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Expert Consensus on Measures to Promote Physical and Psychological Health among COVID-19-Related Healthcare Workers in Korea using Delphi Technique

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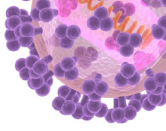
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ABSTRACT

Background: The coronavirus disease 2019 (COVID-19) pandemic has caused health problems and distress among healthcare workers (HCWs), so supportive measures to promote their health and relieve distress are needed.

Materials and Methods: We conducted two rounds of Delphi surveys with 20 COVID-19-related frontline healthcare professionals and public officials. The surveys evaluated means of supporting HCWs' health by improving health care systems and working environments in terms of effectiveness and urgency. The validity of the measures was assessed by calculating the content validity ratio.

Results: The top-priority measures to support HCWs were "secure isolation units capable of treating severe cases" in the facility infrastructure category, "secure nursing staff dedicated for patients in the intensive care units" in the personnel infrastructure category, "improve communication between central office and frontline field" in the cooperation system category, "support personal protective equipment and infection control supplies" in the



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Conflict of Interest

No conflict of interest.

Author Contributions:

Conceptualization: SHL, KTK, YK. Data curation: HWR, KP, SYP, SL, HSC, STH, KJH. Formal analysis: JN, KK. Investigation: HWR, KP, SYP, SL, HSC, STH, KJH. Methodology: JN, KK. Writing - original draft: SHL, JN, KK. Writing - review & editing: YK, HWR, KP, SYP, SL, HSC, STH, KJH, KTK.

aid supplies category, and “realization of hazard pay” in the physical/mental health and compensation category.

Conclusion: There was consensus among the experts on the validity and priorities of policies in the facility, personnel, cooperation, supplies, and compensation categories regarding measures to promote COVID-19 related HCWs' health.

Keywords: COVID-19; Delphi technique; Health personnel; Policy

INTRODUCTION

Novel coronavirus disease 2019 (COVID-19) is an emerging infectious disease (EID) first identified in Wuhan, China, in December 2019 and declared a global pandemic in March 2020 [1]. High transmission rate of COVID-19 had led to dramatic increase of confirmed patients and work overload to healthcare workers (HCWs). HCWs reportedly experience mental health problems and burnout due to stress and the risk of infection during COVID-19 pandemics [2, 3]. A review of the mental health of HCWs who perform COVID-19-related work showed symptoms of extreme tension, depression, and anxiety due to stress, with approximately 29.0% of respondents exhibiting moderate-to-severe disability and 2.2 - 14.5% showing serious stress-related psychiatric symptoms [4]. Prolongation of the COVID-19 pandemic has exacerbated the high burnout rate of HCWs [5, 6].

HCWs are important for preventing and controlling infectious diseases, caring for individuals subject to self-isolation and confirmed patients, and public health. If an infection spreads to HCWs or they suffer from psychological distress or burnout, the healthcare system is at risk of collapse due to a shortage of personnel providing patient care. We conducted focus group interviews in which HCWs mostly complained of work-related struggles [7]. HCWs were overwhelmed by lack of well-trained staff, life without break, communication difficulties, and role ambiguity. Finally, they requested improving the working environment and health care system to solve their sufferings fundamentally [7].

The medical system and the healthcare system may vary among countries and there is a lack of studies on group decision making by Korean health experts, on measures to improve working environment for HCWs who perform COVID-19 related services and to establish the psychological support system to accomplish better performances. Accordingly, we used the Delphi technique to derive an expert consensus on policies to promote physical and psychological health among HCWs during COVID-19 epidemics.

MATERIALS AND METHODS

1. Data collection

A two-round Delphi survey was conducted from July to August 2021 with a 20-member expert panel consisting of COVID-19-related healthcare professionals and public officials. The Delphi survey items were selected based on the analysis of focus group interviews and individual in-depth interviews regarding the support and improvement measures needed to promote physical and psychological health among COVID-19-related healthcare workers. Prior to this study, we conducted extensive literature review and focus group interviews in which HCWs were challenged by working in critical situations, heavy workloads, fear of

infection, lifestyle changes, and psychological as well as physical struggles [7]. Moreover, they demanded improvements in cooperation or reporting systems and basic infrastructure, such as facilities, personnel, and supplies [7].

