

# Comparative Analysis of COVID-19 Infection Prevention Control Guidelines from Seven Countries: Implications on COVID-19 Response and Future Guidelines Development

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**Background:** As prevention of coronavirus disease 2019 (COVID-19) transmission in healthcare settings has become a critical component in its effective management, COVID-19 specific infection prevention and control (IPC) guidelines were developed and implemented by numerous countries. Although largely based on the current evidence-base, guidelines show much heterogeneity, as they are influenced by respective health system capacities, epidemiological risk, and socioeconomic status. This study aims to analyze the variations and concurrences of these guidelines to draw policy implications for COVID-19 response and future guidelines development.

**Methods:** The contents of the COVID-19 IPC guidelines were analyzed using the categories and codes developed based on "World Health Organization guidelines on core components." Data analysis involved reviewing, appraising and synthesizing data from guidelines, which were then arranged into categories and codes. Selection of countries was based on the country income level, availability of COVID-19 specific IPC guideline developed at a national or district level.

**Results:** The guidelines particularly agreed on IPC measures regarding application of standard precautions and providing information to patients and visitors, monitoring and audit of IPC activities and staff illnesses, and management of built environment/equipments. The guidelines showed considerable differences in certain components, such as workplace safety measures and criteria for discontinuation of precautions. Several guidelines also contained unique features which enabled a more systematic response to COVID-19.

**Conclusion:** The guidelines generally complied with the current evidence-based COVID-19 management but also revealed variances stemming from differences in local health system capacity. Several unique features should be considered for benchmark in future guidelines development.

**Keywords:** Infection control; COVID-19; Guideline; Comparative study

## INTRODUCTION

Prevention of coronavirus disease 2019 (COVID-19) transmission in healthcare settings is a critical component in the management of COVID-19. Studies reveal that at the rate of hospital acquired

COVID-19 infection may be as high as 12%–15% [1,2], and that the mortality rate of these patients is higher than its community-acquired counterparts [3]. In addition, conducting adequate infection prevention and control (IPC) measures during COVID-19 pandemic proved not only effective in the management of COVID-19 itself, but

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also in minimizing the burden of other healthcare-associated infections [4], and in alleviating patients' fear of being infected through hospital visits thereby promoting access to essential healthcare services.

IPC is not a new discipline to the medical society and a wide range of established guidelines and standards were already in practice prior to the COVID-19 pandemic. However, with the current evidence-base being mostly on the general approaches in IPC (e.g., hand hygiene, standard and transmission based precautions), there was a demand for specific IPC strategies and measures in the context of COVID-19. In response, the World Health Organization (WHO) and other relevant organizations developed a COVID-19 specific IPC guidance [5-7], which includes the IPC measures based on up-to-date evidence on severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and largely based on the "WHO guidelines on core components of infection prevention and control programs," which include essential elements that IPC policies and programs should hold at both the national and individual facility levels [8].

Numerous countries have developed COVID-19 IPC guidances and recommendations which include specific and practical IPC measures, which generally encompass administrative control measures (e.g., visitor restriction, physical distancing, entry point risk assessments), standards for personal protection equipment (PPE), and management of COVID-19 patients, among others. The government of Korea has also developed COVID-19 IPC guidelines for acute care and long-term care hospitals, which has been distributed for use in 2020 and 2021, respectively. However, it is not surprising to witness the heterogeneity of these guidelines as these control measures are influenced by the different health system capacities, epidemiological risk, political and socioeconomic status, and local expert consensus of respective countries. Current knowledge and evidence regarding SARS-CoV-2 is still incomplete which results in constant shifts and changes in these guidelines, contributing to their diversity in terms of its contents.

Nevertheless, it is critically important to explore the status of these guidelines, focusing on a common subset of guidances that is generally agreed on, as well as similarities and differences resulting from application of current evidence to the health systems of respective countries. The objective of this study is to analyze the contents of COVID-19 specific IPC guidelines from seven different countries, and to explore to what extent the variation and concurrence exists. The re-

sult of this study could assist the development of an up-to-date COVID-19 IPC guidelines as well as other disease specific IPC guidelines in the future.

## METHODS

The contents of the COVID-19 IPC guidelines of different countries were analyzed using the "WHO guidelines on core components (CC) of IPC programmes at the national and acute health care facility level" as its analytic framework. This guideline provides an evidence-base of eight essential components of IPC that should be implemented to achieve effectiveness in reducing healthcare associated infection (HCAI) at the national and facility level [8]. These essential CCs address the complex nature of infection control activities in hospitals, encompassing governance, guidelines, human resources, surveillance, and the built environment. The detailed composition and the evidence-base of each CCs is beyond the scope of this study, and is presented elsewhere [8,9]. The guideline has been utilized in many previous studies as a standard analytic framework enabling exploration of the status and gaps in IPC capacity [10-12].

Nonetheless, the contents of the WHO CC guideline is provided in generalities and does not focus on a specific infectious disease or a healthcare-associated infection. Therefore, for the purpose of this research, the WHO CCs were further developed into categories and codes specific to its applicability in COVID-19 IPC (Table 1). These categories and codes guided the qualitative content analysis of the guidelines in aim to explore the differences and similarities under each CCs. Data analysis involved reviewing, appraising and synthesizing data from guidelines, which were then arranged into categories and codes.

