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Research Article

A Study of the Educational Needs of Clinical Nurses Based on the Experiences in Training Programs for Nursing COVID-19 Patients

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SUMMARY

Purpose: This study aimed to explore the experience of clinical nurses regarding training programs for critically ill patients with coronavirus disease 2019 (COVID-19) and their educational needs.

Methods: Qualitative data were analyzed using content analysis, and quantitative data were analyzed according to Borich's formula. Data for the study were collected in March 2021 from 16 nurses who had completed a nursing program for critically ill patients with COVID-19 and were working at three hospitals designated for COVID-19.

Results: Participants' experiences were classified into three major categories, namely "Participation experiences and perceptions of the training program," "Recommendations for improving the training program," and "Perceptions of working in an infectious environment," and 10 subcategories. According to Borich's formula, the most pressing educational needs in respiratory and non-respiratory nursing, respectively, were for "nursing care for patients on extracorporeal membrane oxygenation" and "application of continuous renal replacement therapy and caring for patients."

Conclusion: To prepare for the periodic emergence of communicable infectious diseases throughout the world and cultivate nursing staff to care for critically ill patients, it is necessary to develop nursing education programs with content corresponding to nurses' needs. This study can be used as base data for cultivating nursing staff for critically ill patients with communicable infectious diseases in keeping with clinical nurses' educational needs and basic educational materials for nursing students.

Trial registration: CRIS, KCT0006359. Registered 20 July 2021 - Retrospectively registered, <https://cris.nih.go.kr/cris/>

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Introduction

Coronavirus disease 2019 (COVID-19) is a viral disease that was first reported in Wuhan, Hubei Province, China. On December 1, 2019, the World Health Organization [1] declared COVID-19 a pandemic, prompting countries around the globe to respond to their respective national emergencies; however, the number of

confirmed cases has been continuously rising, and the emergence of new and more dangerous COVID-19 variants worldwide is a growing concern. The clinical manifestations of COVID-19 vary from being asymptomatic to having fever, cough, shortness of breath, diarrhea, and many other symptoms. The symptoms are mild in the initial stage, can progress to severe symptoms, and may lead to death [2,3]. COVID-19 is particularly deadly in the case of elderly, immunocompromized, and comorbid patients, and in some cases, advanced interventions such as extracorporeal membrane oxygenation (ECMO) and mechanical ventilation are required [4]. Therefore, it is necessary to increase the number of healthcare personnel who can manage critically ill COVID-19-related patients [2,3].

The Korean government has designated national hospitals and built more intensive care units (ICUs) to manage critically ill

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COVID-19-related patients [4,5]. To supply nursing staff for their care, the government has deployed trainees who have completed relevant training courses [6]. However, cultivating nursing staff for critically ill COVID-19-related patients is time consuming, and in-depth educational programs are needed, specifically training programs suited to the novel circumstances including medical personnel movement management, cleaning wards, and wearing protective equipment. Hence, the supply of nurses who can care for critically ill COVID-19-related patients is inadequate [5]. Critically ill COVID-19-related patients should be provided with special nursing care from the basic level of personal hygiene to life-saving treatment for 24 hours [7]; at this point in time, nursing personnel who can provide nursing care for severe COVID-19-related cases are integral.

Since caring for critically ill patients is difficult for nurses experiencing it for the first time, several problems, such as maladjustment and low self-confidence, may arise [8,9]. These may affect the quality of nursing care provided to critically ill patients and lead to excessive work-related stress, as well as increased turnover rates for nurses [10]. A study conducted by the Ministry of Health and Welfare involving experienced nurses caring for COVID-19 patients in Korea reported that nurses viewed themselves as lacking knowledge about COVID-19 patients and that they felt pressured and overwhelmed in response to the demand to provide nursing care for critically ill patients without sufficient nursing experience regarding patients with respiratory communicable infectious diseases, leading to an increase in emotional and psychological stress [11]. The uncertainty that characterizes infectious diseases increases healthcare professionals' stress, anxiety, and depression [12] and decreases sleep quality [13]. In such circumstances, if a sufficient number of nursing staff is secured through systematic educational programs related to the care of critically ill patients with respiratory communicable infectious diseases, healthcare personnel can comply with the regulations for controlling viral spread with regard to infected patients through training involving wearing personal protective equipment (PPE) and nursing practice simulation [14], and they can perform all medical procedures calmly because of the reduced pressure, which may decrease the risk of additional infections. Given these results, it is necessary to address in depth the content of educational programs aimed at training nurses to care for critically ill patients by obtaining sufficient knowledge about COVID-19 and the skills required for managing it.

Nurses' practical education requirement becomes evident when they need to perform nursing practice on a professional level, feel insufficient or face difficulty in nursing, or want to improve their expertise by obtaining up-to-date knowledge and skills [15]. Considering that respiratory infectious diseases, such as Middle East respiratory syndrome (MERS) followed by COVID-19, occur repeatedly, it is important to identify nurses' educational needs to prepare nursing staff to care for critically ill patients.

Therefore, this study explores two aspects of educational needs. First, we will explore subjects' participation experiences with education for nursing critically ill COVID-19-related patients with respiratory infectious diseases based on the study question "What nursing education characteristics and content are required to adequately prepare for nursing critically ill patients?" Second, we confirm the participants' objective educational needs. On this basis, we aim to use the results as base data to improve clinical nurses' competency in nursing critically ill COVID-19-related patients and identify strategies that meet the social requirements of nursing personnel who care for critically ill patients.

Methods

Study design

This study used mixed methods research design [16], combining focus group interviews (FGIs) as the qualitative element and a survey as the quantitative element. The qualitative results reflecting the participants' experiences in the existing training programs were supplemented with a quantitative study to identify the participants' objective educational needs.