The perspective of the evaluation is unmet need of the medical field in context of COVID-19 pandemic in Korea. To identify and prioritize the improvement measures for physical and psychological health among COVID-19 related HCWs, two criteria elements in basic priority rating system (BPRS) [8] were employed. We measured the validity of two elements, the effectiveness and the urgency with respect to improvement measures needed for facilities, personnel, cooperation systems, aid supplies, physical/mental health, and compensation support. Validity was assessed on a five-point Likert scale (1, low; 5, high) and priorities were assessed using the measures in each category (for n measures in a category, assess each as the 1st to n th priority) [9]. The questionnaire also included items that assessed demographic characteristics and COVID-19-related work experience.

2. Ethics statement

The institutional review board of the National Medical Center (IRB No. NMC-2010-081) approved this study and the informed consents from experts who agreed to participate in the study were obtained.

3. Data processing

The Delphi technique involves structuring the collective intelligence of an expert panel through repeated communications. This is mediated by repetitive and controlled feedback in an environment that assures the anonymity of the respondents. The survey was conducted with typical procedure and guidelines of Delphi method which have been described elsewhere in detail [10, 11]. To obtain reliable results using the Delphi technique, it is recommended to form a panel of at least 10 - 15 individuals with homogeneous characteristics [12]. In this study, we established a panel of 20 experts who were specifically selected to cover the range of multidisciplinary clinical and policy expertise needed to respond COVID-19 (Table 1). An expert panel of 14 physicians (specialists of infectious disease, respiratory medicine, emergency medicine, surgery and psychiatry), 4 nurses, and 2 public officials were invited personally by the study group via email or telephone to participate in the process through sub-specialty groups and personal contacts.

The content validity ratio (CVR) was calculated to assess whether differences in opinion among panel members were accepted as shared opinions. The threshold for CVR was determined according to the number of panels; for 20 panels, items with a CVR of ≥ 0.42 were considered valid [13]. The only improvement measures that CVR was above the threshold in both effectiveness and urgency was considered to be valid. Degrees of consensus and the convergence index were used as secondary indicators to assess consensus and convergence [14]. Convergence has a value of 0 when opinions fully concur. The value increases with increasing deviation; values ≤ 0.5 represent positive convergence. Consensus was based on the first quartile (Q1) and third quartile (Q3) values. The value is 1 when complete agreement is reached and decreases as the deviation among opinions increases. A consensus value of ≥ 0.75 suggests that agreement was achieved. Descriptive statistics were used to summarize the demographic characteristics of the expert panel, with numerical data presented as means and standard deviations and categorical data as frequencies and percentages. Statistical significance was determined based on a two-tailed 5.0% level. Data were processed using STATA/MP 16.1 (StataCorp, College Station, TX, USA) and Microsoft Office Excel® (Microsoft Corp., Redmond, WA, USA).

Table 1. General characteristics of Delphi panelists

Variables	Frequency	Percentage (%)
Gender		
Male	11	55.0
Female	9	45.0
Age, years (min = 38, max = 59) ^a	46.1	6.3
Work area		
Seoul	10	50.0
Other than Seoul	10	50.0
Work institution		
General hospital	6	30.0
University hospital	12	60.0
Public health center	1	5.0
Public office	1	5.0
Occupation		
Physician	14	70.0
Nurse	4	20.0
Public official	2	10.0
Specialty		
Infectious diseases	8	40.0
Respiratory medicine	1	5.0
Emergency medicine	2	10.0
Surgery	1	5.0
Psychiatry	2	10.0
Others	5	25.0
Clinical experience, years (min = 6.6, max = 38) ^a	19.7	7.4

^aMean and standard deviation were presented.

