Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Differences in strategies for prevention of COVID-19 transmission in hospitals: nationwide survey results from the Republic of Korea

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SUMMARY

Background: Hospital infection control measures against coronavirus disease 2019 (COVID-19) are often based on expert discretion due to the lack of detailed guidelines.
Aim: To survey the current strategies for preventing the transmission of COVID-19 in medical institutions.
Methods: Thirteen key issues related to the prevention of COVID-19 transmission within medical institutions were selected via discussion among infectious diseases specialists, and related critical questions were obtained following a review of national-level guidelines in government databases. Six hospitals had an open survey between 11th and 25th August 2020 to provide responses to these topics. An online questionnaire developed from these data was sent to infection control teams at 46 hospitals in South Korea between 31st January 2021 and 20th February 2021.
Findings: All 46 hospitals responded to the survey. All operated screening clinics, but 89.1% (41/46) allowed symptomatic patients without COVID-19-associated symptoms to visit general outpatient clinics. Most hospitals (87.2%, 34/39) conducted polymerase chain reaction (PCR) tests for all hospitalized patients. Of 35/46 (76.1%) hospitals with pre-emptive isolation policies for hospitalized patients, 31 (88.6%) released

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patients from isolation after a single negative PCR test, while most (76.9%, 20/26) allowed shared-room accommodation for patients meeting the national criteria for release from isolation despite positive PCR results with above cycle threshold values (34.6%, 9/26), or after a certain period that satisfied the national criteria (26.9%, 7/26).

Conclusion: Individual hospitals in South Korea are currently relying on experience to frame relevant guidelines, and responded differently to some infection control issues on hospital settings during the COVID-19 pandemic.

Introduction

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which emerged in December 2019 in Wuhan, China [1]. SARS-CoV-2 spread rapidly worldwide, and the World Health Organization (WHO) declared a global pandemic on 11th March 2020 [2]. COVID-19 outbreaks in medical institutions are important, and can be associated with high mortality rates, especially amongst the elderly [3–6]. Although strict infection control measures to prevent nosocomial COVID-19 are crucial, the development of these may need to be tailored locally because of the heterogeneity of hospitals and their patient populations [7]. Thus, COVID-19 infection control measures in hospitals often rely on the experience and opinion of in-house experts, and may be benchmarked against the strategies of other hospitals [8].

In the light of these issues, this study aimed to evaluate the issues of infection control strategies for COVID-19, which were not dealt with appropriately in the guidelines, in the real-world setting in Korean hospitals during the early phase of the pandemic.

Methods

Questionnaire design

In the initial phase of questionnaire development, 13 issues related to the prevention of COVID-19 transmission within medical institutions were selected via discussion among four infectious diseases (ID) specialists (BK, ESK, KHS and HBK) (Supplement 1, see online supplementary material). To extract the critical questions related to these issues that are relevant in an actual hospital setting, governmental database review of the recommendations and guidelines issued by the World Health Organization (WHO), Centers for Disease Control and Prevention (CDC), European Centre for Disease Prevention and Control, and Korea Disease Control and Prevention Agency (KDCA) between 1st January 2020 and 30th September 2020 was conducted by two researchers (WJ and BK) (Supplement 2, see online supplementary material). In addition, information was obtained about real-world practices related to these issues from six ID specialists working at different hospitals by sending an e-mail with a questionnaire consisting of open questions (Supplement 3, see online supplementary material). Based on a review of the guidelines and information about real-world practices, a questionnaire consisting of 71 questions was developed through discussions among investigators in this study (Supplement 4, see online supplementary material). After conducting a pilot test, the developed questionnaire was refined on the SurveyMonkey platform (Figure S1, see online supplementary material).

Conducting the survey

The survey was conducted over a 21-day period (31st January–20th February 2021), targeting the six hospitals where information about real-world practices for controversial topics was gathered and 40 sample hospitals in South Korea that managed patients with COVID-19 at the time of the survey. The 40 hospitals were selected based on hospital type and regional distribution. Hospitals were assessed based on bed numbers and whether they had state-designated isolation beds and ID specialists, with four categories: those with ≥500 beds with or without state-designated isolation beds, those with <500 beds, and those without ID specialists. Ten hospitals were selected per category while maintaining uniform distributions across regions as much as possible.

