Website: https://journals.lww.com/jnmr

DOI: 10.4103/ijnmr.ijnmr_215_22

Quick Response Code:

Abstract

Background: Considering the threats in the operating room during the COVID-19 pandemic, the optimal care and safety of the operating room nurses should be maintained when performing surgery on an acute respiratory patient. It seems necessary to design a tool to measure the caring behaviors of operating room nurses. Therefore, the present study was conducted with the aim to design a valid and reliable tool for measuring the caring behavior of operating room nurses during the COVID-19 pandemic. **Materials and Methods:** In this sequential, exploratory, mixed-method study, the designing and psychometric evaluation of the caring behaviors of operating room nurses questionnaire during the COVID-19 pandemic were performed in qualitative and quantitative phases from August 2021 to July 2022 in Aja University of Medical Sciences, Iran. In the qualitative phase, the concept of caring behaviors of operating room nurses was explored through interviews and a literature review based on online searches. In the quantitative phase, validity (face, content, and construct), and reliability of the questionnaire were evaluated. **Results:** The findings supported 21 items in the 5 factors of caring behaviors related to attitude toward patients, knowledge of surgical care, virus prevention principles, self-care knowledge, and self-care performance, which explained 35.92 of the total variance. Scale-Content Validity Index/Average and Cronbach's alpha were calculated to be 0.93 and 0.89, respectively. **Conclusions:** Given its desirable reliability and validity, simple scoring, and ease of use by operating room nurses, the Caring Behaviors of Operating Room Nurses Questionnaire is applicable and its use is recommended.

Keywords: *COVID-19, operating room nursing, pandemics, perioperative care, psychometrics*

Introduction

In the health care system, the care provided in the operating room is considered to be the front line of care.[1] With the outbreak of the COVID-19 pandemic, the operating room has become identified as one of the most dangerous hospital departments around the world.[2] Due to the urgency of management, the presence of a large number of staff, and the need for activities with high transmission risk such as airway management, operating rooms are high-risk areas for aerosol transmission of respiratory infections, especially infection caused by COVID-19.[3] For this reason, surgical procedures have been included in the group of high-risk activities during the epidemic. Although elective surgeries have been postponed during this period, emergency surgeries are still being performed.[4] The effect of COVID-19 on surgeries includes a wide range of problems related to human resources and personnel, the prioritization of procedures, and the risk of transmission of the virus during surgery, and surgical training. Thus, topics and techniques related to virus transmission prevention and COVID-19-related caring behaviors in the operating room have become more important.[5] Infected surfaces and airborne particles have been identified as the most important sources of transmission of COVID-19 infection in the operating room. The risk of transmission of COVID-19 through respiratory droplets is an important issue for surgical personnel.[6] In addition, during the COVID-19 pandemic, 29% of the medical team at a hospital in Wuhan, China, had a nosocomial infection caused by COVID-19.[7] In the operating room, procedures such as intubation of patients,

How to cite this article: Hozesorkhi RM, Vafsi SB, Mohammadimehr M, Kazemi-Galougahi MH, Ebadi A, Afzal M. Development and psychometric properties of the caring behaviors of operating room nurses questionnaire during the COVID-19 pandemic: A mixed-method study. Iran J Nurs Midwifery Res 2023;28:417-25.

Submitted: 16-Jul-2022. **Revised:** 17-Apr-2023.
Accepted: 19-Apr-2023. **Published:** 24-Jul-2023.

suction of secretions, use of electrocautery, use of tools such as hammers, reamers, and drills, as well as the use of CO_2 and its evacuation in laparoscopic surgery cause aerosol transmission.[8]

Under the current circumstances, the preparation of the operating room for the protection of the operating room nurses is very important. It is very important to have detailed information about the surgical management of patients with COVID-19 and recommendations about isolation for surgeries of patients with suspected or confirmed diagnoses of COVID-19.[9] The preparation of the operating room includes the identification and preparation of the isolated operating room, measures related to the modification of the workflow and processes, the introduction of Personal Protective Equipment (PPE) to the employees, and the development of clinical guidelines.[10] Considering the threats in the operating room, the optimal care and safety of the operating room nurses should be maintained when operating a patient with acute respiratory symptoms. Thus, the researcher in this study chose a concept called caring behaviors to include all the desired concepts. Caring behaviors are categorized into two groups, physical care behaviors, and psychological care behaviors. Physical care behaviors include physical actions, diagnostic interventions, treatments, procedures, education, and problem-solving in the path of achieving the physical improvement of patients. Psychological care behaviors are related to building trust in patients, accepting feelings, and having faith and honesty in behavior.[11] Several tools (instruments) were designed to investigate the caring behaviors of nurses before the COVID-19 pandemic, including the Nurses' Caring Behavior Questionnaire designed by Wolf (1998) with 75 items, and finally, reduced to 42 questions after revision.[12]