All categories and codes were developed within the scope of respective CCs and did not breach the original evidence-base. However, some components were rendered to a more broad interpretation to allow in-depth exploration of COVID-19 IPC actions. For example, the component on IPC guidelines (CC2) focuses on the availability of general IPC guidelines (e.g., on hand hygiene) and of the expertise to develop and manage such guidelines. However, for the purpose of this study, this analysis of this component included availability and applicability of COVID-19 specific IPC guidelines, which include source

**Table 1.** The structure of WHO IPC core components and its applicability in COVID-19

WHO IPC core component	Applicability in COVID-19 IPC	
	Category	Codes
Core component 1 (CC1): IPC governance and program	IPC governance	<ul style="list-style-type: none"> <li>Establish of COVID-19 response governance (including IPC teams)</li> <li>Provide governance structure, roles, and responsibilities</li> </ul>
	IPC programs and plans	<ul style="list-style-type: none"> <li>Establish COVID-19 specific response strategies and plans</li> </ul>
Core component 2 (CC2): IPC guidelines (COVID-19 specific guidelines)	Triage, screening, and patient traffic management	<ul style="list-style-type: none"> <li>Screening and isolation of suspected COVID-19 patients at entry point</li> <li>Managing patient and staff traffic</li> <li>Physical distancing and prevention of overcrowding</li> <li>Managing visitors</li> </ul>
	Source control and infection prevention precautions	<ul style="list-style-type: none"> <li>PPE use (HCWs, patients, visitors, etc.)</li> <li>Application of infection prevention precautions (for all visitors)</li> <li>IPC in aerosol generation procedures</li> </ul>
	Management of COVID-19 patients	<ul style="list-style-type: none"> <li>Patient placement and cohorting</li> <li>Application of infection prevention precautions (for COVID-19 patients)</li> <li>Provision of information regarding precautions and PPE use (signage, posters, etc.)</li> <li>Arrangement of HCWs, medical equipments, medical procedures, etc.</li> <li>Cleaning and disinfection of environment, equipments, waste, linen, etc.</li> <li>Management of inter/intra facility transfers and discharge</li> </ul>
Core component 3 (CC3): IPC education and training	Education and training of HCW	<ul style="list-style-type: none"> <li>Education on general IPC measures (hand washing, precautions, etc.)</li> <li>Education on management of COVID-19 suspected/confirmed patients</li> <li>Education on PPE use</li> </ul>
	Information provision to patients and visitors	<ul style="list-style-type: none"> <li>Information on general IPC measures, COVID-19 specific measures, etc.</li> <li>Information on adequate healthcare facility access during COVID-19 epidemic</li> </ul>
Core component 4 (CC4): healthcare-associated infection surveillance	National, local surveillance	<ul style="list-style-type: none"> <li>Monitoring of and rapid response to national surveillance data</li> </ul>
	In-facility surveillance	<ul style="list-style-type: none"> <li>In-facility surveillance of COVID-19 symptoms and lab-confirmed cases (HCWs, patients)</li> </ul>
Core component 6 (CC6): monitoring and audit of IPC practices and feedback	Monitoring and audit of COVID-19 IPC practices	<ul style="list-style-type: none"> <li>Monitoring and audit of compliance to IPC measures and/or policies, staff illnesses and/or symptoms, education/training, supply of materials and equipments, etc.</li> </ul>
Core component 7 (CC7): workload, staffing, and bed occupancy	Workload and staffing	<ul style="list-style-type: none"> <li>In-facility plans on workload evaluation and staff supplement</li> </ul>
	Workplace safety policies	<ul style="list-style-type: none"> <li>Workplace risk assessment on COVID-19</li> <li>Appraisal of at-risk HCWs (underlying conditions, pregnancy, etc.)</li> <li>Tracing and monitoring of staff with symptoms, staff exposed to COVID-19, etc.</li> <li>Restriction from and return to work policies</li> </ul>
Core component 8 (CC8): built environment, materials, and equipment for IPC	Built environment	<ul style="list-style-type: none"> <li>Readiness and management of spaces, rooms, testing, ventilation infrastructure, etc.</li> </ul>
	Materials and equipments	<ul style="list-style-type: none"> <li>Readiness and management of PPE, hand hygiene materials, medical equipments, etc.</li> </ul>

WHO, World Health Organization; IPC, infection prevention and control; COVID-19, coronavirus disease 2019; PPE, personal protective equipment; HCW, health care workers.

control, PPE use, and IPC during COVID-19 patient management. Implementation of multimodal strategies (CC5) is a relatively new term in IPC and is defined as three or more core components implemented in an integrated way to achieve improvement of an outcome and change behavior. Many previous studies revealed that institutions have difficulties in conducting a multimodal strategy in IPC even in high-income countries [11,12], and that existing IPC guidelines do not effectively discuss multimodal strategies [10]. Based on

such speculations, an in-depth analysis of CC5 was omitted in this study.