A link to the online-based survey was forwarded via e-mail to physician or nurse members of the infection control team (ICT) of each hospital. Hospital ICTs in South Korea are comprised of infection control doctors and nurses dedicated to infection control and prevention in their hospital [9]. Given that the main practitioners related to the COVID-19 response vary depending on the hospital, a person in charge of practical affairs was asked to answer according to the circumstances of each hospital. To encourage participation, reminders were

Table I
Basic information of medical institutions participating in the survey

Hospital characteristics	*N* (%) (*N*=46)
Type of hospital	
University-affiliated hospital: national or public	6 (13.0)
University-affiliated hospital: private	15 (32.6)
Non-university-affiliated hospital: national or public	17 (37.0)
Non-university-affiliated hospital: private	8 (17.4)
Number of hospital beds	
<300	10 (21.7)
300–599	15 (32.6)
600–899	11 (23.9)
900–1199	4 (8.7)
>1200	6 (13.0)
No infectious diseases specialists	10 (21.7)

Table II
Screening and selective treatment policy to prevent patients with coronavirus disease 2019 (COVID-19) from entering hospitals

	N (%) (*N*=46, unless otherwise stated)
Existence of screening clinic for COVID-19	46 (100)
Criteria of patients treated at the screening clinic[a]	
Fever of unknown cause	45 (97.8)
Respiratory symptoms	46 (100)
Epidemiological association with patients with COVID-19	43 (93.5)
Family members had fever, respiratory symptoms or epidemiological association with patients with COVID-19	35 (76.1)
Test for COVID-19 voluntarily	39 (84.8)
Entry into general outpatient clinics was allowed for patients with fever or respiratory symptoms unlikely to be associated with COVID-19[a]	41 (89.1)
No epidemiological association with patients with COVID-19	11/41 (26.8)
Healthcare workers at the screening clinic determine that the possibility of COVID-19 is minimal	24/41 (58.5)
Patients were negative on COVID-19 testing within a certain period (e.g. 2—3 days)	38/41 (92.7)
Scheduled follow-up for diseases presenting fever or respiratory disease	26/41 (63.4)
Existence of measures to prevent the influx of COVID-19 into the hospital caused by caregivers and family/friends[a]	42 (91.3)
Restrictions on access to general wards by visitors other than the patient's essential caregivers	38/42 (90.5)
Total restrictions on visits to general wards	21/42 (50.0)
Total restrictions on visits to intensive care units and special wards	28/42 (66.7)
Regular monitoring of fever and respiratory symptoms of caregivers	24/42 (57.1)
Mandatory PCR test for caregivers	27/42 (64.3)
Existence of system to pre-screen scheduled patients to prevent the influx of suspected cases of COVID-19[a,b]	35 (76.1)
Texts are sent to suspected cases of COVID-19 advising them not to visit the general outpatient area	28/35 (80.0)
Self-examinations for suspected cases of COVID-19 are conducted through the internet or mobile before visiting the hospital	21/35 (60.0)
Telephone interviews are conducted for suspected cases of COVID-19	3/35 (8.6)
Management and education concerning mask-wearing for patients and caregivers in the hospital[a]	46 (100)
Education on mask-wearing is provided to patients and caregivers when hospitalized	33 (71.7)
Banners and postings on wearing masks thoroughly and properly are placed throughout the institution	41 (89.1)
Regular public address announcements on the need for patients and guardians to wear masks	35 (76.1)
Designated staff monitor patients and guardians and provide guidance on mask-wearing in the hospital	10 (21.7)
Performing PCR tests for non-suspected cases of COVID-19[a]	39 (84.8)
Subject of testing	
Patients requiring general anaesthesia	19/39 (48.7)
All patients requiring hospitalization	34/39 (87.2)
Patients requiring hospitalization in a closed psychiatric ward	9/39 (23.1)
Patients who came from a different institution or a nursing home	16/39 (41.0)
Patients requiring hospitalization in the intensive care unit	9/39 (23.1)

PCR, polymerase chain reaction.
[a] This question asked the respondent to select multiple items.
[b] Suspected cases of COVID-19 had fever, respiratory symptoms and epidemiological associations with patients with COVID-19.

sent on the 5th, 10th and 15th days. Only one questionnaire was administered per hospital.