Study participants

Eighteen study participants were recruited from among nurses who completed a training program for critically ill patients with COVID-19 who were working at three hospitals designated for COVID-19 in Gyeonggi Province. Two people were excluded from the study because they withdrew due to the side effects of COVID-19 vaccination; thus, 16 people participated in the study. Six participants belonged to A hospital, six to B, and four to C, and FGIs were conducted with them at their respective hospitals. They all received training at government-designated teaching hospitals from September 2020 to February 2021, after which they returned to their hospital where they currently care for confirmed cases of COVID-19. Perspectives on the proper number of focus group participants differ in the literature. This study adopted the opinion [17] that the desirable number is six to ten participants per group. Given practical considerations related to group dynamics and participants' high interference tendency, there were at least three participants per group.

Data collection

Data were collected from March 4 to March 11, 2021. A list of COVID-19-designated hospitals located in Gyeonggi Province was obtained to gather participants, and participant recruitment advertisements were posted on three hospitals' online bulletin boards after obtaining approval from the respective heads of department among those hospitals implementing education programs for critically ill patients with COVID-19. Participants who saw the advertisements and voluntarily expressed their interest in participating in the study were selected, and FGIs were scheduled in advance according to the participants' availability. Considering the risk of COVID-19 infection, three FGIs were conducted using Zoom video conferencing. Each group meeting lasted approximately one hour. FGIs were led by a researcher with extensive FGI and qualitative research interview experience, and other researchers participated as assistant facilitators. Before the interviews, consent to study participation was reconfirmed, and interview guidance was provided. By voluntary agreement, interviews were recorded and transcribed. Group interviews were conducted until content saturation was reached, and it was determined that no new content could be derived through the team meetings. Researchers developed a guide to general interview questions to maintain the flow of the interview in keeping with the clarified purpose. Related ad-hoc interview questions were also used. The main guiding questions were as follows:

- Please describe your experience of participating in the nurse training program for critically ill patients with communicable infectious diseases.
- What did you like about participating in the nurse training program for critically ill patients with communicable infectious diseases?

- What did you dislike about participating in the nurse training program for critically ill patients with communicable infectious diseases?
- What changes did you notice after participating in the nurse training program for critically ill patients with communicable infectious diseases?

At the end of the FGIs, the participants completed a 10–15-minute questionnaire aimed at investigating general characteristics and educational needs related to critically ill patients with communicable infectious diseases. The questionnaire consisted of 16 items about nursing critically ill patients with respiratory diseases, 20 items about nursing critically ill patients with non-respiratory diseases, and six items about infection control. There were 42 items based on guidelines and books about the management of critically ill patients, and a survey was conducted on effective learning methods for each item [7,18–20].

Data analysis

The qualitative data collected were analyzed using inductive content analysis, following Elo and Kyngas' suggestions [21]. The inductive method is useful when data from previous studies on research phenomena are insufficient or knowledge about phenomena is segmented. The interviews revealed the participants' experiences of nursing education programs aimed at shaping dedicated personnel to care for critically ill patients with COVID-19. This study aimed to identify and categorize common factors to generalize their experiences. Based on content analysis, words and phrases were chosen as the unit of analysis in the preparation phase. Following the stages of open coding, category formation, and abstraction in the organizing phase, the specific data analysis procedure was as follows: First, transcribed data were read several times to grasp the fundamental content and flow of the interview as a whole; second, the transcript was read and marked up to arrange repeated words and phrases in order to extract codes; third, researchers examined the arranged codes together and categorized them through grouping and comparison according to the characteristics; fourth, the categorized content was confirmed and repeatedly perused and re-classified to grasp the meaning and relevance; and fifth, through deduction of abstract categories reflecting the key categorized interview content and the relevance, a description of a phenomenon in keeping with the purpose of the study was derived. Regarding the rigor of the study, following Lincoln and Guba [22], credibility was established directly with the participants by confirming the meanings derived from the transcribed conversations, and validity was verified through transcripts indicating that our participants had clearly recounted their experiences. Neutrality was ensured through meetings among the researchers to avoid biases and personal judgements; these meetings were held in consultation with a qualitative researcher. In addition to the FGIs, 16 participants were surveyed about their educational needs in nursing programs related to dedicated critical care. Questionnaires were analyzed as follows. Regarding the subjects' general characteristics, frequencies, percentages, and standard deviations were verified. The educational needs related to nursing patients with respiratory infectious diseases were analyzed using the Wilcoxon signed rank test and Borich's formula. According to Borich [23], educational needs can be deduced through a discrepancy analysis of current and desired levels. In this study, using Borich's formula for needs, after subtracting the subject's performative self-confidence from the importance of each item, the difference was multiplied by each item's average importance and then divided by the total number of cases to calculate the needs. Based on this value, the larger the needs coefficient, the higher the demand priority.

Ethics approval and consent to participate

The institutional review board reviewed and approved the study (IRB approval no.). Informed consent was obtained from all the subjects involved in the study. Written informed consent was obtained from the patients for publication of this article.

Results

Study participants' general characteristics

All study subjects were women (100.0%), and their mean age was 31.94 ± 6.21. Regarding marital status, there were five (31.3%) married women and 11 (68.8%) unmarried women. Regarding education, three (18.8%) had an associate's degree and 13 (81.3%) had a bachelor's degree. Regarding work, one nurse (6.3%) was working in an emergency room (ER), six nurses worked in an ICU (37.5%), and nine (56.3%) worked in a COVID-19 ward. The total duration of clinical experiences was 8.90 ± 6.21 years, and the duration of experience in the current department was 1.09 ± 1.27 years. The sources of COVID-19-related information were the hospital website's homepage (6 nurses, 37.5%), the Korea Disease Control and Prevention Agency (5 nurses, 31.3%), mass media (2 nurses, 12.5%), and the Internet (7 nurses, 43.8%) (Table 1).

Content analysis for focus group interviews

Participants' experiences regarding nursing programs aimed at shaping dedicated critical care nurses were classified into three major categories and ten subcategories (Table 2).