In the outbreak of acute respiratory infections, plans should be made and documented to reduce the risk of infection and the spread of infection in the surgical team. Two points are important in this regard: 1- The possibility of infection in the operating room is high for various reasons, including crowding; and 2- The training period of the surgical team is very long and it is not easy to replace the new staff.[13] Therefore, it is very important to identify and evaluate the factors related to the caring behaviors of operating room nurses during an acute respiratory infection pandemic in order to reduce the rate of infection and the spread of infection in the operating room. There are a limited number of data collection tools in this field. Gümüs and Basgün's study is similar to this study, but the tool designed in that study only focused on the knowledge dimension and did not examine other effective dimensions in providing care in the operating room during the outbreak of COVID-19.[14] Therefore, due to the lack of a tool to evaluate the caring behaviors of operating room nurses during the COVID-19 pandemic, it seems essential to design a questionnaire in this regard. The present study was conducted with the aim to design a valid and reliable tool for measuring the caring behavior of operating room nurses during the COVID-19 pandemic.

Materials and Methods

In this sequential, exploratory, mixed-method study, the designing and psychometric evaluation of the caring behaviors of operating room nurses during COVID-19 instrument was performed in two phases from August 2021 to July 2022 on operating room nurses working in the Aja University of Medical Sciences in Tehran, Iran, the qualitative phase (designing the caring behaviors of operating room nurses instrument) and quantitative phase (examining the validity and reliability of the caring behaviors of operating room nurses instrument[15] [Figure 1]. In the first stage, data were collected through deep semi-structured interviews. First, participants were selected using purposeful sampling. Data were collected through in-depth and semi-structured individual interviews with open-ended questions with 12 operating room nurses [Table 1]. The study inclusion criteria were personnel who had been operating in the operating room for at least 6 months and had a history of dealing with COVID-19 patients. For the interview, the researcher communicated with the participants by referring to the relevant wards, and after obtaining written and verbal consent to participate in the study, the time and place of the interview were determined with the opinion of the participants. Interviews started with a general question, "What is your experience of the situation with a patient with COVID-19 in the operating room?", and continued with more specific questions, such as "What care measures do you perform to reduce the risk of COVID-19 in the operating room?", and "What are the other factors that cause the spreading of the COVID-19 in the operating room?". A total of 12 interviews were conducted, all interviews were recorded in a quiet place and sampling continued

Table 1: Demographic information of operating room nurses participating in interviews (*n*=12)

Demographic information	*n* (%).
Gender	
Male	7 (58.33)
Female	5 (41.66)
Marital status	
Married	8 (66.66)
Single	4 (33.33)
Level of education	
B.A*	10 (83.33)
M.A**	2 (16.66)
Job position	
Head nurse	1 (8.33)
Shift nurse	2 (16.66)
Nurse	9 (75)