Selection of countries was based on the country income level and the availability of COVID-19 specific IPC guideline developed at a national or district level. The selected countries are either high income (United States, Canada, United Kingdom, Republic of Korea, Australia, Qatar) or middle income (South Africa). This is based on the speculations that the application of the WHO CC framework in

low-income countries, in its full spectrum, may be somewhat limited due to resource limitations. The selection was also based on the online accessibility to the necessary guidelines and policy documents. The guidelines that were included in the final analysis were “COVID-19 infection prevention and control for hospital-level healthcare facilities (Republic of Korea) [13],” “COVID-19 infection prevention and control manual for acute and non-acute healthcare settings (New South Wales/Australia) [14],” “COVID-19: guidance for maintaining services within health and care settings: infection prevention and control recommendations (United Kingdom) [15],” “national infection prevention and control interim guideline for COVID-19 (Qatar) [16],” “infection prevention and control for COVID-19: interim guidance for acute healthcare settings (Canada) [17],” “COVID-19 disease: infection prevention and control guidelines (South Africa) [18],” and “interim infection prevention and control recommendations for healthcare personnel during the coronavirus disease 2019 pandemic (US) [19],” The guidelines were collected through official government

websites and/or searched within archives of government documents. All guidelines selected for analysis were those that were approved by the national (or regional) government or a national level agency.

## RESULTS

### 1. IPC governance and program (CC1)

Guidelines from the United Kingdom, Canada, and Australia presented the detailed roles and responsibilities of different actors involved in the IPC governance at the national and/or district level (Table 2). Republic of Korea and South Africa mentioned the necessity and responsibility of an in-hospital COVID-19 IPC response team, but did not specify roles and responsibilities of higher-level governance (e.g., boards and committees).

In terms of COVID-19 IPC plans and programs, Republic of Korea

**Table 2.** Comparative analysis of COVID-19 IPC guidelines: contents corresponding to Core Component 1 (CC1), CC3, CC4, and CC6 of the WHO IPC CC

	CC1		CC3		CC4	CC6
	Governance	Programs and planning	Education and training	Information provision to visitors/patients	Surveillance*	Monitoring and audit
Korea	▲ Set up of in-hospital COVID-19 IPC response team	● Requires development of in-hospital "COVID-19 IPC plan"	● All staff (PPE use, IPC practices)	●	▲ Facility (o)/national (x)	● Monitoring of IPC practices, staff illnesses
UK	● Roles of trusts, boards, employers, etc.	● Requires organizational strategies/plans and emergency scenarios	● All staff (PPE use, IPC practices)	●	● Facility (o)/national (o)	● Monitoring of IPC practices, staff illnesses, PPE supply, vaccination, etc.
Canada	● Structure and role of employers, committees, etc.	● Requires operation of "Institutional readiness" programs	● All staff (PPE use, IPC practices, COVID-19 management)	●	● Facility (o)/national (o)	● Monitoring of IPC practices, PPE supply, HCW education, staff illnesses, etc.
Australia (NSW)	● Governance and responsibilities of committees, councils, etc.	● Requires organizational strategies and plans for COVID-19 IPC	● All staff (PPE use, IPC practices, COVID-19 management)	●	● Facility (o)/national (o)	● Monitoring of IPC practices, staff illnesses, PPE supply
USA (CDC)	△	△	● All staff (PPE use, IPC practices)	●	● Facility (o)/national (o)	● Monitoring of IPC practices, staff illnesses
Qatar	△	△	● All staff (PPE use, IPC practices)	●	▲ Facility (o)/national (x)	● Monitoring of staff illnesses
South Africa	▲ Responsibilities of IPC team, staff only	△	● HCW (PPE use, IPC practices)	-	▲ Facility (o)/national (x)	● Monitoring of IPC practices, PPE supply, staff illnesses

● Complying to WHO CC; ▲ partial mention (analyzed document mentions only subsets of what is required under respective WHO CC); △ not mentioned in the analyzed documents, but existent in other policy documents, guidelines, and/or regulations.

COVID-19, coronavirus disease 2019; IPC, infection prevention and control; CC, core components; WHO, World Health Organization; PPE, personal protective equipment; HCW, health care workers; CDC, Centers for Disease Control and Prevention.

\*Facility, performing in-facility surveillance; national, monitoring and response to national level COVID-19 surveillance.

stipulated that hospitals should develop and distribute a contextualized in-hospital COVID-19 IPC plan. Canada, United Kingdom, and Australia recommended a comprehensive planning which promote emergency preparedness and institutional readiness to COVID-19 response. Examples include proactive monitoring and procurement of PPE supply (Canada) and ensuring local standard operating procedures to include emergency scenarios depending on the level of COVID-19 incidence (United Kingdom). Although the requirement for a dedicated IPC team and programs was not explicitly mentioned in the guidelines from the United States, Qatar, and South Africa, it was mentioned in generalities in separately existing policy documents.

## 2. IPC education and training (CC3)

It is clearly stipulated that COVID-19 specific education and training should be provided to all staff, including medical, administrative, and housekeeping staff, in guidelines of all countries except South Africa which recommends training to healthcare workers (Table 2). All countries recommend training should be provided on proper PPE use and IPC practices including precautions, hand hygiene, etc. Proper PPE use is especially emphasized in guidelines of all seven countries, all of which provide visual instructions on donning and doffing of PPE. Canada and Australia mentions a more comprehensive range of training topics pertaining to healthcare staff, which include management of suspected or confirmed COVID-19 patients (e.g., screening COVID-19 at entry points, taking swabs, and handling of specimens).