RESULTS

The demographic and COVID-19 work-related characteristics of the Delphi panelists are shown in **Table 1**. There were more males (55.0%) than females, and the mean age was 46.1 ± 6.3 years. Of the respondents, 50.0% worked in Seoul and 50.0% elsewhere, and 90.0% worked in a general or university hospital. With respect to occupation, most respondents were physicians (70.0%), and infectious disease (40.0%) was the most common specialty. The mean clinical experience of the respondents was 19.7 ± 7.4 years.

The initial round of validity of measures to promote physical and psychological health among COVID-19-related healthcare workers by category is shown in **Table 2**. It was identified that 5 out of 26 (19.2%) improvement measures were assessed as valid with respect to effectiveness and urgency. Panelists also rated the priorities of health-promotion measures among healthcare professionals who perform COVID-19-related work. **Table 3** displays the results of initial round, including average ranks for each improvement measures. Following the initial round of survey, the second round of validity of measures to promote physical and psychological health among COVID-19-related healthcare workers by category is shown in **Table 4**. It was identified that 13 out of 26 (50.0%) improvement measures were assessed as valid with respect to effectiveness and urgency compared to initial round. The second round of the priorities of health-promotion measures among healthcare professionals who perform COVID-19-related work are shown in **Table 5**. In the second round, all measures evaluated as valid in the first round were ranked higher than in the first round.

It was identified that three measures were assessed as valid with respect to both effectiveness and urgency in the facility infrastructure category, namely “design structures that can be prepared for infectious diseases”, “secure isolation units capable of treating severe cases”,

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Table 2. Delphi round one results: assessment by category of the validity of measures to promote health among healthcare workers who perform COVID-19-related work