*Bachelor of Arts. **Master of Arts

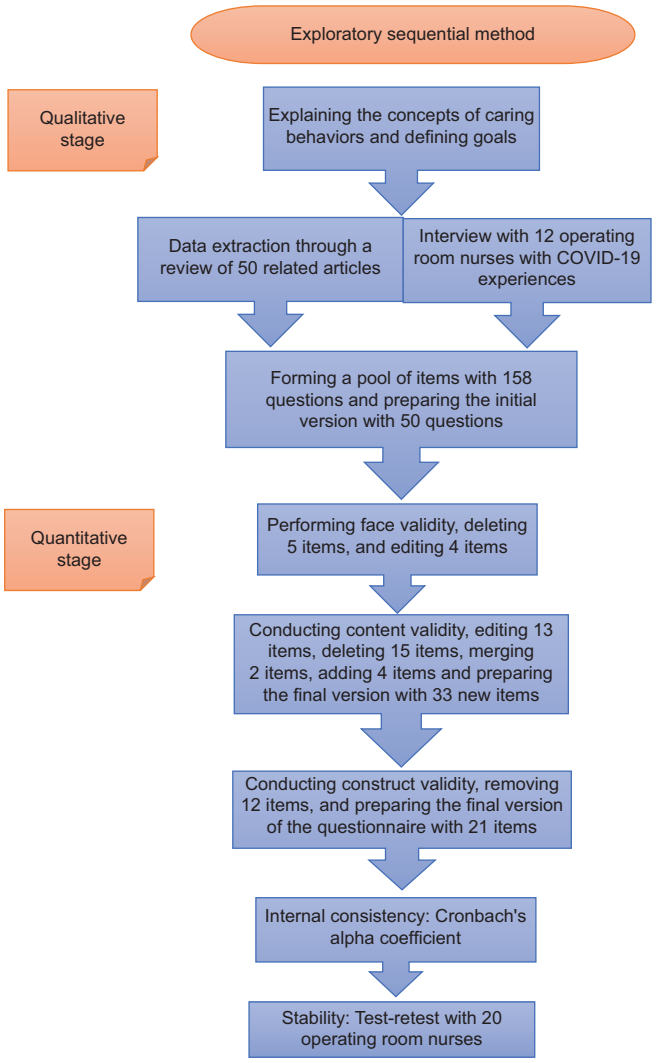

Figure 1: Procedures for designing the caring behaviors of operating room nurse questionnaire during the COVID-19 pandemic and its psychometric evaluation

until data saturation was reached, i.e., the interviews no longer provided new data. Given the importance of selecting participants with different clinical perspectives and experiences, an effort was made to select individuals with maximum diversity in terms of parameters such as age, work experience, gender, and work in different fields of surgery. At the same time as conducting the interviews, the data were analyzed according to the content analysis method of *Graneheim* and *Lundman*. Accordingly, 8 stages were considered including data collection, the definition of conceptual units, text coding, control and synchronization of codes with the text, grouping, and expansion of categories based on similarities and compatibility, reviewing categories, and re-comparing them with data to ensure the accuracy of codes, accurate identification of the main categories and comparison of categories with each other, and reporting of results.[16] According to the mentioned stages, the conversations made in the interviews were digitally recorded, then handwritten word by word, and analyzed using MAXQDA software (version 10; VERBI Software GmbH, Berlin, Germany). For the analysis, the interviews were read several times, according to the concepts in the text of the interview, the semantic units were separated as code and written next to the text of the interview, Codes that were conceptually close to each other were placed in one group, and similar groups were placed in separate categories. To ensure the accuracy and reliability of the data, the criteria of validity, confirmability, and reliability were used according to Guba and Lincoln.[17] Guba and Lincoln substituted reliability and validity with the parallel concept of "trustworthiness," containing the 4 aspects of credibility, transferability, dependability, and confirmability. These included specific methodological strategies for demonstrating qualitative rigor, such as the audit trail, member checks when coding, categorizing, or confirming results with participants, peer debriefing, negative case analysis, structural corroboration, and referential material adequacy.[18,19]

In the next step, we conducted a literature review based on an online search of the PubMed, ProQuest, Elsevier, Google Scholar, SID, IRANDOC, MEDLIB, IRANMEDEX, and Magiran databases from inception to July 1, 2022. The keyword used in the search engine to find matching articles included "caring behavior", "surgical instructions", "operating room preparation", and" COVID-19 pandemic".[5,9,10,20,21] Our initial search yielded 80 articles. Duplicates were first removed. All titles and abstracts of articles were read by at least one author and Articles related to the COVID-19 pandemic, and those which proposed approaches that directly affect the dynamics of surgery (e.g., how staff and patients circulate in the operating room) were selected. Articles selected for full-text reading were read by at least 2 authors. If those authors disagreed on the inclusion of an article in the review, a third author read the article to reach a consensus. Finally, 50 articles were selected. Then, related words and expressions were identified and extracted based on content relevance. Primary codes were given to the extracted data. Thus, the initial list of items was completed. In order to design the questionnaire, phrases, and items from the qualitative content analysis and phrases from the literature review were collected based on the opinion of the research team and experts in the field of psychometrics and instruments. Then, similar and repetitive items were removed or merged and some phrases and words were modified. After these modifications, the initial questionnaire with 50 items was prepared for validation and psychometrics.