Results

Basic information on participating hospitals (Table I)

All 46 invited hospitals responded to the survey. Among them, 13.0% (6/46) were university-affiliated national or public hospitals, 32.6% (15/46) were university-affiliated private hospitals, 37.0% (17/46) were non-university-affiliated national or public hospitals, and 17.4% (8/46) were non-university-affiliated private hospitals. There were no ID specialists in 21.7% (10/46) of the participating hospitals.

Screening and selective treatment policies to prevent patients with COVID-19 from entering hospitals (Table II)

All 46 hospitals operated screening clinics, which treated patients with respiratory symptoms, fever of unknown cause, and epidemiological association with patients with COVID-19, and accepted people who wanted to undergo polymerase chain reaction (PCR) tests for COVID-19.

In total, 41/46 (89.1%) hospitals allowed patients with symptoms generally unrelated to COVID-19 to visit the general outpatient clinics. Thirty-eight (92.7%) of these 41 hospitals used a negative COVID-19 test result within a certain period to determine whether symptomatic patients could enter the general outpatient clinics.

Table III
Isolation practices for patients with symptoms suggestive of coronavirus disease 2019 (COVID-19) but without a confirmed diagnosis

	N (%) (*N*=35)
Healthcare workers who determine pre-emptive isolation	
Pre-emptive isolation for all patients or patients who meet specific conditions	7 (20.0)
Doctor who treated the patient directly	26 (74.3)
Healthcare workers belonging to specific departments[a]	22 (62.9)
Type of isolation room	
Single isolation room	31 (88.6)
Cohort isolation room	6 (17.1)
Partly operated as cohort isolation room, and other single rooms	8 (22.9)
Criteria for removing patients from pre-emptive isolation	
COVID-19 PCR test confirmed negative once	31 (88.6)
COVID-19 PCR test confirmed negative twice	3 (8.6)
Determined on a case-by-case basis	1 (2.9)
Range of patients isolated before PCR results were confirmed	
All patients admitted to hospital	23 (65.7)
Existence of suspected symptoms of COVID-19	12 (34.3)
Existence of results of imaging tests that are suspected to be pneumonia	12 (34.3)
Existence of epidemiological association with a patient with COVID-19	12 (34.3)
Patients admitted to high-risk wards[b]	3 (8.6)
Patients came from a nursing home or transferred from a different institution	3 (8.6)

PCR, polymerase chain reaction.
Only hospitals with policies on pre-emptive isolation were included.
[a] Infectious diseases, pulmonology, and/or infection prevention and control practitioners.
[b] Intensive care units and/or haematopoietic stem cell transplant wards.

Forty-two of 46 (91.3%) hospitals implemented measures to prevent the introduction of COVID-19 into the hospital by caregivers/visitors. Of these 42 hospitals, 38 (90.5%) only allowed general ward access to the patients' essential caregivers, 24 (57.1%) monitored fever and respiratory symptoms of caregivers regularly, and 27 (64.3%) performed mandatory PCR tests for caregivers.

All medical institutions provided education concerning the use of masks for patients and caregivers, while 35/46 (76.1%) hospitals made regular public address announcements guiding patients and caregivers to wear masks. Only 10 (21.7%) hospitals had designated staff to monitor and provide guidance to patients and visitors about mask-wearing. PCR tests were performed even for patients without suspected COVID-19 in 39/46 (84.8%) hospitals, and 34 (87.2%) of these 39 hospitals tested all patients requiring hospitalization. Additional screening and selective treatment policies for patients with suspected COVID-19 are provided in Table S1 (see online supplementary material).

Table IV
Policies for patients with coronavirus disease 2019 (COVID-19) whose polymerase chain reaction (PCR) results remained positive but whose symptoms improved, allowing release from isolation

	N (%) (*N*=27, unless otherwise stated)
Personal protective equipment for the treatment of patients[a]	
Coveralls with PAPR	0 (0)
Coveralls with N95/KF94 mask	0 (0)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover + shoe covers	0 (0)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover	2 (7.4)
N95/KF94 mask + disposable gown + gloves + goggles/face shield	3 (11.1)
N95/KF94 mask + disposable gown + gloves	4 (14.8)
N95/KF94 mask + gloves	4 (14.8)
N95/KF94 mask	17 (63.0)
Surgical mask	11 (40.7)
Allocation of hospital room[a,b]	
Shared room in a general ward	20/26 (76.9)
Regardless of PCR test results (Ct value) or time of release from isolation	5/26 (19.2)
If PCR test results (Ct value) meet certain criteria	9/26 (34.6)
After a certain period from time of release from isolation, regardless of PCR test results (Ct value)	7/26 (26.9)
Single room for isolation, without negative pressure	4/26 (15.4)
Regardless of PCR test results (Ct value) or time of release from isolation	1/26 (3.8)
If PCR test results (Ct value) meet certain criteria	3/26 (11.5)
After a certain period from time of release from isolation, regardless of PCR test results (Ct value)	1/26 (3.8)
Single room for isolation with negative pressure	2/26 (7.7)
Cohort room for isolation with negative pressure	0/26 (0)