Categories and improvement measures		Mean	SD	CVR	Consensus	Convergence
Facility infrastructure						
Design structures that can be prepared for infectious diseases	Effectiveness	4.60	0.70	0.70	0.80	0.50
	Urgency	3.80	0.70	0.40	0.80	0.50
Secure isolation units capable of treating severe cases	Effectiveness	4.60	0.70	0.90	0.80	0.50
	Urgency	4.20	0.90	0.60	0.80	0.50
Secure enough beds in emergency medical centers	Effectiveness	4.60	0.60	0.90	0.80	0.50
	Urgency	4.30	0.70	0.70	0.80	0.50
Provide housing or vehicle support for healthcare workers	Effectiveness	3.20	0.70	-0.30	0.70	0.50
	Urgency	2.90	0.80	-0.60	0.70	0.50
Secure active monitors and beds for confirmed patients in preparation for confirmed cases in psychiatric ward	Effectiveness	3.70	1.20	0.00	0.40	1.00
	Urgency	3.30	1.20	-0.10	0.30	1.00
Apply non-face-to-face, remote, centralized intensive care facilities and systems in the infectious disease ward	Effectiveness	4.20	0.70	0.80	0.80	0.50
	Urgency	3.60	0.80	-0.10	0.70	0.50
Personnel infrastructure						
Secure nursing staff dedicated for patients in the intensive care units	Effectiveness	4.60	0.60	0.90	0.80	0.50
	Urgency	4.50	0.70	0.90	0.80	0.50
Develop experienced infectious disease personnel	Effectiveness	4.50	0.70	0.80	0.80	0.50
	Urgency	4.30	0.80	0.50	0.60	1.00
Secure experienced back-up nursing staff who can be assigned quickly to institutions at the national level	Effectiveness	3.60	1.10	0.00	0.40	1.00
	Urgency	3.30	1.00	-0.10	0.30	1.00
Implement infectious disease-related work in the curriculum of residents	Effectiveness	4.10	0.70	0.60	0.80	0.50
	Urgency	3.50	1.00	-0.20	0.70	0.50
Implement robotic or advanced logistics systems in the infectious disease ward	Effectiveness	3.60	0.90	0.10	0.80	0.50
	Urgency	2.80	0.80	-0.80	0.70	0.50
Cooperation system						
Improve cooperation with confirmed patients and guardians	Effectiveness	3.90	0.90	0.30	0.50	1.00
	Urgency	3.80	1.00	0.00	0.40	1.00
Integrated management by the national government to strengthen cooperation between local governments	Effectiveness	3.80	0.80	0.30	0.80	0.50
	Urgency	3.30	0.90	0.00	0.40	1.00
Improve interdepartmental cooperation and communication within the organization	Effectiveness	4.50	0.60	0.90	0.80	0.50
	Urgency	4.30	0.70	0.70	0.80	0.50
Improve communication between control center and field	Effectiveness	4.60	0.60	0.90	0.80	0.50
	Urgency	4.30	0.80	0.70	0.80	0.50
Strengthen communication between medical institutions responding to infectious diseases	Effectiveness	4.10	1.00	0.30	0.50	1.00
	Urgency	3.70	1.00	0.20	0.50	1.00
Efficiency and upgrade of reporting system	Effectiveness	4.50	0.70	0.70	0.80	0.50
	Urgency	4.20	1.00	0.50	0.60	1.00
Requirement for education and manuals for various occupational groups and subjects	Effectiveness	3.70	0.80	-0.10	0.70	0.50
	Urgency	3.30	0.80	-0.40	0.70	0.50
Establish response manuals and scenarios in preparation for confirmed patients in psychiatric ward	Effectiveness	3.90	0.80	0.50	0.80	0.50
	Urgency	3.60	1.00	0.10	0.80	0.50
Aid supplies						
Support personal protective equipment and infection control supplies	Effectiveness	4.60	0.50	1.00	0.80	0.50
	Urgency	4.00	0.90	0.40	0.50	1.00
Supply consumables and disposable goods	Effectiveness	4.40	0.60	0.90	0.80	0.50
	Urgency	3.90	0.90	0.10	0.50	1.00
Physical/mental health and compensation						
Medical cost support	Effectiveness	4.20	0.90	0.50	0.60	1.00
	Urgency	4.00	1.30	0.40	0.60	1.00
Paid vacation for set period	Effectiveness	4.60	0.70	0.80	0.80	0.50
	Urgency	3.90	1.10	0.30	0.50	1.00
Emotional support, psychological counseling, and psychiatric treatment support	Effectiveness	3.80	0.90	0.30	0.50	1.00
	Urgency	3.40	0.80	0.00	0.70	0.50
Realization of hazard pay	Effectiveness	4.50	0.80	0.60	0.80	0.50
	Urgency	4.20	0.80	0.50	0.50	1.00
Consider fairness when paying benefits	Effectiveness	4.20	0.80	0.50	0.50	1.00
	Urgency	3.80	0.90	0.20	0.50	1.00

COVID-19, coronavirus disease 2019; SD, standard deviation; CVR, content validity ratio.

Table 3. Delphi round one results: priorities by category of improvement measures to promote health among healthcare workers who perform COVID-19-related work