The validity of the caring behaviors of the operating room nurse questionnaire was evaluated using face, content, and construct validity procedures. Face validity was achieved both qualitatively and quantitatively. First, 10 operating room nurses who had experience dealing with COVID-19 patients participated in the interview and provided their corrective opinions on the difficulty,

relevancy, and ambiguity of the items (qualitative face validity). Item impact technique was used to evaluate the quantitative face validity; 10 operating room nurses were invited to pilot the instrument, determining the importance of the items on a Likert-type scale ranging from 1 (not important) to 5 (absolutely essential). The item impact score of each item was calculated using the formula: importance × frequency (%). In this formula, frequency is the percentage of nurses who ascribed a score of 4 or 5 to the intended item and importance is the mean score of that item. If the impact score of the item was greater than 1.5, the item was considered suitable and was maintained for the next stage.[22] Content validity was assessed both qualitatively and quantitatively. To determine the qualitative content validity, the questionnaire was provided to 12 subject experts (faculty members of operating room departments of universities) were provided to express their expert opinions regarding the observance of grammar, the use of appropriate words, and the placement of items in their proper place. Their expert opinions were taken into consideration in removing or maintaining items. Then based on their comments, the instrument's items were edited by adding, removing, or changing the words. In the second stage, the quantitative content validity was assessed through Content Validity Ratio (CVR) and Content Validity Index (CVI); CVR illustrates whether the items are essential or not. Accordingly, 12 experts were asked to rate the essentiality of the nursing social responsibility instrument items on a 3-point scale ranging from 1 to 3 (not essential: 1; useful but not essential: 2; and essential: 3).[23] According to Lawshe (1975), when the number of experts is 12, the minimum acceptable CVR is equal to 0.56.[24] CVI shows the degree to which the items of the intended instrument are relevant. CVI was calculated for each item of the scale (item level or I-CVI) and for the overall scale (scale level or S-CVI). For this purpose, 12 subject experts were asked to determine the relevance of the questionnaire items according to the subscales of the questionnaire in a 4-part Likert scale. (not related, partially related, related but should be slightly reviewed, and quite relevant). The content validity index for each item was calculated by dividing the number of experts who rated that item as 3 or 4 by the total number of experts; a score of 0.79 or more was considered for accepting the items based on CVI.[25] In the next step, based on the mean score of the content validity index of all items, the average content validity index (S-CVI/Ave) was calculated. Polit and Beck recommend a score of 0.9 or more for the average content validity index.[25] Cohen's kappa coefficient is used to calculate inter-rater agreement for qualitative (categorical) items.[25] The construct validity of the tool was evaluated in a cross-sectional study on operating room nurses in Aja University of Medical Sciences hospitals. For sampling, the main researcher referred to 5 hospitals affiliated with Aja University of Medical Sciences and a convenience sampling method was used to recruit the participants after obtaining their informed consent. The study inclusion criteria included a minimum of 6 months of work experience in the hospital during the COVID-19 pandemic. The Kaiser-Meyer-Olkin (KMO) index was used to determine sampling adequacy. This index ranges between 0 and 1. If the value of the index is close to 1 (at least 0.6), the target data are suitable for factor analysis. Otherwise (usually less than 0.6), the factor analysis results are not valid for the target data. A KMO index value of greater than 0.9 is considered excellent.[26] There is a difference of opinion about the sample size for factor analysis, in other words, different methods have been reported to determine the appropriate sample size in factor analysis. Another point of view considers the sample size of 100 to 200 subjects to be sufficient for different purposes. In this study, the standard of at least 300 people was used for the sample size. Thus, 330 questionnaires were prepared and distributed among operating room nurses considering the possibility of sample loss, and data were collected from 300 questionnaires and analyzed using SPSS software (version 25; IBM Corp., Armonk, NY, USA) [Table 2]. Moreover, Bartlett's test of sphericity was performed to determine the appropriateness of the factor analysis model. The significance of this test means that the correlation matrix between the items is confirmed and the factor analysis model is appropriate.[26] If the significance of Bartlett's test is less than 0.05, factor analysis is suitable for identifying the structure (factor model).[26] In order to conduct construct validity, an Exploratory Factor Analysis (EFA) was used, and in this phase, the Principal Axis Factoring (PAF) method and the varimax rotation were used. Missing data were less than 10%.[27] To achieve the optimal number of factors, the

Table 2: Demographic information of operating room nurses participating in exploratory factor analysis (*n*=300)