Significance of IPC information provision to patients and visitors to hospitals is explicitly documented in the guidelines of all countries except South Africa. These guidelines equally mention printed, or other forms of accessible information made available in entry points or other areas with high visibility. It is recommended that information should be provided on hand hygiene, handling of medical consumables, physical distancing, PPE use, information regarding hospital access, other up to date information on COVID-19, etc. Canada and Australia mentions the need to provide information in multiple languages as required.

## 3. IPC surveillance (CC4) and monitoring (CC6)

The component of surveillance (CC4) has two dimensions: (1) monitoring and response to national and/or local surveillance and (2) facility level surveillance of COVID-19 (Table 2). All analyzed countries recommended facility level surveillance of signs and symptoms of COVID-19 in healthcare workers, staff, and patients. However, only the United Kingdom, Canada, Australia, and the United States recommended monitoring of and rapid response to national and local surveillance data and regional epidemiology of COVID-19 on an ongoing basis. All countries specified monitoring and auditing of IPC practices (e.g., hand hygiene and PPE use) and staff illnesses (e.g., onset of symptoms and tracing of symptomatic staff). However, only a subset of countries mentioned the need for monitoring of system management and administrative measures such as PPE supply (Canada, United Kingdom, Australia, South Africa).

## 4. IPC guidelines (CC2)

### 1) Administrative controls and standard precautions

The administrative control measures were generally mentioned as an important and effective mode of limiting COVID-19 transmission in all of the guidelines (Table 3). However, only Korea, the United Kingdom, Canada, Australia, and the United States provided detailed descriptions of all of the analyzed indicators which include screening, isolation, and patient flow management. Although screening and isolation measures were mentioned, measures regarding patient flow management were not described in detail in guidelines from Qatar and South Africa. All guidelines recommended physical distancing from at least 1.0 m up to 2.0 m. While most countries generally discouraged hospital visitors, the United Kingdom mentioned that restriction of visitors may be considered during high incidence periods and the United States did not explicitly recommend general restriction of visitors. All guidelines included details on the use of signage and posters to aid administrative measures. All countries recommended immediate application of standard precaution to all patients and visitors at all circumstances, and additional transmission based precautions in designated circumstances (e.g., aerosol generating procedures [AGPs]).

**Table 3.** Comparative analysis of COVID-19 IPC guidelines: contents corresponding to core component 2 (CC2) of the WHO IPC CC

	CC2						
	Triage and traffic	Management of visitors	Physical distancing*	Signage/posters	Universal masking	Precautions <sup>†</sup>	AGP
Korea	● Screening (o), isolation (o), patient flow management (o)	● Minimize	>1.0 m	●	●	●	●
UK	● Screening (o), isolation (o), patient flow management (o)	● Minimize during high incidence period	2.0 m	●	●	●	●
Canada	● Screening (o), isolation (o), patient flow management (o)	● Minimize	2.0 m	●	●	●	●
Australia (NSW)	● Screening (o), isolation (o), patient flow management (o)	● Minimize	>1.5 m	●	●	●	●
USA (CDC)	● Screening (o), isolation (o), patient flow management (o)	▲ Not explicit	1.8 m (6 ft)	●	●	●	●
Qatar	▲ Screening (o), isolation (o), patient flow management (x)	● Minimize	1.8 m (6 ft)	●	●	●	●
South Africa	▲ Screening (o), isolation (o), patient flow management (x)	● Minimize	>1.0 m	●	●	●	●

● Complying to WHO CC; ▲ partial mention (analyzed document mentions only subsets of what is required under respective WHO CC).

COVID-19, coronavirus disease 2019; IPC, infection prevention and control; CC, core components; WHO, World Health Organization; AGPs, aerosol generating procedures; CDC, Centers for Disease Control and Prevention.

\*Metrics in meters. †Application of standard precautions for all patients and transmission-based precautions in certain circumstances.

## 2) Management of COVID-19 patients

On management of COVID-19 confirmed or suspected patients, the guidelines largely agreed on the need to place the patient in a single room, and if not available, to consider cohorting in consultation with IPC experts (Table 4). Some countries mentioned that the single room should be equipped with a dedicated toilet (Canada, United States) or a ventilation system (Australia, Qatar) or both (Korea, South Africa). The guidelines also generally agreed that droplet and contact precautions should be applied at minimum, except Australia which suggested application of droplet, contact, and airborne precautions.

While PPE for health care worker (HCW) caring for suspected or confirmed patients was equally considered an essential component in the guidelines of all seven countries, its level of recommendation were slightly different among guidelines. Surgical mask, eye protection, glove, and gown were recommended in the United Kingdom and South Africa. N95 respirator, eye protection, glove, and gown were recommended in Canada, Australia, the United States, and Qatar. Korea recommended N95 respirator, eye protection, glove, and gown or coveralls. For AGPs, higher level PPE were recommended in all guidelines.