Categories and improvement measures	Mean	SD	CVR	Consensus	Convergence
Facility infrastructure					
Design structures that can be prepared for infectious diseases	2.20	1.20	-0.70	0.00	1.00
Secure isolation units capable of treating severe cases	2.10	1.10	-0.80	0.00	1.00
Secure enough beds in emergency medical centers	3.10	1.30	-0.30	0.30	1.00
Provide housing or vehicle support for healthcare workers	5.40	0.90	1.00	0.70	1.00
Secure active monitors and beds for confirmed patients in preparation for confirmed cases in psychiatric ward	4.60	1.40	0.40	0.40	1.50
Apply non-face-to-face, remote, centralized intensive care facilities and systems in the infectious disease ward	3.90	1.40	0.40	0.30	1.50
Personnel infrastructure					
Secure nursing staff dedicated for patients in the intensive care units	1.70	1.00	-0.80	0.00	0.50
Develop experienced infectious disease personnel	2.10	0.90	-0.90	1.00	0.00
Secure experienced back-up nursing staff who can be assigned quickly to institutions at the national level	3.50	1.20	0.10	0.80	0.50
Implement infectious disease-related work in the curriculum of residents	3.60	1.00	0.10	0.80	0.50
Implement robotic or advanced logistics systems in the infectious disease ward	4.50	1.10	0.70	0.80	0.50
Cooperation system					
Improve cooperation with confirmed patients and guardians	5.20	1.90	0.70	0.50	1.50
Integrated management by the national government to strengthen cooperation between local governments	4.20	2.30	0.20	0.10	2.00
Improve interdepartmental cooperation and communication within the organization	3.00	1.60	-0.30	0.00	1.00
Improve communication between control center and field	2.80	2.10	-0.50	-0.50	1.50
Strengthen communication between medical institutions responding to infectious diseases	4.80	1.70	0.60	0.50	1.00
Efficiency and upgrade of reporting system	4.10	2.30	0.00	0.00	2.00
Requirement for education and manuals for various occupational groups and subjects	5.80	1.70	0.60	0.50	1.50
Establish response manuals and scenarios in preparation for confirmed patients in psychiatric ward	6.30	2.00	0.70	0.60	1.50
Aid supplies					
Support personal protective equipment and infection control supplies	1.30	0.60	-1.00	0.00	0.50
Supply consumables and disposable goods	1.90	0.40	-1.00	1.00	0.00
Physical/mental health and compensation category					
Medical cost support	2.90	1.60	-0.20	-0.30	2.00
Paid vacation for set period	2.70	1.20	-0.50	0.30	1.00
Emotional support, psychological counseling, and psychiatric treatment support	3.70	1.20	0.30	0.50	1.00
Realization of hazard pay	2.30	1.30	-0.50	-0.50	1.50
Consider fairness when paying benefits	3.60	1.30	0.00	0.10	1.50

COVID-19, coronavirus disease 2019; SD, standard deviation; CVR, content validity ratio.

and “secure enough beds in emergency medical centers”; two measures in the personnel infrastructure category, namely “secure patient care nursing staff” and “develop experienced infectious disease personnel”; four measures in the cooperation system category, namely “improve interdepartmental cooperation and communication within the organization”, “efficiency and upgrade of reporting system”, “improve cooperation with confirmed patients and guardians”, and “improve communication between central and field”; two measures in the aid supplies category, namely “support protective equipment and disease control supplies” and “supply consumables and disposable goods”; and two measures in the physical/mental health and compensation category, namely “paid vacation for set period” and “realization of hazard pay” in the result from assessment of measures to promote health among healthcare professionals who perform COVID-19-related work.

Among the priority of measures to promote health among healthcare professionals who perform COVID-19-related work that assessed to be valid, those with the highest priority in each category were “secure isolation units capable of treating severe cases” (facility infrastructure category), “secure patient care nursing staff” (personnel infrastructure category), “improve communication between central and field” (cooperation system category), “support protective equipment and disease control supplies” (aid supplies category), and “realization of hazard pay” (physical/mental health and compensation category).

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Table 4. Delphi round two results: assessment by category of the validity of measures to promote health among healthcare workers who perform COVID-19-related work