Demographic information	*n* (%)
Age	
Mean	29.91
Std. Deviation	5.19
Gender	
Male	144 (48)
Female	156 (52)
Marital status	
Married	181 (60.33)
Single	119 (39.66)
Level of education	
B.A*	224 (74.66)
M.A**	75 (25)
Employment Status	
Official	117 (39)
Temporary	183 (61)
Work experience (year)	
Mean	6.12
Std. Deviation	5.14

*Bachelor of Arts. **Master of Arts

following tables of SPSS results were considered: 1- the total variance, 2- the eigenvalue, and 3- the scree plot. KMO and Bartlett's test of sphericity were also performed. To determine the number of factors, the eigenvalue was considered to be more than 1, and the factor load was more than 0.32.[28,29]

The internal consistency and stability of the questionnaire were measured to assess its reliability.[30] Internal consistency was assessed with a sample of 300 operating room nurses. The test-retest method was used to assess the consistency of the questionnaire with 20 nurses over a 2-week interval. The scores of the 2 tests were determined through the calculation of the Intra-class Correlation Coefficient (ICC) for each of the sub-domains and the whole questionnaire.[30]

Ethical considerations

This research was approved by the ethics committee of Aja University of Medical Sciences with the code IR.AJAUMS.REC.1400.064 dated May 27, 2021. The study materials (interview questions and informed consent form) were approved by the ethics committee of the university. The participants were informed of the objectives of the study and the voluntary basis of their participation. In the qualitative phase, verbal and written consent was obtained for conducting the interview. In the quantitative stage, only written consent was obtained for completing the questionnaires. The participants were assured of the confidentiality and anonymity of their information.

Results

First, the qualitative content of the data obtained from the interviews with 12 operating room nurses working in the operating room was analyzed. Then, using the content extracted from the interview and the texts related to the research topic, the extracted factors include caring behavior related to the attitude towards the patient, caring behavior related to knowledge of surgical care for patients, caring behavior related to virus prevention principles, caring behavior related to self-care knowledge, and caring behaviors related to self-care performance.

Subscales or factors' definitions

Caring behavior related to attitude towards the patient includes all care related to how to communicate with and how to deal with a patient with an acute respiratory infection. Caring behavior related to knowledge of surgical care for patients includes all care related to knowledge of all guidelines related to the conditions of an acute respiratory infection pandemic in the operating room. Caring behavior related to virus prevention principles includes all care related to knowledge of how to use aseptic and disinfection techniques to reduce the spread of viruses in the operating room. Caring behavior related to self-care knowledge includes all care related to knowledge principles to prevent operating room nurses from contracting acute respiratory infections. Caring behavior related to self-care performance includes all care related to personal protection techniques including the use of PPE when dealing with a patient with an acute respiratory infection.

To design the questionnaire, a list of items was extracted from 3 sources: 1) a review of previous articles, 2) semi-structured interviews with nurses, and 3) a review of existing questionnaires. Among these items, the most important and relevant items, including 158 items, formed the item pool. These items covered all aspects of caring behavior in operating room nurses (physical care and psychological care). After 2 meetings with the research team and professionals, the number of items decreased to 50 through the selection of the most relevant items, and then, the psychometric evaluation was conducted.

Face validity

In the phase of evaluating the face validity of the tool, 4 items were excluded, and 5 items were revised and edited and became more understandable based on the views of the participating operating room nurses.

Content validity

During the qualitative content validity phase, 12 items were eliminated due to a CVR ≤0.56 (according to Lawshe's cut-point for 12 specialists), 13 items were corrected, 2 items were merged into other items, and 4 new items were suggested. In calculating I-CVI, 3 items with a score of less than 0.79 were omitted, and thus, the third version of the questionnaire of factors related to the caring behaviors of operating room nurses was prepared with 33 items. In addition, the S-CVI/AVE was calculated to be 0.93.