The guidelines largely agreed on the need to mask the suspected and confirmed patients and the need to minimize the transfer of patients

(except for the United Kingdom). Although all of the guidelines mentioned that the decision on when to discontinue precautions should be primarily based on clinical evaluation of the patient on a case by case basis, most guidelines included a detailed criteria for reference, except Korea.

## 5. Workload and workplace safety regarding COVID-19 (CC7)

All guidelines agreed on the need to risk-assess, trace, and monitor staff symptoms and illnesses to promote workplace safety. All countries, except for Qatar, explicitly suggested the need to assess staff who are at risk or vulnerable (e.g., staff working in higher exposure, pregnant, old age, and underlying conditions). Only Canada, Australia, and the United States discussed both the HCW's restriction from and return to work policies, whereas Korea, the United Kingdom, and Qatar did not provide details on return to work policies. Only Canada and the United States provided detailed mention on the need for workload evaluation and ensuring systems to maintain adequate staffing in the event of shortages.

**Table 4.** Comparative analysis of COVID-19 IPC guidelines: management of COVID-19 patients, corresponding to core component 2 (CC2) of the WHO IPC CC

	Management of COVID-19 patients (suspected and/or confirmed)						
	Patient placement (cohorting)	Droplet and contact Precautions	PPE (patient)	PPE (HCWs)	Discontinuation of precautions	Cleaning and disinfection	Inter/intra facility Transfer
Korea	Single room; dedicated toilet/sink negative pressure; cohorting (o)	●	Mask	(1) N95+eye+glove+(gown or coveralls); (2) (AGPs) N95+eye+glove+coveralls	–	Equipment: after each use; procedural rooms (e.g., CT); between cases; terminal cleaning: upon discharge	Minimize
UK	Single room; physical separation using screens, curtains; cohorting (o)	●	Mask	(1) Surgical mask+eye+glove+gown; (2) (AGPs) FFP3 respirator+eye+glove+gown	14 Days from first positive PCR test+48 hours without a fever or respiratory symptoms	Equipment: after each use, after contamination, at regular intervals; rooms/cohort areas: twice/day; terminal cleaning: upon discharge, symptom resolution	Planned
Canada	Single room; dedicated toilet/sink; cohorting (o)	●	Mask	(1) N95 (or medical mask)+eye+glove+gown; (2) (AGPs) N95+eye+glove+gown	10 Days from onset of symptoms	Equipment: after each use; room cleaning: regularly; high touch areas: daily	Minimize
Australia (NSW)	Standard isolation or single room; negative pressure room with anteroom; cohorting (o)	Droplet, contact, and airborne	Mask	N95+eye+glove+gown (surgical mask not recommended)	14 Days from onset of symptoms+resolution of fever+improvement of respiratory symptoms for previous 72 hours	Equipment: after each use; high-touch areas: daily; procedural rooms (e.g., CT); between cases; terminal cleaning: upon discharge, symptom resolution	Minimize
USA (CDC)	Single room; dedicated toilet/sink; cohorting (o)	●	Mask	N95 (or higher-level respirator)+eye+glove+gown	10 Days since symptom onset+at least 24 hours since last fever and symptom resolution	Equipment: after each use; terminal cleaning: upon discharge/transfer	Minimize
Qatar	Single room; negative pressure/ventilation; cohorting (o)	●	Mask	N95 (surgical mask, when not available)+eye+glove+gown	Negative PCR from at least two tests ≥24 hr apart while patient was afebrile for at least 24 hr	Equipment: after each use	Minimize
South Africa	Single room; dedicated toilet/sink; ventilation; cohorting (o)	●	Mask	(1) Surgical mask+eye+glove+gown; (2) (AGPs) N95+eye+glove+gown	Patient should remain in COVID-19 isolation area until discharge	Equipment: after each use; high-risk areas: 3-4 times/day; terminal cleaning: upon discharge/transfer	Minimize

● Complying to droplet and contact precautions. All guidelines also specified that discontinuing precautions should be determined based on clinical evaluations. COVID-19, coronavirus disease 2019; IPC, infection prevention and control; CC, core components; WHO, World Health Organization; PPE, personal protective equipment; HCW, health care workers; AGPs, aerosol generating procedures; CT, computed tomography; FFP3, filtering facepiece class 3; PCR, polymerase chain reaction; CDC, Centers for Disease Control and Prevention.

6. Built environment, equipment, materials (CC8)

All guidelines provided information on adequate PPE and hand hygiene supplies (e.g., types/amount, placement, procurement), management and operation of ventilation systems, and cleaning and disinfection of the environment and medical equipment (Table 5). Other notable contents include handling of linen and waste (Korea, the United Kingdom, Canada, Australia) and deceased body (Canada, Australia, Qatar, South Africa) (data not shown).