Categories and improvement measures		Mean	SD	CVR	Consensus	Convergence
Facility infrastructure						
Design structures that can be prepared for infectious diseases	Effectiveness	4.65	0.65	0.80	0.80	0.50
	Urgency	3.90	0.62	0.70	1.00	0.00
Secure isolation units capable of treating severe cases	Effectiveness	4.65	0.48	1.00	0.80	0.50
	Urgency	4.25	0.77	0.80	0.75	0.50
Secure enough beds in emergency medical centers	Effectiveness	4.70	0.56	0.90	0.80	0.50
	Urgency	4.25	0.62	0.80	0.75	0.50
Provide housing or vehicle support for healthcare workers	Effectiveness	3.05	0.74	-0.40	0.33	1.00
	Urgency	2.60	0.58	-1.00	0.67	0.50
Secure active monitors and beds for confirmed patients in preparation for confirmed cases in psychiatric ward	Effectiveness	3.55	0.80	0.10	0.75	0.50
	Urgency	3.20	0.81	-0.10	0.33	1.00
Apply non-face-to-face, remote, centralized intensive care facilities and systems in the infectious disease ward	Effectiveness	4.15	0.79	0.70	0.75	0.50
	Urgency	3.65	0.85	0.20	0.75	0.50
Personnel infrastructure						
Secure nursing staff dedicated for patients in the intensive care units	Effectiveness	4.80	0.40	1.00	1.00	0.00
	Urgency	4.50	0.59	0.90	0.80	0.50
Develop experienced infectious disease personnel	Effectiveness	4.60	0.66	0.80	0.80	0.50
	Urgency	4.40	0.66	0.80	0.78	0.50
Secure experienced back-up nursing staff who can be assigned quickly to institutions at the national level	Effectiveness	3.65	0.85	0.20	0.75	0.50
	Urgency	3.25	0.70	-0.40	0.67	0.50
Implement infectious diseases-related work in the curriculum of residents	Effectiveness	4.10	0.70	0.80	0.75	0.50
	Urgency	3.45	0.86	-0.20	0.67	0.50
Implement robotic or advanced logistics systems in the infectious disease ward	Effectiveness	3.50	0.81	0.00	0.71	0.50
	Urgency	2.75	0.89	-0.70	0.67	0.50
Cooperation system						
Improve cooperation with confirmed patients and guardians	Effectiveness	4.00	0.55	0.70	1.00	0.00
	Urgency	3.90	0.62	0.50	0.75	0.50
Integrated management by the national government to strengthen cooperation between local governments	Effectiveness	3.70	0.56	0.30	0.75	0.50
	Urgency	3.35	0.57	-0.20	0.67	0.50
Improve interdepartmental cooperation and communication within the organization	Effectiveness	4.45	0.50	1.00	0.75	0.50
	Urgency	4.20	0.60	0.80	0.75	0.50
Improve communication between control center and field	Effectiveness	4.80	0.40	1.00	1.00	0.00
	Urgency	4.45	0.59	0.90	0.78	0.50
Strengthen communication between medical institutions responding to infectious diseases	Effectiveness	4.05	0.67	0.60	0.75	0.50
	Urgency	3.65	0.73	0.20	0.75	0.50
Efficiency and upgrade of reporting system	Effectiveness	4.45	0.59	0.90	0.78	0.50
	Urgency	4.30	0.64	0.80	0.75	0.50
Requirement for education and manuals for various occupational groups and subjects	Effectiveness	3.70	0.64	0.20	0.75	0.50
	Urgency	3.30	0.84	-0.40	0.67	0.50
Establish response manuals and scenarios in preparation for confirmed patients in psychiatric ward	Effectiveness	3.80	0.60	0.60	1.00	0.00
	Urgency	3.50	0.87	0.20	0.75	0.50
Aid supplies						
Support personal protective equipment and infection control supplies	Effectiveness	4.70	0.46	1.00	0.80	0.50
	Urgency	4.00	0.63	0.60	1.00	0.00
Supply consumables and disposable goods	Effectiveness	4.50	0.50	1.00	0.78	0.50
	Urgency	4.00	0.63	0.60	1.00	0.00
Physical/mental health and compensation						
Medical cost support	Effectiveness	4.05	0.74	0.50	0.50	1.00
	Urgency	3.90	0.94	0.40	0.50	1.00
Paid vacation for set period	Effectiveness	4.65	0.65	0.80	0.80	0.50
	Urgency	3.95	0.86	0.60	0.75	0.50
Emotional support, psychological counseling, and psychiatric treatment support	Effectiveness	3.45	0.74	0.00	0.71	0.50
	Urgency	3.15	0.91	-0.30	0.67	0.50
Realization of hazard pay	Effectiveness	4.70	0.56	0.90	0.80	0.50
	Urgency	4.20	0.68	0.70	0.75	0.50
Consider fairness when paying benefits	Effectiveness	4.20	0.68	0.70	0.75	0.50
	Urgency	3.70	0.90	0.40	0.75	0.50

COVID-19, coronavirus disease 2019; SD, standard deviation; CVR, content validity ratio.