Category 1. Participation experiences and perceptions of the training program

This category concerns the overall structure and characteristics of training as well as post-training changes in participants.

Disorganized program arrangement in early stage. Due to the onset of the COVID-19 pandemic in early 2020, the nursing personnel shortage was highlighted, and a nursing program aimed at shaping dedicated critical care nurses commenced as an improvement measure at the national level. However, during the initial training period, there were some problems, including indecision regarding the ratio of theoretical education to practical training in the

Table 1 General Characteristics of the Participants.

	Gender	Age (year)	Marital Status	Education level	work department	Total clinical career (year)
1	Women	34	Single	Bachelor degree	COVID-19 ward	7.02
2	Women	37	Married	Bachelor degree	COVID-19 ward	16.00
3	Women	48	Married	Bachelor degree	COVID-19 ward	25.00
4	Women	34	Single	Bachelor degree	COVID-19 ward	10.00
5	Women	30	Single	Associate degree	ICU	8.00
6	Women	36	Married	Bachelor degree	ICU	13.10
7	Women	35	Married	Associate degree	COVID-19 ward	14.00
8	Women	27	Single	Bachelor degree	COVID-19 ward	3.10
9	Women	27	Single	Bachelor degree	ER	5.00
10	Women	28	Single	Bachelor degree	COVID-19 ward	4.03
11	Women	27	Single	Associate degree	COVID-19 ward	3.00
12	Women	26	Single	Bachelor degree	ICU	5.00
13	Women	29	Single	Bachelor degree	ICU	7.00
14	Women	40	Married	Bachelor degree	ICU	15.00
15	Women	26	Single	Bachelor degree	ICU	3.00
16	Women	27	Single	Bachelor degree	COVID-19 ward	4.09

COVID-19 = coronavirus disease-2019, ICU = intensive care unit.

education plan, preceptors' lack of experience with the relevant content, and the absence of a practical training protocol. During the first round of training, practical training was provided exclusively for 4 weeks. This was changed to 1 week of theoretical instruction and 3 weeks of practical training. This was further modified to an even split, consisting of 2 weeks of theoretical instruction and 2 weeks of practical training, and it is this arrangement that has been implemented so far. The nursing staff of tertiary hospital ICUs were deployed in great numbers to COVID-19 nursing departments. As a result, many new personnel were assigned to the ICUs where this study's participants practiced, and the absence of an education protocol made it difficult to administer the program. Many participants expressed their dissatisfaction with practical training and thought that it would be more effective to increase the amount of theoretical instruction. Although the training included scenario-based simulation practice, it seems that the preparation offered was insufficient for the participants to effectively apply the content of the program.

First, there was a lot of trial and error. Those who first participated in the training had clinical practice almost exclusively, and I joined for the second session on clinical practice and theory together. The time dedicated to theory was absolutely adequate, but as for clinical practice, we only observed, and the preceptors were not well prepared, so it was not that helpful. It seems that they had not quite decided what to teach and what to practice. (1-1).

There were many new nurses. The preceptors were busy teaching them, so there was no one for us to ask ... (1-2).

(For simulation practices), I understand that the intention was for us to practice, like in the actual situation, wearing protective clothing. However, the situation was not clearly set, and it was disorganized. I wish that it had been better organized. (3-1).

Progressing to systematic arrangement of the training program. Although programs varied by educational institutions, the training program gradually became more organized through trial and error over successive rounds. Nurse educators and doctors delivered theoretical lectures, and critical care content was included. The theoretical portion of the program gave participants opportunities to practice what they learned through lectures and on site. Participants could familiarize with content by assessing and operating devices first-hand. Participants also received one-on-one training with a preceptor according to their duty roster, and the preceptors made efforts to thoroughly educate participants with the aid of a checklist.

For the first 2 weeks, we had theoretical sessions, and during the following 2 weeks of practice sessions, the preceptor explained how

Table 2 Analysis of Focus Group Interview.

Category	Subcategory
Participation experiences and perceptions of the training program	Disorganized program arrangement in early stage
	Progressing to systematic arrangement of the training program
	Inadequate hands-on clinical practice
	Perceived self-efficacy in critical care after training
Recommendations for improving the training program	Motivation by nurses with expertize
	Inclusion of specific institutional practice
	More hands-on practice and simulation training
Perceptions of working in an infectious environment	Inclusion criteria for trainee selection
	Anxiety and fear about the work
	Burden of wearing personal protective equipment

to operate a ventilator, even though I did not get to do it myself and shared various patient cases. I think I understood to some degree. (2-1).

During 2 weeks of theoretical sessions, we attended a lecture in the hall in the morning and went to the site in the afternoon, where a nurse educator re-explained what we learned in the morning and let us practice it ourselves. As a preceptor taught us for the remaining two weeks, it was very systematic. (2-2).

Inadequate hands-on clinical practice. Since the participants did not belong to the institutions (hospitals) where the clinical practice sessions were held, they could not perform nursing care directly, and practice was mainly through observation. Moreover, despite the program's aim of cultivating dedicated critical care nurses for COVID-19, the participants expressed dissatisfaction regarding limited opportunities to practice nursing patients with COVID-19. Although they acknowledged that direct contact with COVID-19 patients would entail an infection risk and the need for intensive care, they noted that such contact would be necessary to meaningfully experience the operation of a COVID-19 ward.

It was not helpful because I only observed during practice. It was more valuable, and I learned a lot from the ICU where I was first assigned after I returned to the hospital after training. (2-3).

I was assigned to the SICU [surgical intensive care unit], where there were many neurosurgical patients. In fact, patients with COVID-19 have many respiratory problems, but I only cared for neurosurgical patients for 2 weeks. I could provide critical care, but I could not practice the important aspects of caring for patients with COVID-19. (2-4).