Ct, cycle threshold.
[a] This question requested the respondent to select multiple items.
[b] One hospital wrote a non-categorical answer for the question, and the hospital decided after consulting with the infectious disease specialist.

Pre-emptive isolation policies for patients admitted with symptoms suggestive of COVID-19 (Table III)

Pre-emptive isolation of patients with symptoms suggestive of COVID-19 was used in 35/46 (76.1%) hospitals. The majority (65.7%) of hospitals had a policy of universal isolation of admitted patients. Thirty-one (88.6%) of these 35 hospitals de-

Table V
Procedures and operations on patients with suspected or confirmed coronavirus disease 2019 (COVID-19)

	N (%) (*N*=46, unless otherwise stated)
Decision-making process for operations or procedures on patients with suspected COVID-19 in an emergency situation[a]	
No operations or procedures are performed for patients with suspected COVID-19	11 (23.9)
Even in an emergency, all surgeries and procedures are prohibited until a negative PCR result is confirmed	8 (17.4)
Decisions are made by the person in charge of the specific department[b]	16 (34.8)
Decisions are made by the doctor who is in charge of the patient	12 (26.1)
Decisions are made through the discussion of a consultative committee in the hospital	5 (10.9)
Operations and procedures are performed based on the patient being confirmed with COVID-19	21 (45.7)
Performing emergency procedures or operations on patients with suspected COVID-19	35 (76.1)
Elective procedures or operations on patients with suspected COVID-19 requiring pre-emptive isolation[c]	
All procedures or operations are postponed until the patient is released from pre-emptive isolation	29/34 (85.3)
Procedures or operations are performed without delay, wearing personal protective equipment for COVID-19	5/34 (14.7)
Procedures or operations are performed without delay, without wearing personal protective equipment for COVID-19	0/34 (0)
Elective procedures or operations on patients confirmed with COVID-19[d]	
All procedures or operations are postponed until the patient is released from isolation	26/33 (78.8)
Procedures or operations are performed without delay, wearing personal protective equipment for COVID-19	7/33 (21.2)
Elective procedures or operations on patients with COVID-19 whose PCR results are consistently positive but whose symptoms have improved and are released from isolation[e]	
All procedures or operations are postponed until a negative PCR result is confirmed	3/25 (12.0)
Procedures or operations are performed without delay, wearing personal protective equipment for COVID-19	1/25 (4.0)
Procedures or operations are performed without delay, without wearing personal protective equipment for COVID-19	5/25 (20.0)
Procedures or operations are performed if PCR test results (Ct value) meet certain criteria	10/25 (40.0)
Procedures or operations are performed after a certain period from the time of release from isolation, regardless of the PCR test results (Ct value)	6/25 (24.0)

PCR, polymerase chain reaction; Ct, cycle threshold.
[a] This question asked the respondent to select multiple items.
[b] Infectious diseases, pulmonology, and the infection control and prevention office.
[c] Eleven hospitals that did not have a pre-emptive isolation policy for patients with suspected COVID-19, and one hospital that did not perform elective procedures or operations were excluded.
[d] Seven hospitals that did not have an isolation policy for patients with confirmed COVID-19, and six hospitals that did not perform elective procedures or operations were excluded.
[e] Nineteen hospitals that did not have a policy for patients with COVID-19 whose PCR results are consistently positive but whose symptoms have improved and are released from isolation, and two hospitals that did not perform elective procedures or operations were excluded.

isolated patients after the first negative PCR test after hospitalization, and three (8.6%) hospitals required two negative swabs. The remaining hospital released patients on a case-by-case basis. Additional information on isolation policies for patients with suspected or confirmed COVID-19 is provided in Table S1 (see online supplementary material).