Table 5. Delphi round two results: priorities by category of improvement measures to promote health among healthcare workers who perform COVID-19-related work

Categories and improvement measures	Mean	SD	CVR	Consensus	Convergence
Facility infrastructure					
Design structures that can be prepared for infectious diseases	2.40	1.02	-0.80	0.50	0.50
Secure isolation units capable of treating severe cases	1.50	0.74	-1.00	0.00	0.50
Secure enough beds in emergency medical centers	3.00	1.22	-0.40	0.33	1.00
Provide housing or vehicle support for healthcare workers	5.70	0.95	0.90	0.83	0.50
Secure active monitors and beds for confirmed patients in preparation for confirmed cases in psychiatric ward	4.90	1.18	0.80	0.60	1.00
Apply non-face-to-face, remote, centralized intensive care facilities and systems in the infectious disease ward	4.00	1.30	0.60	0.75	0.50
Personnel infrastructure					
Secure nursing staff dedicated for patients in the intensive care units	1.45	0.59	-1.00	0.00	0.50
Develop experienced infectious disease personnel	1.75	0.54	-1.00	0.50	0.50
Secure experienced back-up nursing staff who can be assigned quickly to institutions at the national level	3.35	1.06	-0.20	0.67	0.50
Implement infectious disease-related work in the curriculum of residents	3.95	0.67	0.50	0.75	0.50
Implement robotic or advanced logistics systems in the infectious disease ward	4.90	0.70	0.90	1.00	0.00
Cooperation system					
Improve cooperation with confirmed patients and guardians	5.45	1.60	0.80	0.45	1.50
Integrated management by the national government to strengthen cooperation between local governments	4.40	1.93	0.30	0.25	1.50
Improve interdepartmental cooperation and communication within the organization	2.80	1.40	-0.40	0.00	1.00
Improve communication between control center and field	1.45	0.86	-0.90	0.00	0.50
Strengthen communication between medical institutions responding to infectious diseases	4.60	1.59	0.40	0.33	1.50
Efficiency and upgrade of reporting system	3.85	1.93	-0.10	0.00	1.50
Requirement for education and manuals for various occupational groups and subjects	6.35	1.31	0.90	0.85	0.50
Establish response manuals and scenarios in preparation for confirmed patients in psychiatric ward	7.10	1.14	1.00	0.73	1.00
Aid supplies					
Support personal protective equipment and infection control supplies	1.15	0.36	-1.00	1.00	0.00
Supply consumables and disposable goods	2.00	0.45	-1.00	1.00	0.00
Physical/mental health and compensation category					
Medical cost support	2.80	1.66	-0.30	-1.00	2.00
Paid vacation for set period	2.60	1.20	-0.60	0.60	0.50
Emotional support, psychological counseling, and psychiatric treatment support	4.00	0.89	0.60	0.75	0.50
Realization of hazard pay	2.05	1.07	-0.80	0.00	1.00
Consider fairness when paying benefits	3.70	1.31	0.20	0.25	1.50

COVID-19, coronavirus disease 2019; SD, standard deviation; CVR, content validity ratio.

DISCUSSION

We collected expert opinions on supporting HCWs' health by improving COVID-19 related working environments. The improvement measures with the highest priority were "secure isolation units capable of treating severe cases" (facility infrastructure category), "secure nursing staff dedicated for patients in the intensive care units" (personnel infrastructure category), "improve communication between central office and front field" (cooperation system category), "support personal protective equipment and infection control supplies" (aid supplies category), and "realization of hazard pay" (physical/mental health and compensation category).

