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Examining the current intelligence on COVID-19 and infection prevention and control strategies in health settings: A global analysis

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Abstract

Objective In the current absence of vaccine for COVID-19, public health response target breaking the chain of infection by focusing on the mode of transmission. This paper summarizes current evidence-base around the transmission dynamics, pathogenic, and clinical features of COVID-19, to critically identify if there are any gaps in the current IPC guidelines.

Methods This study involved a review of global COVID-19 IPC guidelines such as WHO, the CDC, and European Centre for Disease Prevention and Control (ECDC). Guidelines from two high income countries (Australia and UK) and one middle income country (China) were also reviewed. We searched publications in English on 'Pubmed' and Google Scholars. We extracted information related to COVID-19 transmission dynamics, clinical presentations and exposures that may facilitate the transmission and compared and contrasted these findings with the recommended IPC measures.

Results The review findings showed nosocomial transmission of SARS-CoV-2 in health settings through droplet, aerosol and by an oral-fecal or fecal-droplet route. However, the IPC guidelines fail to cover all transmission modes and the recommendations also conflict with each other. Most guidelines recommend surgical masks for healthcare providers during routine care and N95 respirators for aerosol generating procedures. However, recommendations around type of surgical masks varied. In addition, CDC recommends cloth masks when the surgical mask is totally unavailable.

Conclusion IPC strategies should consider all the possible routes of transmission and target all patient care activities where there may be person to person transmission risk. This review may assist international health agencies to update their guidelines.

INTRODUCTION

The global outbreak of coronavirus disease (COVID-19) is caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). During the last two decades, there have been two other coronavirus events- SARS-CoV) and Middle East respiratory syndrome (MERS)-CoV which resulted in a considerable burden of cases across multiple countries [1, 2]. Outbreaks of newly emerging or remerging infectious diseases present a unique challenge and a threat to healthcare providers (HCPs) and other frontline responders because of limited understanding about the emerging threat, a reliance on infection prevention and control (IPC) measures that may not consider all transmission dynamics of the emerging pathogens, and variations in staff understanding and skills around the use of personal protective equipment (PPE).

During both the outbreaks of SARS-CoV and MERS-CoV, patients-to-patients and patient-to-HCP transmission occurred in health settings [3, 4]. While the level of risk across hospital occupants (to HCPs and others) is on a spectrum, all of these groups pose unique challenges when it comes to reducing transmission. In the hospital settings, performing aerosol generating procedures(AGPs) such as intubation, suction, bronchoscopy, cardiopulmonary resuscitation or use of a nebulizer on SARS patients facilitated patients to HCP transmission [3, 5, 6]. Overcrowding in emergency rooms, poor compliance with IPC, and contamination of environment were also reported as contributor to the virus spread [7-11].

In the health settings, we know that the most common pathway of human-to-human transmission had been the contact of the mucosae with infectious respiratory droplets or fomite [12]. However, prior studies have also detected coronaviruses in sputum, nasal or nasopharyngeal

swabs, endotracheal aspirate, bronchoalveolar lavage, urine, feces, tears, conjunctival scraps, blood and lung tissues [13-16]. Prior research also showed that SARS-CoV can survive in sputum, serum, and feces for at least 96 hours and in urine, 72 hours [17] and in surfaces it can survive up to nine days[18]. This means that the recommended mitigation strategies may need to be sufficiently broad to control these transmission modes.

The COVID-19 IPC guidelines have been adopted and or developed based on the knowledge gained from experience during responding MERS-CoV or SARS-CoV outbreaks [19-22]. However, the available published literature to date have identified that the SARS-CoV-2 is genetically similar to, but distinct from the SARS-CoV [22-24] in terms of transmissibility, virus shedding, and characteristics [25-28]. Therefore, a critical review of the available literature of the COVID-19 outbreak is essential to inform and update IPC guidelines. This study aimed to examine the current recommendations for IPC in light of what is known to date about COVID-19.

METHODS

This study involved a review of global COVID-19 IPC guidelines such as World Health Organization (WHO), the United States Centers for Disease Control and Prevention (CDC), and European Centre for Disease Prevention and Control (ECDC). The rational for selecting these international guidelines was these guidelines are commonly used globally as a reference [29, 30]. Guidelines from two high income countries (Australia and UK) and one middle income country were also selected. We searched publications in English on 'Pubmed' and Google Scholar for the period between January 1 to April 27, 2020, using the search terms "2019-nCoV"or COVID-19, or "2019 novel coronavirus" or "SARS-CoV-2". To identify COVID-19 IPC guidelines, we visited the websites of the international public health agencies such as CDC, ECDC, WHO and the Australian Government Department of Health, bureau of disease prevention and control of the national health commission of the people's republic of China and the government of UK portals.. Using the terms mentioned above, we also undertook a Google search for newspaper articles, reports and updates related to the disease.