Construct validity

After performing the EFA, the results of the 2 main outputs were presented as follows. The first output presented the calculated value of the KMO index, which was 0.73. Therefore, the sample size was sufficient to perform factor analysis. Bartlett's test of sphericity also showed the suitability of the factor analysis for the identification of the structure of the factor model at the level of $p \leq 0.001$ [Table 3]. The second output is the total variance explained in Table 4. The variance is explained by the initial solution, extracted components, and rotated components. This first section of the table shows the initial eigenvalues. The total column gives the eigenvalue or amount of variance in the original variables accounted for by each component [Table 4]. In the implementation of the analysis of the main components of the 33-item questionnaire, factor coefficients greater than 0.32 were considered important factor loadings.[29] Hence, after performing EFA using the maximum likelihood (ML) method with varimax rotation and considering an eigenvalue higher than 1, 6 factors were extracted [Figure 2]. According to the pebble

Table 3: The results of performing exploratory factor analysis and reliability test on the caring behaviors of operating room nurses questionnaire

Factor name	Item number	Factor load	The title of the item	Initial Eigenvalues		Reliability	
				Total	% of Variance	Cronbach's alpha	ICC*
Factor 1: Caring behaviors related to attitude toward patients (Psychological Care)	Item 1	0.78	As soon as the patient enters the operating room, I introduce myself to her.	7.54	35.92	0.75	0.88
	Item 6	0.68	I give hope and motivation to the patient	2.15	10.25		
	Item 9	0.69	I care about protecting the patient's privacy while prepping and draping her.	1.98	9.44		
Factor 2: Caring behaviors related to knowledge of surgical care for patients	Item 10	0.74	I have adequate knowledge of the instructions related to surgical priorities in epidemic situations.	1.61	7.69	0.83	0.89
	Item 11	0.76	I have adequate knowledge of the high-risk procedures that lead to the production of respiratory aerosols.	1.19	5.70		
	Item 12	0.47	I have the necessary knowledge about the precautions related to the patient who is a candidate for emergency surgery	1.02	4.85		
	Item 13	0.79	I have enough knowledge about the principles of cardiopulmonary resuscitation in a patient.	0.95	4.54		
	Item 14	0.63	I have the necessary knowledge about how to admit a patient.	0.76	3.64		
	Item 15	0.79	I have adequate knowledge about the observance of care principles during endotracheal intubation in the patient.	0.63	3.04		
	Item 16	0.71	I have adequate knowledge about the precautions related to laparoscopic surgery in a patient.	0.58	2.77		
	Item 17	0.78	I have the necessary knowledge about the precautions related to the use of equipment (cutters, strikers, perforators, etc.) during surgery.	0.51	2.42		
Factor 3: Caring behaviors related to principles of preventing the spread of the virus	Item 18	0.53	I have adequate knowledge about how to properly put on and take off personal protective equipment.	0.39	1.88	0.76	0.84
	Item 21	0.60	I have adequate knowledge about how to deliver surgical instruments to the CSR** after the surgery.	0.35	1.66		
	Item 22	0.56	I have adequate knowledge about how to properly transport a patient and the principles of isolation.	0.30	1.44		
	Item 23	0.77	I have adequate knowledge about the physical standards of the operating room for the patient's surgery.	0.24	1.17		
Factor 4: Caring behaviors related to self-care knowledge	Item 24	0.67	I have adequate knowledge of the symptoms of an acute respiratory infection	0.18	0.90	0.77	0.86
	Item 25	0.86	I have adequate knowledge of diagnostic methods for acute respiratory infection.	0.15	0.74		
	Item 26	0.80	I have adequate knowledge of methods for the prevention of the transmission of acute respiratory infections.	0.15	0.72		
Factor 5: Caring behaviors related to self-care performance	Item 27	0.74	I use high-filtration masks such as N95 during surgery on patients with acute respiratory infections.	0.12	0.59	0.75	0.90
	Item 28	0.82	I use a face shield or goggles during surgery on a patient with acute respiratory infection.	0.06	0.31		
	Item 30	0.79	I use waterproof gauze and two pairs of latex gloves during surgery on a patient with acute respiratory infection.	0.05	0.25		
Total		0.89	0.92				

*The Intra-class Correlation Coefficient. ** Central Sterilization Room

Table 4: The Kaiser-Meyer-Olkin test and Bartlett's test of Sphericity for sample adequacy

Kaiser-Meyer-Olkin and Bartlett's test			
KMO*	**Chi-square**	**Degrees of freedom**	***p***
0.73	4519.58	210	< 0.001

*Kaiser–Meyer–Olkin test

chart and KMO criteria, it was possible to choose 5 factors, because in this case a better factor solution was presented, finally 5 factors were extracted by the researcher [Table 4 and Figure 2].