Perceived self-efficacy in critical care after training. Medical equipment such as continuous renal replacement therapy (CRRT) and ECMO were new to nurses without ICU experience; however, training improved their understanding of how to use the equipment, as they were able to practice setting up and preparing it in person, as well as observe how to apply it to various patients. This was also a good opportunity to clarify medications with which they were previously unfamiliar. Consequently, overall nursing competency for critical care improved, including assessment of the nervous system, in addition to the respiratory system. Participants became more communicative with their colleagues as a result, and the quality of patient care improved, leading to increased self-confidence in nursing.

I was unfamiliar with ventilators, but learning about them and operating one by myself during training helped me gain a clear understanding of how to use them. I was roughly aware of what would happen based on theoretical knowledge" if applicable, but I gained a clearer understanding of what the figures mean when operating the CRRT. (1-3).

I have worked only in the ward in the hospital, so I did not provide actual care for patients. However, after training, I [now] know how to look after the patients. (2-5).

I am less fearful than before, and I have a little more self-confidence. My fear of machines dissipated a lot, and now I can interpret their output. In that respect, I think I have changed significantly. (3-2).

Motivation by nurses with expertize. Participants were motivated by expert nurses, the program educators' expertize and passion, the teamwork spirit between medical staff in emergency situations, and the nurse preceptors' management of material resources in

preparation for emergency situations. They reflected on their nursing practice so far and attempted to apply what they had learned after returning to their workplaces.

The nurse educators really looked like professionals, and even though I have been working in the clinical field for a long time, I thought I still had so much to improve [on], so I felt ashamed of myself. I was a lot more motivated. (1-1).

She was very experienced [from working] at another hospital. After perusing my experience, she skipped content that would have been redundant and explained the theory first, about procedure, with which I was unfamiliar and then, I got the chance to practice it after she gave me a demonstration of how to do it. She is so impressive because she actively taught me in this way. (3-2).

In the practice session, there was a nurse who was really good at organizing and cleaning up. She organized everything in the ward for use in emergency situations. So, now I am also organizing staff in my ward. (1-3).

Category 2. Recommendations for improving the training program

The second category concerns participants' post-training opinions regarding the need to improve future training, as well as trainees' perceptions of the actual situation as soon-to-be critical care nurses.

Inclusion of specific institutional practice. Participants were disinterested in medical equipment and practices that had not yet been established at their workplace. In cases where some participants' home institutions were equipped with some of them, product type varied; hence, there was an adjustment period. Participants therefore demanded customized training to reflect their work environment. On the other hand, since the education program was administered by an external institution, there were problems such as having to practice in the pediatric intensive care unit (PICU) even though some participants did not have pediatric intensive patients at their institution. Therefore, regarding education delivery methods, it was suggested that it would be more efficient if nurse educators could visit the institution where the trainees belong and provide content tailored to their respective work environments, rather than having trainees visit a site other than their institution. In addition, participants also said that when they received training at another institution, it was difficult to care for critically ill patients immediately after returning to their own, and sufficient time should be provided for them to adjust to a preceptor.

My hospital is not equipped with CRRT or ECMO yet, so even though I have learned about these, there is nowhere to apply it. That's a shame. Now, I am aware of it only theoretically. If that equipment is introduced in my hospital later, I think I [will] need to learn to use them from scratch again. (2-1).

In the practice session, some of us were assigned to the PICU. It is very rare to see pediatric patients in my hospital. We just practiced for no reason because there is almost no opportunity to apply such knowledge after returning. (2-2).

Because the systems are completely different between the hospital where I received training and the one where I am working, it seems like it would take far more than a month or two to apply what I learned in training in the field. However, as I cannot receive training forever, I think that after practicing in the external institution for about a month as I am doing now, I will need time to adapt to the field again. After grasping the bigger concept, I think we should focus on the finer details after returning. (2-2).

More hands-on practice and simulation training. Given that critically ill patients' status changes frequently and rapidly, it was found that the current mainly observation-based 4-week theoretical and practical training program was limited in terms of its ability to enhance participants' adaptability and coping skills in the field. Despite their theoretical understanding after training, many participants doubted whether they had acquired the actual practical skills to care for critically ill patients. In addition, the need for simulation training was mentioned as a means to increase the program content's practical applicability.

If participants in training receive content that is applicable in practice, then nurses will know how to take care of critically ill patients. We need to be trained on how to cope with situations according to the test results and the status of patients. (1-4).

We know the alphabet from A to Z, but it is difficult to speak in English. I know how to turn the machines on and off, but I think it takes more time and effort to apply such things and cope with unexpected situations. (3-3).

Currently, nursing students' simulation training involves a demonstration with a simulator. It will be helpful for us to repeat such practice and apply it to different situations. (1-2).

Inclusion criteria for trainee selection. Trainees either participated in training voluntarily or upon recommendation from a manager at their workplace, such as a head nurse. Institutions recommended personnel for training based on their ICU work experience and the trajectory of their nursing career. Voluntary participants felt the need to acquire additional knowledge and more advanced methods when their hospital was designated for patients with COVID-19. Post-training, participants could cope well with emergency situations. They also created ripple effects by educating other nurses when they returned to work. Such personnel should have sufficient (5–10 years or more) experience in nursing practice and be motivated to receive training.

Since the hospital where the practice sessions are held is large and well organized, it would be good if nurses with about five years of nursing experience or those with an intermediate position or higher receive training and can teach junior nurses what they learned upon return. (2-2).

Motivation seems to be the most important factor. Nurses with no interest have nothing to gain despite [the] opportunities [they are] given, but it will be a good opportunity for motivated nurses to learn a lot if the hospital provides the opportunities. (3-2).

Category 3. Perceptions of working in an infectious environment

The third category concerns perceptions of caring for critically ill patients that should be considered when developing future training program content.

Anxiety and fear about the work. Participants received training during the relevant period, but even thereafter, they were still not accustomed to caring for critically ill patients and feared mishandling situations due to the inability to predict changes in patients' condition.