DISCUSSION

The WHO CCs is an evidence-based guideline on the implementation of essential components for IPC programs in terms of effectiveness in reducing HCAI at the national and facility level [8,9]. The result of this study reveals that the analyzed guidelines from seven countries contain a common subset of guidances across the eight core components that WHO recommends. The guidelines particularly agreed on IPC measures regarding application of standard precautions (CC2) and providing information to patients and visitors

**Table 5.** Comparative analysis of COVID-19 IPC guidelines: contents corresponding to core component 7 (CC7) and CC8 of the WHO IPC CC

	CC7					CC8				
	Risk assessment	Tracing and monitoring	At-risk staff	Restriction from/return to work policies	Staff supplement/workload evaluation	PPE supply	HH supply	Ventilation	Environment cleaning	Equipments
Korea	●	●	●	▲ Restriction (o), return (x)	–	●	●	●	●	●
UK	●	●	●	▲ Restriction (o), return (x)	–	●	●	●	●	●
Canada	●	●	●	● Restriction (o), return (o)	●	●	●	●	●	●
Australia (NSW)	●	●	●	● Restriction (o), return (o)	–	●	●	●	●	●
USA (CDC)	●	●	●	● Restriction (o), return (o)	●	●	●	●	●	●
Qatar	●	●	–	▲ Restriction (o), return (x)	–	●	●	●	●	●
South Africa	●	●	●	–	–	●	●	●	●	●

● Complying to WHO CC; ▲ partial mention (analyzed document mentions only subsets of what is required under respective WHO CC). COVID-19, coronavirus disease 2019; IPC, infection prevention and control; CC, core components; WHO, World Health Organization; PPE, personal protective equipment; HH, hand hygiene; CDC, Centers for Disease Control and Prevention.

(CC3), monitoring and audit of IPC activities and staff illnesses (CC6), and management of built environment/equipments (CC8). Simultaneously, guidelines showed considerable differences in certain components, such as workplace safety measures (CC7) and criteria for discontinuation of precautions (CC2).

Much evidence shows that an IPC governance at both the national and facility level and a dedicated IPC team is the single most important component in an institution's IPC capacity in managing HCAs [20,21]. In general, the results of this study show that most of the guidelines specify the roles and responsibilities of IPC teams (Korea, the United Kingdom, Canada, Australia, South Africa). Although leadership support in IPC is proven to be critical in effective operation of IPC activities in healthcare facilities [8,21], a few guidelines (South Africa, Korea) did not actively mention the role of leadership and decision-making actors in the analyzed guidelines. The United Kingdom dedicated a separate section to describe the responsibilities of the organization and employers, including risk assessment and training of staff, monitoring of IPC practices, and securing safety of work places. To enable full support for IPC programs, it is important that details concerning the role of senior leadership and commitment is clearly laid out.

WHO CC recommends that hospitals should have an IPC program with clearly defined objectives, and in line with such guidance, Korea, the United Kingdom, Canada, and Australia required an in-hospital COVID-19 plans and strategies. It is noteworthy that several guidelines (the United Kingdom, Canada, Australia) took this further to re-

quire hospitals operate disaster preparedness programs, such as ensuring local standard operating procedures to include emergency scenarios (the United Kingdom). Canada required hospitals to operate an organizational readiness programs, which include facilities and systems monitoring and readiness (e.g., monitoring and coordinated procurement of PPE and hand hygiene equipments with provincial buying groups, engineering controls, and facility design review). As the current COVID-19 pandemic has proven that IPC is not just a local issue at the facility level, but a broader issue of disaster preparedness and response involving multiple sectors and levels of the healthcare system [22,23], it is desirable that COVID-19 IPC plans in healthcare facilities adapt disaster preparedness in its planning.

The importance of education and training of HCWs and information provision to patients is widely agreed in the guidelines from all seven countries. IPC education and training has proven to be effective in reducing HCAI in many previous studies [24,25]. Moreover, WHO CC recommends IPC education and training to target not only the HCWs but also all general staff in the facility, based on relevance of IPC in all staff and visitors in minimizing transmission of HCAs [8,9]. In this regard, all guidelines, except South Africa, explicitly mentioned that education and training should be provided to all staff in the hospital, including administrative and housekeeping staff. Adequate PPE use was the single most emphasized topic to be trained in all guidelines, with ample amount of visual resources and references, reflecting the importance of proper PPE use in COVID-19 management. Some countries provided links to training materials available elsewhere,



which is a convenient measure to make guidelines both handy and useful. Although most countries described a range of topics to be trained on and brief explanation on the mode of training, only a few countries provided detailed description on the exact messages to be delivered (Canada, the United Kingdom, Australia) and described that such communication should be delivered regularly with updates on evidence and facility policies (Canada), which is a feature that may be adapted by other guidelines.

WHO CC recommends that hospitals conduct surveillance on a range of HCAs within the facility and also regularly monitor national/local level surveillance. Whereas guidelines from all seven countries described the need to conduct in-facility surveillance, mostly on COVID-19 symptoms and laboratory-confirmed COVID-19 cases, only a few countries stipulated the need to ensure response to ongoing national level COVID-19 surveillance (the United Kingdom, Canada, Australia, the United States). The United Kingdom recommended that hospitals should ensure a rapid and continued response to population incidence data in aim to adapt services and administrative measures in its accordance. Australia provides IPC actions and recommendations by epidemiological alert levels. Although not provided in the COVID-19 IPC guideline from Korea, this information does exist in a separate manual [26], and it is desirable that such information is depicted in disease specific guidelines as well, albeit in a more abridged format, if considered necessary.