Management of patients with COVID-19 whose PCR results remained positive but whose symptoms improved, allowing release from isolation (Table IV)

During the study period, according to national guidelines, patients with COVID-19 who were at least 10 days post symptom onset could be released from isolation if their symptoms were improved and they were afebrile [7]. Twenty-seven (58.7%) hospitals followed this recommendation. Most (76.9%) hospitals allowed de-isolated patients to occupy shared rooms, but often required additional criteria to be met [e.g. cycle threshold (Ct) value thresholds].

Procedures and operations for patients with suspected or confirmed COVID-19 (Table V)

Most (76.1%) hospitals performed emergency procedures or operations for patients with suspected COVID-19, but 85.3% of hospitals postponed elective procedures or operations on patients with suspected COVID-19 until they were de-isolated, and 78.8% postponed elective procedures or operations on patients with confirmed COVID-19 until they were de-isolated. Some centres required additional criteria to be met (e.g. Ct value thresholds or time period after release from isolation).

Table VI
Hospital work restriction policies for healthcare workers

	N (%) (*N*=46, unless otherwise stated)
Those who have visited high-risk areas for COVID-19, without fever or respiratory symptoms[a]	
Work is restricted for a certain period without PCR test	5/44 (11.4)
Work is restricted for a certain period, performing PCR test	3/44 (6.8)
Work is restricted until negative PCR results are confirmed	15/44 (34.1)
Monitored without PCR test. If they become symptomatic, a PCR test is conducted and they are restricted from work	19/44 (43.2)
Those who have fever or respiratory symptoms	
Work is restricted for a certain period without PCR test	0 (0)
Work is restricted for a certain period, performing PCR test	0 (0)
PCR tests are performed, and work is restricted until negative results are confirmed	46 (100)
Existence of restrictions on certain activities outside the hospital[b]	29 (63.0)
Prohibition on attending offline conferences or symposiums	19/29 (65.5)
Prohibition on eating out or attending get-togethers	20/29 (69.0)
Prohibition on travelling overseas	26/29 (89.7)
Prohibition on using multi-use facilities	17/29 (58.6)
Prohibition on using public transport	0/29 (0)
Prohibition on visiting other regions	3/29 (10.3)
Conditions for returning to work among healthcare workers with COVID-19 after national isolation release criteria have been met	
Immediately after meeting national isolation release criteria	12 (26.1)
After a certain period following release from isolation, regardless of PCR test results	9 (19.6)
When PCR test results (Ct value) meet certain criteria	11 (23.9)
After confirming negative PCR results	14 (30.4)

PCR, polymerase chain reaction; COVID-19, coronavirus disease 2019; Ct, cycle threshold.
Values are presented as *N* (%).
[a] Two hospitals that did not have a work restriction policy for healthcare workers who had visited high-risk areas were excluded. Two hospitals wrote non-categorical answers for the question. One hospital monitored healthcare workers after performing PCR tests without work restriction, and another hospital decided in the infection control office.
[b] This question asked the respondent to select multiple items.

Table VII
Personal protective equipment for healthcare workers providing care for patients with coronavirus disease 2019 (COVID-19)

	N (%) (*N*=46, unless otherwise stated)
Personal protective equipment for treatment of patients with confirmed COVID-19: asymptomatic or mild-to-moderate symptoms[a,b]	
Coveralls with PAPR	17/39 (43.6)
Coveralls with N95/KF94 mask	37/39 (94.9)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover + shoe covers	5/39 (12.8)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover	5/39 (12.8)
N95/KF94 mask + disposable gown + gloves + goggles/face shield	3/39 (7.7)
N95/KF94 mask + disposable gown + gloves	1/39 (2.6)
N95/KF94 mask + gloves	0/39 (0)
N95/KF94 mask	0/39 (0)
Surgical mask	0/39 (0)
Personal protective equipment for the treatment of patients with confirmed COVID-19: severe symptoms[a,c]	
Coveralls with PAPR	32/37 (86.5)
Coveralls with N95/KF94 mask	33/37 (89.2)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover + shoe covers	4/37 (10.8)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover	3/37 (8.1)
N95/KF94 mask + disposable gown + gloves + goggles/face shield	2/37 (5.4)
N95/KF94 mask + disposable gown + gloves	0/37 (0)
N95/KF94 mask + gloves	0/37 (0)
N95/KF94 mask	0/37 (0)
Surgical mask	0/37 (0)
Personal protective equipment for the treatment of patients with confirmed COVID-19: aerosol-producing procedures[a,b]	
Coveralls with PAPR	36/39 (92.3)
Coveralls with N95/KF94 mask	22/39 (56.4)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover + shoe covers	2/39 (5.1)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover	2/39 (5.1)
N95/KF94 mask + disposable gown + gloves + goggles/face shield	3/39 (7.7)
N95/KF94 mask + disposable gown + gloves	0/39 (0)