Data management and analysis

We extracted the information related to COVID-19 transmission dynamics, clinical presentations and exposures that may facilitate the transmission while reviewing the literature. For guidelines, we extracted title, country/organization, department, target audience, and the different control measures recommended to control COVID-19. MSI extracted the information from the guidelines and all co-authors reviewed and validated. We performed a content analysis of all the data, summarized under the themes and then compared and contrasted the findings under COVID-19 IPC measures[31].

RESULTS

Transmission Dynamics

The SARS-CoV-2 is a zoonotic virus and bats are assumed to be the reservoir [23, 32]. The suspected modes of COVID-19 transmission in Wuhan are from bats to humans through animal that served as an intermediate host facilitating the transfer of the virus in humans [23]. The SARS-CoV-2 can be spread via droplet and aerosol (in closed environment with high concentration of aerosols) that transmits from human to human through everyday interactions and contact (person touches the patient or object contaminated with the virus) [21, 22, 33-43]. Doremalen et al. (2020) found the SARS-CoV-2 may remain viable in aerosols up to three hours and on surfaces up to several days [44, 45]. The public health England classified COVID-19 as an airborne high consequence infectious disease in the United Kingdom (UK) [21]. The transmission may occur presymptomatic, during the incubation period, or even after recovery [46, 48]. Like influenza and other respiratory pathogens, it is assumed that the SARS-CoV-2 may also transmit through respiratory droplet such as coughing and sneezing [49]. The CDC team reasoned that when an infected person coughs or sneezes, the large respiratory droplets expressed from the patients' mouth and nose are likely to transmit the virus from the infected patient to a healthy person[50]. The propelled droplets can directly deposit on the mucous membrane of the mouth, nose, or eyes of a nearby person or on the surface of objects[49]. These droplets may travel up to ≈4 m[51] and may increase the risk of infection to HCP [52]. Guo, Z. D. et al (2020) also identified SARS-CoV-2 in shoe soles of HCPs working in intensive care units (ICU) and therefore, shoe can be a carrier of the virus [51]. In an experimental study conducted by Doremalen, et al (2020) the author found the SARS-CoV-2 can remain viable on plastic and stainless still up to 3 days [44]. Moreover, SARS-CoV-2 RNA was identified in a

cruise ship 17 days after the ship was vacated [45]. Aerosol generating activities such as bronchoscopy, bronchial suction, tracheal intubation, and sputum induction may generate aerosol containing the virus and increase the risk [19, 42]. These modes of transmission may contribute spreading the virus in health settings including super spreading events [53] and provide guidance for IPC in health settings.

Exposures that may facilitate risk of infection

It is estimated the incubation period of COVID-19 is 2-14 days[64]. Backer, et al (2020) estimated the mean incubation period to be 6.4 days (95% confidence interval [CI], 5.6–7.7) [65] . The available findings showed that transmission of SARS-CoV-2 may occur before and after symptoms onset [45]. Zou et al (2020) found that modest viral loads in the nasal and throat swabs early in the illness, with viral loads peaking approximately 5 days after symptom onset and the virus could be detected until 15 days of onset of illness and can facilitate the transmission throughout the illness episode [27]. Sharing a toilet in health settings can also be a source of infection as the SARS-CoV-2 was detected in toilet bowl and sink [66, 67]. Inappropriate selection of PPE may also put HCP at risk of infection[68]. Exposure to aerosol generating activities was identified to be the risk factor of acquiring the disease[42], but what are the others drivers of transmission and exact mode of transmission need further exploration. For example, patients' blood, saliva and stool had been found positive with SARS-CoV-2 virus [60, 63, 69], but what role these body fluids may play in the disease transmission in health settings and in which way remained unanswered.

Occupational risk

As of 8 April, 2020, more than 22,000 HCPs have been infected with COVID-19 in 55 countries[70]. HCP share around 11% of all reported COVID-19 cases in Italy[70] , 13.6% in Spain[71], around 14% in UK [72, 73] and 3.8% in China[70].One of the largest known hospital acquired infection of SARS-CoV-2 was reported in a hospital among 17/138 (12.3%) patients and 40/138 (29%) healthcare workers in China [54]. Of the infected HCPs, 77.5% were from general wards, 17.5% were from the emergency department, and 5% were from intensive care units [54]. Li et al (2020) reported there were no reported cases of COVID-19 in HCP before January 1, 2020 [74]. From January 1 -11, 3% (7/248) HCP were infected, and from January 12-22, there were 7% (8/22) cases of HCP were infected and the findings shows healthcare associated infection was increasing [74]. A more recent study in a hospital in the UK showed ongoing transmission of COVID-19 amongst HCP [75].