I received training, but I will be under a lot of pressure to save patients' lives under conditions to which I am not fully accustomed. I am anxious about communication, such as knowing what exactly to do as a nurse in charge, giving instructions to acting nurses, and reporting to doctors. (1-1).

I have no idea when the patient's condition changes. Because I am not good at coping with such situations, I feel anxious in that sense. This is not anxiety about caring for patients. This may be because I am not good at dealing with rapidly changing situations. (3-4).

Burden of wearing personal protective equipment. Nurses caring for critically ill patients with COVID-19 must wear PPE. However, participants had difficulty working while wearing PPE because the equipment acted as a major physical obstacle. On the other hand, anticipating emergency cases in which there is inadequate time to put on PPE, they expressed their views about ethical dilemmas related to PPE.

I cannot hear well in PPE. During emergencies, I need to move quickly. So, I am afraid that because I [could] mistakenly hear a doctor's prescription, I may give [a patient] an incorrect drug or do something wrong, causing harm to a patient. (1-2).

Of course, I am afraid of performing cardiopulmonary resuscitation in general, but in the case of COVID-19, we need to do it in Level D PPE. Therefore, it is inevitable that we get slower at doing everything. Because communication is not easy and movement, for example, to get something is slowed down, we need more staff. It is difficult, even for experienced people. Therefore, it will be especially difficult for inexperienced nurses. (2-2).

When emergencies occur, we run. However, in that situation, if we go there without wearing PPE, we cannot protect ourselves, and if we put on PPE, it takes more than 10 minutes. However, as you know, timing is very important. I am really concerned about what I should do in a situation like that. (1-3).

Analysis of educational needs using Borich's formula

The results of the analysis of the subjects' educational needs for critical care are presented in Table 3. Regarding the subjects'

Table 3 Analysis of Critical Care Educational Needs and Priority.

Content	Importance M±SD	Confidence M±SD	z	p	Borich score	Borich priority
Respiratory nursing						
Anatomy and physiology of the respiratory system	4.31 ± 0.80	3.44 ± 0.51	3.27	.001	3.77	13
Physical assessment of the respiratory system	4.31 ± 1.01	3.44 ± 0.51	2.56	.010	3.77	13
Oxygen therapy (including high-flow oxygen therapy)	4.63 ± 0.71	3.88 ± 0.61	2.26	.023	3.47	16
Nursing care for the patient with dyspnea	4.69 ± 0.79	3.81 ± 0.65	2.95	.003	4.10	11
Nursing care of patients on intubation	4.50 ± 1.03	3.63 ± 0.71	2.37	.017	3.94	12
Understanding a mechanical ventilator	4.75 ± 0.57	3.25 ± 0.57	3.38	.001	7.13	4
Nursing care of patients on mechanical ventilators	4.75 ± 0.68	3.19 ± 0.75	3.47	.001	7.42	3
Nursing care of a patients on extubation	4.50 ± 0.89	3.31 ± 0.79	2.55	.011	5.34	8
Application of the prone positioning	4.00 ± 1.26	3.13 ± 1.02	1.81	.069	3.50	15
Tracheostomy management	4.31 ± 0.87	3.06 ± 0.77	2.98	.003	5.39	7
Understanding of a diagnostic test for pneumonitis and its treatment	4.44 ± 0.72	3.38 ± 0.61	2.98	.003	4.71	10
Understanding of a diagnostic test for ARDS and its treatment	4.38 ± 1.08	3.13 ± 0.61	2.83	.005	5.47	6
Understanding of Aspergillus co-infections	4.38 ± 0.88	2.94 ± 0.68	3.23	.001	6.29	5
Understanding of ECMO	4.25 ± 1.06	2.44 ± 1.15	2.70	.007	7.70	2
Nursing care for patient on ECMO	4.25 ± 0.93	2.00 ± 0.81	3.24	.001	9.56	1
Understanding of ABGA and acid-base imbalance	4.69 ± 0.62	3.56 ± 0.62	3.28	.001	5.27	9
Non-respiratory nursing						
Anatomy and physiology of the circulatory system	4.38 ± 0.80	3.19 ± 0.65	3.09	.002	5.47	7
Physical assessment of the circulatory system	4.44 ± 0.89	3.19 ± 0.65	3.33	.001	5.82	5
Understanding of ECG	4.50 ± 0.81	3.00 ± 0.63	3.21	.001	6.75	3
Defibrillator application	4.63 ± 0.71	3.50 ± 0.89	3.16	.002	5.49	6
Understanding of a diagnostic test for acute coronary syndrome and its treatment	4.38 ± 0.88	2.94 ± 0.85	3.13	.002	6.29	4
Understanding of CPR	4.50 ± 0.96	3.38 ± 0.80	3.08	.002	5.34	8
Nursing care of patients with shock	4.44 ± 1.03	3.31 ± 0.70	2.33	.019	5.27	9
Anatomy and physiology of the digestive system	4.31 ± .060	3.56 ± 0.62	2.65	.008	3.50	15
Physical assessment of the digestive system	4.25 ± 0.68	3.38 ± 0.71	2.81	.005	3.98	14
Understanding of a diagnostic test for digestive system diseases and its treatment	4.13 ± 0.88	3.44 ± 0.51	2.11	.035	3.09	17
Nutrition management	4.06 ± 1.06	3.69 ± 0.60	2.38	.166	1.78	20
Anatomy and physiology of the kidney system	4.19 ± 0.91	3.13 ± 0.71	3.32	.001	4.71	11
Physical assessment of the kidney system	4.13 ± 1.08	3.06 ± 0.77	2.50	.012	4.64	12
Understanding of CRRT	4.31 ± 1.08	2.69 ± 0.87	2.83	.005	7.55	2
CRRT application and nursing care	4.38 ± 1.07	2.31 ± 0.70	3.23	.001	9.30	1
Thrombosis prevention	4.13 ± 1.08	3.06 ± 0.85	2.47	.013	4.38	13
Anatomy and physiology of the nervous system	4.25 ± 0.93	3.13 ± 0.71	3.16	.002	5.05	10
Physical and consciousness assessment of the nervous system	4.19 ± 1.04	3.44 ± 0.72	2.19	.028	3.40	16
Nursing care for stroke patient	4.13 ± 1.20	3.44 ± 0.72	1.96	.049	3.09	17
Nursing care for delirium patient	4.06 ± 1.23	3.38 ± 0.71	2.65	.008	2.79	19
Infection control						
Understanding of respiratory infectious diseases	4.69 ± 0.60	3.81 ± 0.65	3.35	.001	4.10	2
Application of PEE in each nursing situation	4.63 ± 0.80	3.75 ± 0.68	2.50	.012	4.05	3
Aerosol-generating procedures (AGPs)	4.44 ± 0.89	3.31 ± 1.01	2.02	.003	4.99	1
Disposal of infectious waste	4.38 ± 0.80	4.06 ± 0.44	1.66	.096	1.37	6
Disinfection of medical devices and hospital rooms of quarantined patients	4.44 ± 0.89	4.13 ± 0.34	1.38	.166	1.39	5
Nursing care of a patient after death	4.19 ± 1.10	3.81 ± 0.75	1.30	.193	1.57	4