Evidence reveals that regular monitoring of IPC practices coupled with feedback is effective in minimizing HCAI [27]. The guidelines generally recommended monitoring of compliance with IPC practices, which include facility procedures regarding PPE, hand hygiene procedures, and IPC precautions. Monitoring and follow-up was also highly recommended for HCW's COVID-19 signs and symptoms. Additionally, guidelines suggested monitoring for HCW education sessions for COVID-19 (Canada), environmental cleaning practices (Canada), and PPE supply (the United Kingdom, Canada, Australia, South Africa). Several guidelines went further to stipulate the need to share or report the audit results to relevant bodies (Canada, Australia, Qatar, South Africa). This is a desirable feature as WHO CC had also provided evidence on the importance of sharing the monitoring results with senior management, hospital administration, as well as those being monitored, to promote systems change.

The guidelines (CC2) component was analyzed in three parts which

are: (1) administrative control measures, which include guidelines on triage, physical distancing, and traffic management; (2) source control and precautions; and (3) management of COVID-19 patients. Regarding administrative control measures, all guidelines agreed on the need for screening at the point of entry to hospitals and isolation of symptomatic and/or suspected COVID-19 patients from other visitors. The management of patient flow within the hospital was discussed in detail in several guidelines (Korea, the United Kingdom, Canada, Australia, the United States), which included segregating pathways for symptomatic and asymptomatic patients, limiting traffic to ensure physical distancing, using adequate signage and barriers to designate pathways, etc. Canada additionally discussed the need to limit entry points to hospitals. The WHO recommended distance among all individuals in indoor settings should be at least 1 m, and all guidelines were compliant to this recommendation. Although physical distancing is undoubtedly the key IPC measure in reducing transmission of SARS-CoV2, evidence review by WHO reveals that the exact effective distance is still being studied and may depend on multiple factors, including amount of shed virus, type and duration of exposure, and so forth [5,7]. This may explain the variance in the distance recommended by the guidelines. It is noteworthy that several guidelines suggest different distances for different activities, type of PPE worn by the HCW during exposure, and so forth and that further study is anticipated for a general consensus to be made on this issue. Above mentioned administrative measures is advised to be coupled with information display using signage and posters at the entrance of the facility or anywhere else with high visibility, so that visitors have clear indications on the IPC measures currently in practice. All guidelines agreed that the standard precautions should be immediately applied to all patients and visitors and at all times and that universal masking should be practiced by all visitors for source control, which is in line with the COVID-19 specific IPC recommendation from WHO.

In terms of COVID-19 patient management, it is generally agreed among the guidelines that patients should be placed in a single room equipped with a dedicated toilet or a ventilation system or both. All guidelines also equally suggested that the cohorting of patients in the same room or area could be considered when single rooms are not available, which is inline with WHO recommendations. In this regard, WHO also suggests that a dedicated team of health workers be designated to care for confirmed patients [5]. The United Kingdom,

Canada, and the United States also recommends designated HCWs for the purpose of minimizing transmission, especially when incidence is high. Such recommendations regarding designated room and HCWs may depend on the status of resources in different health systems.

The PPE recommendations for HCW caring for suspected or confirmed patients from all seven guidelines complied with the recommendation by WHO, which recommended a respirator (filtering facepiece [FFP]2, FFP3, National Institute for Occupational Safety and Health-approved N95, or equivalent or higher-level certified respirator) or a medical mask should be applied along with a gown, gloves, and eye protection. While all guidelines complied with the minimal requirements from WHO, a few countries recommended a higher level of protection. Korea recommended that HCWs apply gowns or coveralls and Australia restricted surgical masks. Slight variations in the level of PPE recommendation revealed in this study are within the accepted range recommended by WHO. Additionally, as is in the case of HCWs, such variances may result from the different status of PPE supply, socioeconomic landscape, and local expert opinions in respective health systems. More importantly, guidelines should not fail to include contents regarding proper use of PPE, effective PPE procurement and distribution, monitoring and auditing of PPE use in HCWs. A few countries, also provided detailed PPE recommendations depending on different exposure types, activities (e.g., handling specimen and transfers), and disaster alert levels, which are all examples of practical and easy-to-interpret information provision for users.

Information regarding the duration of contact and droplet precautions for patients with COVID-19 is an important aspect of patient management and should be readily available through the COVID-19 specific guideline. Not all of the recommended duration from the guidelines which provided this detail was fully in line with the WHO recommendation of 10 days after symptoms onset and at least three consecutive days without fever or respiratory symptoms. While Australia was most compliant to the WHO recommendations, South Africa clearly mentions that despite such available evidence, a symptom based clinical criteria was adopted for discontinuation of precautions, due to the shortage of test kits the country currently is facing. We speculate that this is an ideal example of practical application of global standards to the local context, highlighting that disaster response should adequately and effectively reflect local capacity.

In general, visitors to hospitals and intra-facility transfers are rec-

ommended to be minimized unless medically necessary. However, in some guidelines (the United Kingdom, the United States), general access to healthcare facilities is not uniformly restricted. Rather, it writes that it should be planned based on clinical evaluations, instead of applying universal restrictions. As more studies reveal that access to essential health services has been unnecessarily restricted during the COVID-19 pandemic, possibly causing more harm to the population health in general [28,29], consideration should be given to allowing more access to healthcare facilities provided that strict IPC measures are adhered to.