External reliability (stability)

To evaluate test-retest reliability, 20 operating room nurses were asked to complete the questionnaire (caring behavior operating room nurse instrument). After 2 weeks, the instrument was sent to the same 20 nurses again. The coefficient of consistency between these 2 tests was 0.92, which confirmed the sustainability of the tool over time [Table 4].

Internal consistency

Cronbach's alpha coefficient of the total 21-item questionnaire was 0.89, all subscales, all of which had a good reliability coefficient [Table 4]. The final version of the questionnaire consisted of 21 items scored on a 5-point Likert scale with 5 factors. The cut-off point for the present questionnaire was set at approximately 28; this amount was added to the minimum score[21] to categorize the different values of answering the questionnaire. Thus, the scores in the lower third (21-49) were considered to be poor, those in the middle third (50-78) were regarded as average, and the scores in the top third (79-105) were considered to be satisfactory.[31]

Discussion

This study was conducted with the aim to design and develop a questionnaire on the caring behaviors of operating room nurses during the COVID-19 pandemic and validate it among operating room nurses. In this study, items were directly designed based on the data obtained from a qualitative study on operating room nurses working under COVID-19 pandemic conditions, using experts' opinions, and a comprehensive review of the existing literature on caring behaviors. While staff are encouraged to acquire adequate knowledge about the pandemic, it is important to assess the knowledge and skills related to it. In addition, the lack of comprehensive training programs or guidelines on preventive measures in most operating rooms and the fact that only half of the staff have received protective training can be a threat to the health of operating room nurses.[14] There is no doubt that this situation has an adverse effect on providing care in the operating room. According to these results, COVID-19 protective measures should be put in place in the form of an algorithm or guidelines in writing. Moreover, it should be ascertained that operating room nurses apply them and they should

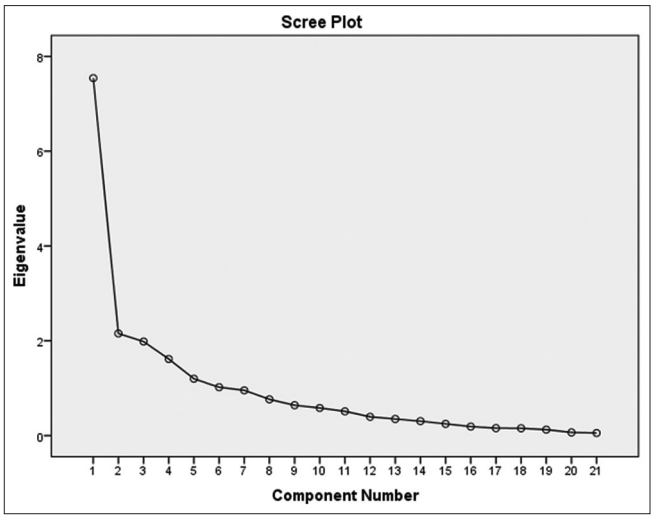

Figure 2: Scree plot for the determination of the number of factors in the questionnaire of caring behaviors of operating room nurses

be periodically evaluated. The appropriate management of operating room threats during the COVID-19 pandemic is very important. There are a limited number of data collection tools in this field. Gümüs and Basgün's study did not examine other dimensions that could affect care in the operating room during the COVID-19 pandemic and only examined knowledge of protection against COVID-19.[14]

In most studies, researchers need valid and reliable tools for data collection.[32] Validity refers to the power of a tool to measure the properties of the studied construct and is a critical factor in the selection or use of a tool. There are 3 main criteria for using a tool in research, which include content validity, construct validity, and reliability[33] Therefore, confirming the validity and reliability of a tool is one of the most important factors that express the ability to use that tool. In this study, face and content validity were determined based on the judgment of experts with knowledge and experience in various fields of tool design and other related fields. To determine content validity, the Wilson table was used based on the Lawshe table and the Waltz and Basel Content Validity Index (CVI).[24,34] Construct validity implies the extent to which the results obtained from the application of metrics are consistent with the theories on which the test is based. More precisely, construct validity hypothesizes the extent to which a measurement tool is a reflection of theoretical concepts. The more it reflects theoretical concepts, the higher the construct validity of the studied tool.[33,35] Component analysis includes the total variance in the initial extraction.[36] The amounts of variances of the variables predict the number of factors. In this method, the cumulative percentages of the variance obtained by the factors are used as criteria to select the number of factors. That is, we accept only the factors that explain a sufficient amount of the variance of the variables. This value is 80 to 90% in medical and other sciences.[37] The variance is explained by the original solution, the extracted

components, and the rotated components. This section is presented in the initial eigenvalues section in Table 4.