COVID-19 Infection prevention and control guidelines

The department of health, Australia, bureau of disease prevention and control of the national health commission of the people's republic of China, CDC, ECDC, Public Health England, and WHO published COVID-19 IPC guidelines targeted health administrators, HCPs or public health unit as a target audience to implement IPC [22, 78-82]. Currently, as IPC measures, suspected source control; use of personal protective equipment, rapid diagnosis, physical distancing, isolation, investigation and follow-up of close contacts are in practice [54]. All guidelines included administrative control, environmental control and PPE and Australia, WHO and CDC also discussed engineering control. A comparison of the recommendations made in the guidelines has been presented in Table 1, Table 2 and Table 3.

Administrative controls

All guidelines recommend early diagnosis and isolation of COVID-19 patients in a single room, if available. In settings where single room isolation facilities are limited, all the guidelines recommend cohorting/zoning suspected patients in a well ventilated room. The guidelines prioritize source control and recommend providing a face masks to patients. The guidelines also recommend training for all HCP on IPC measures. However, there are discrepancies in the guidelines with regards to IPC measures recommended. For example, WHO recommends there should be at least one meter distances between patients or patients to HCPs when patients are cohorted in a large room where as Australia recommends 1.5m and CDC recommends about 2m (≈6ft) between patients.

Four guidelines recommend patient education. Three guidelines suggest establishing surveillance in the hospital to monitor cross infection in patients and HCP.

. All the guidelines highlighted visitor controls in the hospitals. However, only China and WHO discussed about family members care giving role in health settings and recommended family caregivers should use contact and droplet precaution while attending patients in the hospital. Besides, ECDC guidelines recommend PPE for social workers when they provide care in health settings.

Environmental controls

All the guidelines recommend AGPs must be prioritized in negative pressure isolation room or in a well ventilated room, and contact and airborne precautions should be followed during the AGPs. To reduce room contamination in hospital settings, all the guidelines recommended routine clean and disinfect surfaces using disinfectants. The China guideline also recommends air disinfectants using air sterilizer and use of pressure steam sterilization. Incineration or

sterilizing patients' cloths, beddings and utensils are included in Australia, China and UK guidelines. Although fecal-oral route of COVID-19 transmission has not been confirmed yet, China guidelines recommend disinfecting septic tanks. The CDC, ECDC and UK guidelines recommended separate toilets for each patient. Although all the guidelines recommend precautions during patient transfer, only China, ECDC and UK guidelines emphasized on decontaminating transport means and trolley used by confirm patients.

Use of personal protective equipment

Due to the global acute supply shortages of PPE, almost all the guidelines revised their initial recommendations related to PPE use. Five of the six guidelines now recommend reuse of PPE following the manufacturers' instruction. Considering the global scarcity of PPE supplies, the WHO, CDC, ECDC, Australia and UK updated guidelines recommend surgical masks as an acceptable alternative to N95 respirators for HCP during routine care and N95 or equivalent respirators has been prioritized during AGPs. However, recommendations around type of surgical masks varied, for example, some guidelines recommend fluid repellent surgical face masks where as others recommend general surgical mask[82]. The CDC also recommends homemade cloth masks or homemade masks when the face mask is totally unavailable[81].
As contact and droplet precautions, PPE including wearing a surgical mask, and a gown, gloves, face shield, goggles and/or visors, and hand hygiene has been recommended on entering the patient's room, and removing them upon leaving (Table 1). If available, alcohol based hand sanitizers have been prioritized in all guidelines (Table 1). Fit testing and seal check are an essential part of respirator use, but fit testing is recommended in five guidelines and seal check in three guidelines. Precaution during donning and doffing has been recommended in all guidelines.

If an autopsy is required for a patient, the WHO, CDC, ECDC and UK guidelines recommend use of contact and airborne precautions during the postmortem autopsy. However, the WHO recommend performing postmortem autopsies in an adequately well ventilated room whereas CDC recommend performing this procedure in airborne infection isolation room [85, 86].

Engineering control

Physical separation has been found efficient in reducing transmission of respiratory virus in hospital settings. The Australia,CDC and WHO guidelines emphasized on engineering control as an IPC measures. The guidelines recommended spatial barriers or partitions to manage patients in triage areas, curtains in each bed in inpatient wards, closed suctioning systems for airway suctioning for intubated patients, and air flow management as engineering control measures. The CDC guidelines also recommend installing physical barriers using glass or plastic windows at the hospital reception.