CPR = cardio-pulmonary resuscitation; CRRT = Continuous renal replacement therapy; ECG = electrocardiogram; ECMO = Extracorporeal membrane oxygenation; M = Mean; SD = Standard deviation.

educational needs for respiratory nursing, for all items except application of the prone position ($p = .069$), the importance and level of the subjects' self-confidence in their current performance showed a statistically significant difference ($p = .05$). Within the framework of Borich's needs, five items were identified; in descending order, starting with the most urgent, these were: nursing care for patients on ECMO, understanding ECMO, nursing care for patients on artificial ventilators, understanding artificial ventilation, and Aspergillus co-infection. Regarding the educational needs for non-respiratory nursing, for all items except nutrition management ($p = .166$), the importance and level of subjects' self-confidence in their current performance showed a statistically significant difference ($p = .05$). Within the framework of Borich's needs, the following five items were the most urgently needed: application of CRRT and nursing care for such patients, understanding CRRT, understanding electrocardiogram (ECG), understanding diagnostic testing for acute coronary syndrome and its treatment, and physical assessment of the circulatory system. Regarding educational needs for infection control, a statistically significant difference ($p = .05$) was found in the importance and level of current performative self-confidence for the following items: understanding respiratory infectious diseases ($p = .001$), application of PPE to various nursing situations ($p = .012$), and aerosol-generating procedures ($p = .003$), except for the disposal of infectious waste ($p = .096$), disinfection of medical devices and quarantined patients' hospital rooms ($p = .166$), and post-mortem patient care ($p = .193$). In addition, based on Borich's needs, the following items were, in descending order, the most urgently needed: aerosol-generating procedures, understanding respiratory infectious diseases, and application of PPE to various nursing situations. The results for the trainees' learning methods are shown in [Table 4](#).

Discussion

This study aims to explore participation experiences with COVID-19 training program and clinical nurses' educational needs on this area. The findings have a few implications.

First, based on the FGIs, regarding their training experience, the participants thought that the critical care nursing program was initially poorly organized but noted that this improved over time. Moreover, there were educational infrastructural shortcomings, even at the hospitals where the training was conducted, because of the voluminous increase in the number of critically ill patients due to COVID-19 and a shortage of critical care nurses. Accordingly, the participants did not view the early-stage programs as effective. However, with successive training sessions and progressive systematization, the participants eventually expressed satisfaction with the content. A study [9] on nursing experiences with patients with confirmed COVID-19 diagnoses involving Iranian nurses emphasized the importance of supplying trained nursing personnel prepared to cope with pandemic situations. This study also highlighted the importance of systematic education programs and manpower supply-and-demand planning to prepare for medical crises. In addition, in this study, it was necessary for the participants to practice providing nursing care for patients with confirmed COVID-19 diagnoses; however, the risk of infection and efforts toward strict infection control made it difficult to proceed with such practice. Nevertheless, the ability to cope with various situations involving respiratory infectious diseases is essential for dedicated nursing personnel responsible for caring for critically ill patients with respiratory diseases, unlike other communicable infectious diseases. Therefore, to overcome such situations, it will be necessary to develop diverse simulation training programs using high-fidelity simulation or virtual reality so that trainees can practice providing critical care for confirmed COVID-19 cases in the program setting.

Second, the content of the FGIs conducted as part of this study showed that pre-training, the participants feared caring for confirmed COVID-19 patients, but their fear declined after training, and their competency as dedicated nurses for critically ill patients improved. They were also found to be stimulated by expert nurses. A study conducted in China [24] on nurses caring for confirmed COVID-19 patients reported that nurses without prior experience caring for patients with infectious diseases or critically ill patients feared performance of such nursing care and experienced stress as a result. A study [11] conducted in Korea involving nurses experienced with caring for confirmed COVID-19 patients also reported psychological pressure among the nurses because they were assigned to critical care with insufficient experience caring for infected patients. Similarly, the participants in this study also expressed feelings of fear before training and a decline in self-confidence. However, the study results showed that nursing education for critically ill patients improved the subjects' self-confidence in terms of nursing assessment, drug administration, and use of medical equipment. This indicates that nursing programs for critically ill patients with infectious diseases are an effective method to enhance nursing competency for critical care and the quality of nursing care.