The global society has come to realize that the management and support of health workforce is a critical factor of the health system resilience in its response to COVID-19 [30]. All guidelines included details regarding COVID-19 risk assessment of staff, tracing and monitoring of symptomatic and confirmed staff, and restriction from work policies. In contrast, only Canada, the United States, Australia included sufficient description regarding when, when not, and how to return to work for staff who are suspected or confirmed of COVID-19. Some guidelines take this further to include safe arrangements for staff to take breaks or consume meals, non-punitive sick leave, and ensuring systems to acquire necessary staffing in the case of staff shortages (Canada, the United States). It is advised that guidelines spare ample description on occupational and workplace safety, not only for the purpose of limiting transmission among staff but also to maintain sustainable systems capacity in the facility.

The management of built environment, supplies, and equipments was the component that showed minimum disparities among the guidelines analyzed. There were some notable features of some guidelines which enabled a more systematic response to COVID-19. Korea provided an essential IPC to-do list at the first several pages of the guideline, which the hospitals can quickly refer to when in need of information regarding the most prioritized and immediate actions. The United Kingdom describes all IPC actions by COVID-19 care pathways, which stratified patients according to the level of COVID-19 risk. Australia included standard operating procedures and necessary IPC measures by “alert levels,” which is an ideal example of synchronizing facility response to the local/national epidemic situation. Several guidelines also provided specific IPC measures that should be applied in different healthcare settings (e.g., maternity care, and dialysis units), which may require specific IPC measures. The policy im-

**Table 6.** Policy implications and recommendations for COVID-19 response and future guidelines development

WHO IPC CC	Implications and recommendations
Core component 1 (CC1): IPC governance and program	<ul style="list-style-type: none"> <li>Roles and responsibilities should be clearly stated for both (1) staff (including IPC teams) and (2) leadership (committees, employers, senior management)</li> <li>In-facility IPC planning should encompass “disaster preparedness”</li> </ul>
Core component 2 (CC2): IPC guidelines (COVID-19 specific guidelines)	<ul style="list-style-type: none"> <li>Recommendations should be based on up-to-date evidence on COVID-19 management</li> <li>Recommendations may be adjusted to the local circumstances to promote practicality and effectiveness in resources management, provided that such arrangements does not bleach up-to-date evidence</li> <li>Measures to ensure access to essential healthcare services should be considered, provided strict adherence to IPC</li> </ul>
Core component 3 (CC3): IPC education and training	<ul style="list-style-type: none"> <li>Provide training to all staff (healthcare workers, administrative, housekeeping, etc.)</li> <li>Provide links and/or locations of educational materials and resources</li> <li>Provide details on what and how to deliver training</li> </ul>
Core component 4 (CC4): healthcare-associated infection surveillance	<ul style="list-style-type: none"> <li>Perform monitoring of national and local surveillance data</li> <li>Respond and adapt services according to the population incidence/prevalence data</li> </ul>
Core component 6 (CC6): monitoring and audit of IPC practices and feedback	<ul style="list-style-type: none"> <li>Monitoring and audit should be performed on: compliance to IPC measures, staff illnesses and/or symptoms, education/training, supply of materials and equipments, etc.</li> <li>Results of the monitoring should be shared with: staff, senior management, etc.</li> </ul>
Core component 7 (CC7): workload, staffing and bed occupancy	<ul style="list-style-type: none"> <li>Safe workplace policies should include: risk assessment (including at-risk staff), tracing and monitoring, restriction from and return to work policies</li> <li>Recommend measures for workload evaluation, supplement plans in the case of staff shortages</li> </ul>
Core component 8 (CC8): built environment, materials, and equipment for IPC	<ul style="list-style-type: none"> <li>Provide instructions regarding management of materials, medical equipments, ventilation, spaces, functions, etc.</li> <li>Recommend installation of a system for “readiness” (procurement, supply monitoring, etc.)</li> </ul>

COVID-19, coronavirus disease 2019; WHO, World Health Organization; IPC, infection prevention and control; CC, core components.

plications and recommendations for COVID-19 response and future guidelines development, based on the discussions is summarized and provided (Table 6).

To the best of our knowledge, this is the first study comparatively analyzing the COVID-19 specific IPC guidelines among countries, using the WHO CC framework, suggesting policy recommendations in COVID-19 response and development of disease-specific IPC guidelines for future reference. The limitations of this study are that some of the disparities and absences in the content of the guidelines may be due to the rapid shift of the information and evidence-base of COVID-19. COVID-19 recommendations also may not be limited to the analyzed guidelines, and have been dispersed in other relevant policy documents and guidelines from the countries, in which case the analysis of the selected guidelines may have limited the scope of this study.

In summary, guidelines from seven countries showed general agreement in components such as application of precautions, provision of information to patients and visitors, monitoring and audit of IPC activities and staff illnesses, and management of built environment/equipments. The guidelines revealed considerable differences in

workplace safety measures and criteria for discontinuation of precautions. Several guidelines also contained unique features which enabled a more systematic response to COVID-19. While COVID-19 IPC guidelines should undoubtedly encompass all necessary components of IPC to ensure the safety of the patients and healthcare workers, it should not fail to consider any measures that enable patient access to essential healthcare services during public health emergencies.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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