(*continued on next Column*)

Table VII (*continued*)

	N (%) (*N*=46, unless otherwise stated)
N95/KF94 mask + gloves	0/39 (0)
N95/KF94 mask	0/39 (0)
Surgical mask	0/39 (0)
Personal protective equipment for the treatment of patients with suspected COVID-19[a,d]	
Coveralls with PAPR	2/38 (5.3)
Coveralls with N95/KF94 mask	15/38 (39.5)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover + shoe covers	7/38 (18.4)
N95/KF94 mask + disposable gown + gloves + goggles/face shield + hair cover	22/38 (57.9)
N95/KF94 mask + disposable gown + gloves + goggles/face shield	13/38 (34.2)
N95/KF94 mask + disposable gown + gloves	1/38 (2.6)
N95/KF94 mask + gloves	0/38 (0)
N95/KF94 mask	0/38 (0)
Surgical mask	0/38 (0)

PAPR, powered air-purifying respirator.

[a] This question asked the respondent to select multiple items.

[b] Seven hospitals that did not have an isolation policy for patients with confirmed or suspected COVID-19 were excluded.

[c] Seven hospitals that did not have an isolation policy for patients with confirmed COVID-19, and two hospitals that did not perform aerosol-producing procedures were excluded.

[d] Seven hospitals that did not have an isolation policy for patients with suspected COVID-19, and one hospital that did not operate a screening clinic were excluded.

Hospital work-restriction policy for healthcare workers (Table VI)

Healthcare workers who had visited areas at high risk for COVID-19 and who were asymptomatic were excluded from work and PCR tested if they became symptomatic in 43.2% of hospitals. All hospitals excluded healthcare workers with fever or respiratory symptoms from work and conducted PCR tests. However, only 29/46 (63.0%) hospitals placed restrictions on the activities of healthcare workers outside the hospital. Fourteen (30.4%) hospitals required staff to have a negative PCR test result before returning to work, and only 12 (26.1%) hospitals allowed healthcare workers to return to work immediately after meeting the national isolation release criteria. Additional data for decision-making systems for COVID-19-related issues are provided in Table S3 (see online supplementary material).

Personal protective equipment for healthcare workers providing care for patients with COVID-19 (Table VII)

The majority of hospitals provided coveralls with a powered air-purifying respirator (PAPR) and coveralls with an N95/KF94 mask for the treatment of patients with COVID-19. While 43.6% of hospitals provided coveralls with PAPR for the treatment of asymptomatic or mild-to-moderate patients, 86.5% and 92.3% of hospitals provided coveralls with PAPR for the treatment of severe patients and patients who needed aerosol-producing procedures, respectively. The proportion of hospitals that provided coveralls with an N95/KF94 mask for the management of suspected cases of COVID-19 was 39.5%, which was lower than that for hospitals that provided N95/KF94 masks, disposable gowns, gloves and goggles/face shields (57.9%). Additional information about personal protective equipment for healthcare workers is provided in Table S2 (see online supplementary material).

Discussion

This study investigated the measures taken by medical institutions to prevent the spread of COVID-19 in South Korea. This enabled identification of real-world strategies, especially in areas where no detailed guidelines have been established.

All hospitals operated screening clinics, and approximately 90% allowed patients with symptoms that are not considered to be associated with COVID-19 to enter their general outpatient clinics. As screening clinics have minimal facilities and a workforce that can only provide minimal examinations [10], most hospitals managed patients with fever and respiratory symptoms but unlikely to have COVID-19 in general outpatient clinics (where careful evaluation and management could be provided). Unfortunately, there were no clear criteria for the entry of symptomatic patients into general outpatient clinics, which could lead to confusion among frontline medical professionals [7]. At the time of writing, unlike when the study was conducted, unrestricted general outpatient clinic entry has been allowed in almost all South Korean hospitals since the emergence of the Omicron variant. As countermeasures to the surge of the highly transmissible but less serious Omicron variant, hospitals in South Korea have been encouraged to perform COVID-19 diagnostic testing and to manage low-risk patients at their outpatient clinics since 3rd February 2022 [11].