In the facility infrastructure category, "design structures that can be prepared for infectious diseases", "secure isolation units capable of treating severe cases", and "secure enough beds in emergency medical centers" were valid improvement measures with respect to effectiveness and urgency and the consensus was reached on "secure isolation units capable of treating severe cases" rating the highest priority. It should not be ignored that securing isolation units capable of treating severe cases would be possible under the assumption that well-trained medical personnel are reserved. Such findings can be explained by a situation encompassing "living with COVID-19", with an increased vaccination rate and at-home

treatments being administered to patients with mild disease to prepare for an increase in the number of confirmed cases [15]. The need for securing enough beds in emergency medical centers is supported with the previous study [16] that revealed the difficulties in transferring patients due to the shortage of isolation room in emergency center causing a considerable stress to emergency medical technicians (70.0% of participants) in charge of COVID-19 related work.

In the personnel infrastructure category, “secure nursing staff dedicated for patients in the intensive care units” and “developing experienced infectious disease personnel” were valid improvement measures with respect to effectiveness and urgency. The “secure isolation units capable of treating severe cases” had the highest priority. According to interviews with nurses providing care to patients with COVID-19, the nurses mentioned work content unrelated to the main issue, change in work schedule, and fatigue due to high-intensity work [17, 18]. A shortage in human resources can lead to work overload, ambiguity in role delegation, and frequent changes in work schedule due to staffing problems. Training of intensive care nurses is time consuming, and the role requires much clinical experience. Therefore, even after the pandemic subsides, development of human resources must continue via government investment, including revitalization of severe trauma centers.

Third, in the cooperation system category, the experts reached consensus that “efficiency and upgrade of reporting system” was a valid improvement measure with the highest priority. Protective factors against psychological stress among HCWs performing work related to novel infectious diseases are clear communication with leaders and training or support from managers [19]. A double or triple reporting system and inefficient administrative work system make it increasingly difficult for workers tired from providing patient care. The COVID-19 pandemic is ongoing and there have been improvements in systems as compared to the early stages, but the need for such improvements must continue to be emphasized.

Fourth, in the aid supplies category, “support personal protective equipment and infection control supplies” and “supply consumables and disposable goods” were improvement measures with validity and “support protective equipment and infection control supplies” had the highest priority. A shortage in infection control supplies could increase mental health problems, such as posttraumatic stress disorder, among healthcare professionals [20]. Therefore, such supplies must be assured in the early stages of developing epidemics or pandemics.

Fifth, in the physical/mental health and compensation categories, “paid vacation for set period” and “realization of hazard pay” were improvement measures with validity respectively, and “realization of hazard pay” had the highest priority. The previous study has reported that the medical doctors, nurses, and the administrative workers complained that they often receive unfair treatment or inadequate emotional as well as financial support, even with their sacrifices and contributions as front-liners [7]. Delayed and unfair benefit payments cause a loss of trust in the management hierarchy and promote division; therefore, how payments are made is as important as their magnitude [21].

This study had the following limitations. First, there were disagreements among the expert panel members regarding the priorities of improvement measures in each category; therefore, the results should be interpreted with caution. However, the results derived despite such disagreement are valuable in that they represent the average of the highest priorities among the measures assessed by the expert panel. Second, the findings from a Delphi study

cannot represent the opinions of all healthcare professionals in Korea. However, the panel members were from various regions and had diverse fields of expertise. Third, whether some of the suggested priorities have been implemented and their feasibility are unclear. However, such aspects depend on the available budget and the will of national and local governments; therefore, they cannot be easily determined by an expert panel.

We gathered expert opinions on policies to promote the health of COVID-19 related HCWs. We tested the validity of measures related to facilities, personnel, cooperation systems, health, and compensation categories, and presented the priorities of such measures. The findings will aid in improving working environments, supporting the health of, and preventing burnout by, HCWs treating confirmed patients and conducting community infection control during the COVID-19 pandemic.

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