In this study, five dimensions were extracted to measure the caring behaviors of operating room nurses during the COVID-19 pandemic (5 factors). The first dimension of the questionnaire was "caring behaviors related to attitude". The items in this dimension of the questionnaire included "I introduce myself as soon as the patient enters the operating room" and "I give hope and motivation to the patient". During the long COVID-19 pandemic, the incidence of various psychiatric diseases has increased due to forced social isolation and quarantine.[38] Thus, COVID-19-related disorders increase the risk of serious mental diseases, including depression, anxiety, and sleep disorders. Thus, it is essential that health authorities identify groups at high risk of emotional problems in order to monitor their mental health and perform basic psychological and psychiatric interventions.[39] Therefore, how to deal with the patient in the operating room is very important, and this dimension of the questionnaire investigates how operating room nurses deal with a patient with COVID-19. The second and third dimensions of the questionnaire included the factors related to "caring behaviors related to patient care before, during, and after surgery" and "caring behaviors related to knowledge of the principles of virus transmission prevention", respectively. Due to the need for management, the presence of a large number of personnel, and the need for high-risk transmission activities such as airway management, operating rooms are high-risk areas for the transmission of respiratory infections, especially infections caused by COVID-19.[20] The effect of COVID-19 on surgeries includes a wide range of human resources and personnel problems, the prioritization of procedures, the risk of transmitting the virus during surgery, and surgical training.[5] Contaminated surfaces and airborne particles have been identified as the most important sources of transmission of COVID-19 infection in the operating room. The risk of transmission of COVID-19 through respiratory droplets is an important issue for surgical personnel.[40] Therefore, it is very important to investigate the knowledge of operating room nurses in the field of care related to virus transmission prevention and care before, during, and after surgery. The fourth and fifth dimensions of the questionnaire included factors related to "self-care knowledge related caring behaviors" and "caring behaviors related to self-care performance", respectively. Healthcare workers face the pressure of risk of infection, isolation, burnout, and general discrimination, which negatively affects their general health and potentially their ability to make decisions.[13] The COVID-19 pandemic is neither the first nor the last crisis. War, air pollution, embargo, environmental crises, coronavirus, etc., are all crises that have affected higher education and medical education in the country.[41] Given the significant increase in the number and type of surgeries and underlying diseases of patients who are candidates for surgery, especially in terms of COVID-19, the education of operating room nurses to reduce their risk is a necessity.[42] Therefore, the fourth and fifth dimensions are very important as they investigate the caring behaviors of operating room nurses in the field of knowledge and performance of self-care. Considering the higher prevalence of acute respiratory diseases in recent years, this study is one of the research priorities. Moreover, the concepts of this study were extracted through a deep understanding of the mind of the participants with the experiences of COVID-19, as well as the review of existing articles, which has greatly contributed to its further enrichment. Due to the lack of face-to-face access to 2 of the participants due to intensive work shifts during the COVID-19 pandemic, not all information was extracted. This limitation was resolved through a telephone interview, provision of further explanations, and increased interview time.

Conclusion

According to the study results, the 21-item caring behaviors of operating room nurse questionnaire is applicable due to its characteristics such as tool design based on the basic concepts of caring behaviors, review of experiences of operating room nurses in dealing with patients with COVID-19 through qualitative research, confirmed reliability and validity, simple scoring, and easy use by operating room nurses. Given the importance of maintaining and protecting human resources and members of the surgical team in the operating room, as well as the high risk of infection in the operating room, the use of this tool by managers and researchers is of great importance. Therefore, the quality of caring behaviors of operating room nurses can be improved by developing training programs and treatment protocols and appropriate management of operating room nurses. It is suggested that studies on the impact of the use of different educational programs and strategies on the care behaviors of operating room nurses be carried out using the tools designed in this study. The researcher hopes that the study results can be effective in various fields, including training, managing, and improving the knowledge, attitude, and practice of operating room nurses during the outbreak of acute respiratory infections.

Acknowledgments

This article was approved by Aja University of Medical Sciences (Approved project no. 97001424). The authors would like to thank all the operating room nurses who participated in this study.

Financial support and sponsorship

Aja University of Medical Science, Tehran, Iran

Conflicts of interest

Nothing to declare.

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