Due to concerns regarding the transmission of COVID-19 by asymptomatic patients, CDC recommended universal PCR testing of hospitalized patients, including asymptomatic patients [12]. Nevertheless, approximately 15% of the hospitals in this study did not test asymptomatic patients. According to the Infectious Diseases Society of America, screening asymptomatic patients is expected to be effective when the prevalence rate is at least 2%, taking account of the consequences of missed diagnoses and the accuracy of PCR tests [13]. Although they may be less accurate, rapid antigen tests may be considered as an alternative screening option, especially where access to PCR testing is constrained [14].

Three-quarters of the hospitals in this study implemented pre-emptive isolation for patients with suspected COVID-19, and most required at least one negative COVID-19 PCR test for de-isolation. WHO and CDC recommend different criteria for de-isolation; the WHO criteria relate to symptom disappearance, whilst the CDC criteria require a single negative PCR test [7]. In a single-centre study in South Korea, 350 symptomatic patients with epidemiological associations with patients with COVID-19 were pre-emptively isolated, and none of these patients were confirmed to have COVID-19 [15]. This may suggest that universal pre-emptive isolation of symptomatic inpatients with no clear epidemiological association with COVID-19 may not be required. Where PCR tests are performed, it needs to be borne in

mind that a single negative test may not provide assurance that a patient does not have COVID-19, as the mean incubation period for COVID-19 is 5.2 days; a single negative PCR test result should be considered, especially for patients with a recent history of contact with COVID-19 [16—19].

Although the probability of infectious SARS-CoV-2 is usually very low >10 days after symptom onset, severely ill or immunocompromised patients can remain infectious for longer [18,20—23], and the possibility of continuing infectivity of hospitalized patients, especially those undergoing aerosol-generating procedures, is hotly debated [22,24—26]. This explains why only 19% of the hospitals in this study de-isolated patients with COVID-19 into shared rooms regardless of the PCR test result. Despite concerns about the transmission of COVID-19 in hospitals, even after 10 days of isolation, many countries including South Korea advise that isolation can be discontinued after 10 days. To do otherwise would be costly in terms of healthcare resources, and of questionable clinical effectiveness [27].

This study found that most hospitals provided coveralls as personal protective equipment for healthcare workers managing patients with confirmed COVID-19. A Korean study showed that although most healthcare workers knew that the KDCA guidelines allowed healthcare workers to choose either coveralls or long-sleeved gowns, many healthcare workers did not use long-sleeved gowns [28]. This may be attributable to confusion among healthcare workers about the transmission of COVID-19 due to the initial KDCA recommendation about personal protective equipment; at the beginning of the pandemic, KDCA recommended using coveralls when managing patients with COVID-19 [29]. A recent study found that coverall contamination occurred rarely, even while managing patients with severe COVID-19 at the early stage of the illness, and coveralls are not recommended in the April 2021 guideline update [30,31].

As healthcare workers can also spread COVID-19 in hospitals, many have applied stricter return-to-work criteria than are defined in national guidelines. This study found that more than one-third of hospitals required a negative PCR test result from asymptomatic healthcare workers who visited high-risk areas. However, such stringency can result in the lack of a sufficient workforce [32]. Internationally, return-to-work criteria for healthcare workers are now being eased. For example, CDC updated its criteria in January 2022, such that asymptomatic healthcare workers who have had SARS-CoV-2 infection in the preceding 90 days do not require work restrictions following further exposure [33].

This study has limitations. First, it was conducted in February 2021, and will not necessarily reflect current practice. Second, selection bias may arise from most of the surveyed hospitals, as most selected hospitals were public hospitals with ID specialists; selection of participants was not randomized. Third, the survey was performed in South Korea alone, and may not be representative of other countries [34,35]. Nevertheless, the findings remain important as they highlight the importance of appropriate guidelines, and indicate key topics relevant to real hospital settings for further research based on the results of this study.

In conclusion, individual hospitals in South Korea relied on experience to frame relevant guidelines, and responded differently to some infection control issues in hospital settings during the COVID-19 pandemic.

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Conflict of interest statement
None declared.

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Ethical approval
The study protocol was approved by the Institutional Review Board of the Seoul National University Bundang Hospital (B-2101/660-303). Online written informed consent was obtained from the participants.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2022.07.032.

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