Third, the content of the FGIs conducted in this study revealed the need for customized education to suit participants' clinical settings, education that increases practical applicability, and proper trainee selection. In particular, participants suggested that it would be more effective if nurse educators could visit the institutions where the trainees work and provide education tailored to their respective working environments, rather than having participants attend external institutions for training. As previously mentioned, the Korean government has designated hospitals for COVID-19 and established more ICUs [5], as well as rapidly launching educational programs to secure dedicated nursing personnel to care for critically ill patients [6]. However, it is thought that there is a limit to increasing the supply of dedicated nursing staff for critical care at each hospital through the current critical care nursing programs because every hospital's system and settings are different, and critically ill patient care requires the use of various medical equipment. In addition, there was a demand for simulation of the required educational content. Given that simulation education improves clinical performance and knowledge more than conventional educational methods, the scope of nursing education for students is expanding [25,26]. However, hospitals face challenges acquiring expensive simulation facilities and equipment, and scenario development, training for educators, and operation and management also present difficulties [20]. Therefore, regarding training programs for nursing critically ill patients with communicable infectious diseases, it is necessary to share and develop simulation equipment to deliver training practice and content through systematic connections between hospitals and schools in the long term. Government support will be needed to establish a simulation center for healthcare personnel through school–work links.

Fourth, the nurses reported that because they were unaccustomed to caring for critically ill patients and could not predict the situations in which they would be placed, they feared providing such care. Previous studies [8,9] have reported that healthcare personnel described caring for confirmed COVID-19 patients as more difficult and stressful than caring for other patients. This study also showed that caring for critically ill patients with infectious diseases is intense and highly stressful, although the subjects received related training. However, a previous study [24] on nurses working in isolation wards revealed a case in which nurses who had worked in another ward were assigned to the isolation ward, indicating that it intensive cases for the acquisition

Table 4 Analysis of Critical Care Educational Methods.

Content	Lecture N (%)	Lecture + practice N (%)	HFS N (%)	VR N (%)	Others N (%)
Respiratory Nursing					
Anatomy and physiology of the respiratory system	12 (75.0)	1 (6.3)	1 (6.3)	2 (12.5)	0 (0.0)
Physical assessment of the respiratory system	6 (37.5)	2 (12.5)	6 (37.5)	1 (6.3)	1 (6.3)
Oxygen therapy (including high-flow oxygen therapy)	6 (37.5)	3 (18.8)	5 (31.3)	2 (12.5)	0 (0.0)
Nursing care for the patient with dyspnea	6 (37.5)	1 (6.3)	3 (18.8)	6 (37.5)	0 (0.0)
Nursing care of patients on intubation	3 (18.8)	2 (12.5)	8 (50.0)	3 (18.8)	0 (0.0)
Understanding a mechanical ventilator	8 (50.0)	3 (13.8)	1 (6.3)	4 (25.0)	0 (0.0)
Nursing care of patients on mechanical ventilators	5 (31.3)	2 (12.5)	4 (25.0)	5 (31.3)	0 (0.0)
Nursing care of a patients on extubation	5 (31.3)	3 (13.8)	5 (31.3)	3 (13.8)	0 (0.0)
Application of the prone positioning	3 (13.8)	2 (12.5)	8 (50.0)	3 (13.8)	0 (0.0)
Tracheostomy management	3 (13.8)	2 (12.5)	9 (56.3)	1 (6.3)	0 (0.0)
Understanding of a diagnostic test for pneumonitis and its treatment	14 (87.5)	1 (6.3)	1 (6.3)	0 (0.0)	0 (0.0)
Understanding of a diagnostic test for ARDS and its treatment	14 (87.5)	1 (6.3)	1 (6.3)	0 (0.0)	0 (0.0)
Understanding of Aspergillus co-infections	13 (81.3)	1 (6.3)	1 (6.3)	1 (6.3)	0 (0.0)
Understanding of ECMO	9 (56.3)	3 (13.8)	1 (6.3)	3 (13.8)	0 (0.0)
Nursing care for patient on ECMO	2 (12.5)	5 (31.3)	4 (25.0)	5 (31.3)	0 (0.0)
Understanding of ABGA and acid-base imbalance	12 (75.0)	0 (0.0)	2 (12.5)	2 (12.5)	0 (0.0)
Non-Respiratory Nursing					
Anatomy and physiology of the circulatory system	14 (87.5)	1 (6.3)	1 (6.3)	0 (0.0)	0 (0.0)
Physical assessment of the circulatory system	8 (50.0)	1 (6.3)	6 (37.5)	0 (0.0)	1 (6.3)
Understanding of ECG	8 (50.0)	2 (12.5)	3 (13.8)	3 (13.8)	0 (0.0)
Defibrillator application	0 (0.0)	7 (43.8)	7 (43.8)	2 (12.5)	0 (0.0)
Understanding of a diagnostic test for acute coronary syndrome and its treatment	10 (62.5)	1 (6.3)	2 (12.5)	3 (13.8)	0 (0.0)
Understanding of CPR	1 (6.3)	3 (13.8)	7 (43.8)	5 (31.3)	0 (0.0)
Nursing care of patients with shock	9 (56.3)	1 (6.3)	2 (12.5)	4 (25.0)	0 (0.0)
Anatomy and physiology of the digestive system	13 (81.3)	0 (0.0)	2 (12.5)	1 (6.3)	0 (0.0)
Physical assessment of the digestive system	10 (62.5)	2 (12.5)	2 (12.5)	1 (6.3)	1 (6.3)
Understanding of a diagnostic test for digestive system diseases and its treatment	14 (87.5)	0 (0.0)	2 (12.5)	0 (0.0)	0 (0.0)
Nutrition management	13 (81.3)	2 (12.5)	1 (6.3)	0 (0.0)	0 (0.0)
Anatomy and physiology of the kidney system	14 (87.5)	1 (6.3)	1 (6.3)	0 (0.0)	0 (0.0)
Physical assessment of the kidney system	10 (62.5)	1 (6.3)	3 (13.8)	1 (6.3)	1 (6.3)
Understanding of CRRT	10 (62.5)	3 (13.8)	2 (12.5)	1 (6.3)	0 (0.0)
CRRT application and nursing care	0 (0.0)	7 (43.8)	4 (25.0)	5 (31.3)	0 (0.0)
Thrombosis prevention	14 (87.5)	0 (0.0)	2 (12.5)	0 (0.0)	0 (0.0)
Anatomy and physiology of the nervous system	14 (87.5)	0 (0.0)	2 (12.5)	0 (0.0)	0 (0.0)
Physical and consciousness assessment of the nervous system	7 (43.8)	2 (12.5)	5 (31.3)	1 (6.3)	1 (6.3)
Nursing care for stroke patient	10 (62.5)	1 (6.3)	3 (13.8)	2 (12.5)	0 (0.0)
Nursing care for delirium patient	12 (75.0)	1 (6.3)	1 (6.3)	2 (12.5)	0 (0.0)
Infection control					
Understanding of respiratory infectious diseases	14 (87.5)	1 (6.3)	1 (6.3)	0 (0.0)	0 (0.0)
Application of PEE in each nursing situation	11 (68.8)	1 (6.3)	2 (12.5)	2 (12.5)	0 (0.0)
Aerosol-generating procedures (AGPs)	11 (68.8)	1 (6.3)	2 (12.5)	2 (12.5)	0 (0.0)
Disposal of infectious waste	13 (81.3)	1 (6.3)	1 (6.3)	1 (6.3)	0 (0.0)
Disinfection of medical devices and hospital rooms of quarantined patients	13 (81.3)	1 (6.3)	1 (6.3)	0 (0.0)	1 (6.3)
Nursing care of a patient after death	9 (56.3)	0 (0.0)	5 (31.3)	2 (12.5)	0 (0.0)

CPR = cardio-pulmonary resuscitation; CRRT=Continuous renal replacement therapy; ECG = electrocardiogram; ECMO = Extracorporeal membrane oxygenation; HFS=High fidelity simulation; M = Mean; SD=Standard deviation; VR=Virtual simulation.

of infection control, self-protection, and communication skills for self-improvement would be helpful as a turning point in career development. In conclusion, nurses are professionals with a sense of duty and a drive for self-improvement. Therefore, if systematic education programs can be provided to regularly and adequately meet subjects' needs amid a national crisis, the burden of nursing care for critically ill patients may lighten, and even when pandemic infectious diseases occur in the future, there will be a sufficient supply of critical care nurses.

Fifth, in this study, the subjects' educational needs for critical care were analyzed using Borich's formula. The results showed that demand was the highest for ECMO and mechanical ventilation among the educational needs for respiratory nursing, while for

non-respiratory nursing, there was high demand for CRRT and ECG application. This corresponds to the results of a study [20] in which educational needs were investigated in ICU nurses through analysis of the importance of nursing practice, performance frequency, and level of difficulty. In that study, the subjects' most urgent educational needs were related to high-risk equipment such as ECMO, ventricular assistance devices, artificial pacemakers, and intra-aortic balloon pumps.

To provide such education, educational institutions should be equipped with medical devices at the relevant hospitals, and these devices should be readily available. Since long-term education and experience with a diverse cross-section patients are necessary, the government and nursing educators should contemplate appropriate

educational programs. In terms of infection control, the most pressing needs were aerosol-generating procedures, understanding respiratory infectious diseases, and situational PPE application. Therefore, it is necessary to organize educational programs that reflect these results. In the case of patients with respiratory infectious diseases in particular, there are various issues, including situational PPE application. Clinical nurses face many challenges in nursing practice. Amid the current COVID-19 pandemic crisis, it will be necessary to standardize guidelines for nursing patients with respiratory infectious diseases across several countries through collaborative efforts, instead of using standardized nursing guidelines limited to one nation. In addition, because this study's subjects wanted training regarding the use of high-risk equipment, training should be delivered mostly as practice or based on high-fidelity simulation or virtual reality, necessitating collaborative efforts to develop appropriate programs.

This mixed-methods study's significance lies in its in-depth investigation of nurses' educational needs for nursing critically ill patients. We have made suggestions based on the results obtained. First, it can be seen that a nursing education program for critically ill patients with infectious diseases is an effective means to enhance nurses' critical care capacity and improve the quality of nursing care. Therefore, various educational programs have been established, and research to verify their effectiveness is suggested. Second, the participants highlighted the merits of educational nurses receiving national-centered education followed by education tailored to their home institution's specific working environment. Therefore, it is necessary to build a network to nurture nursing education, specifically supporting tailored education at individual hospitals. Third, content that it is difficult to deliver in the nursing education program for patients with infectious diseases needs to be developed as part of a simulation education program.

The limitations of this study are as follows. It is common to calculate the number of samples based on the t-test for the Borish education need assessment equation. In the case of embedded design among mixed methods research, embedded data plays a secondary role and be supplemental to the primary dataset. As a mixed method study was conducted with same 16 nurses, calculation for the minimum sample size, validation of the reliability and validity of the newly developed tool were omitted in this study. In addition, this study involved nurses at government-designated COVID-19 hospitals, it is necessary to also identify the educational needs of nurses who care for confirmed COVID-19 patients in the wider clinical field. Repeated future studies on educational needs should therefore be conducted by expanding the subjects to include various types of hospitals.

Conclusion

Changes in the medical industry due to COVID-19 demand changes in, including the expansion of, nurses' roles, an increase in the quality of nursing care, and a high level of knowledge and skills. Such demands emphasize the need to acquire new knowledge and skills for critical care. A number of participants in this study saw the need for critical care education and noted that training improved critical care nursing competency. Therefore, it is necessary to develop educational programs for nursing critically ill patients to meet learners' needs, enhance the educational effect of nursing programs for critical care, and supply healthcare personnel to satisfy social needs.

Ethical consideration

The institutional review board reviewed and approved the study (GWNUIRB-2021-12).

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Consent for publication

Not applicable.

Availability of data and materials

The data presented in this study are available on request from the corresponding author.

Conflict of interest

The authors have no competing interests to declare.

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