Corpse handling and management

All the guidelines recommend standard precautions during dead body handlings. Only Australia, China and UK guidelines recommend the use of body bags in the IPC guidelines. The China guideline recommends putting cotton balls or gauze in deceased's mouth, noses, ears, anus and tracheotomy or any open wound [22]. All the guidelines also recommend burial ritual may be allowed with standard precautions. A dedicated vehicle is recommended for body transport.

DISCUSSION

The review identified the transmission model and risk exposures of the COVID-19 outbreak. The identified signs and symptoms of the case patients suggest SARS-CoV-2 can be transmitted through cough, sneezes, saliva, nasal secretions, stool and vomits in a mode of droplet, aerosol, fecal-oral or fecal-droplet transmission[42, 69]. However, based on our review of the guidelines, there are currently discrepancies around the recommendations with not all documents acknowledging the three routes of transmission. To reduce exposures to SARS-CoV-2, all the guidelines recommended early diagnosis and rapid isolation of the case patients. However, studies to date have identified that rapid diagnosis of patients is challenging [87]. This is because the sign and symptoms of SARS-CoV-2 are non-specific and may be confused with all microbial causes of respiratory tract infections [87]. The non-specific nature of the virus as well as asymptomatic patients may affect the IPC measures.

Our study identified the recommendation of special separation between patients or between patients and HCP is inadequate as droplet precautions in hospital settings. The recommendation of physical distance in the guidelines varies between 1m to 2m, however, recent study suggests the virus may travel more than 4m [51]. Moreover, environmental factors such as air flow, humidity and use of air conditioners or air mixing fans may also influence the horizontal travel of droplets. Outbreak of COVID-19 linked to air conditioning has been reported in China[88]. Our findings warrant a revision of the special separation recommendation.

Although there is very limited evidence that SARS-CoV-2 could be airborne, all of the guidelines recommend placing patients in a single room, if available. The exponential large

number of patients in several countries showed the implementation of this isolation recommendation may be impossible due to shortage of single isolation rooms [89, 90]. Therefore, cohorting patients in a large shared rooms has become a practical alternative measures that has also been recommended in most updated guidelines. All the international guidelines should make specific recommendations for hospitals that treat several patients in a large shared room. In addition, bed sheets and bed rails can be an important source of droplet and fomite transmission[18]. All the guidelines did not give proper instruction on how to handle the beddings and clothing of the patients. Since the SARS-CoV-2 may remain viable on surface for days, a recommendation is needed for safe handling of beddings and patients clothing.

The presence of virus in stool samples indicates the virus may also transmit through fecal-oral or fecal-droplet transmission [63, 67, 69]. The prior evidence of SARS coronavirus transmission through feces further supports the likelihood of COVID-19 transmission in the form of an oral-fecal or fecal-droplet[91]. In recent studies, investigators detected SARS-CoV-2 in toilet bowl, sink and air [66, 92]. Toilet flushing may generate bio-aerosols contaminated with pathogens. A prior study detected pathogenic microorganism in air samples collected from hospital toilets, and the pathogen may remain viable in the air for at least 30 minutes post flush suggest possibility of fecal-droplet transmission [93]. Our review findings warrant specific recommendations to prevent fecal oral or fecal-droplet infection in hospital settings.

Shortage of PPE is expected during pandemics due to high demand and was reported in past pandemics as well[94] Due to the shortage of PPE supply, all the guidelines recommend HCP should wear surgical mask as a droplet precaution as well as during specimen collection [19, 22]

and N95 or equivalent respirators were recommended only during AGPs in all guidelines [19]. The review showed that the virus may transmit through aerosols[42, 92], can remain viable in aerosols for several hours[44, 92] and therefore, face masks may not provide sufficient protection to the HCP due to HCP's long and repeated exposures in confined spaces[77]. In addition, a recent study found that the transmission dynamics of COVID-19 seems more like influenza than SARS-CoV [27]. A randomized control study among HCP exposed to influenza patients found that surgical mask may provide some protection to the wearers probably by minimizing the frequency of times a person touches their nose and mouth [95]; however, surgical mask may not be fully effective for respiratory pathogens because of leakage due to loose-fitting of the surgical masks [96]. Considering the shortage of HCP globally[97], the international guidelines should recommend optimal protection and IPC standards to protect front line HCP. There are already more than 22,000 HCPs are infected and other countries have been reporting ongoing nosocomial transmission of SAR-CoV-2 in HCP [70, 72, 98, 99]. The role of face mask in protecting HCP from SAR-CoV-2 has been questioned [100]. We understand that global shortage of N95 or equivalent respirators might have prompted the WHO, UK, ECDC, Australia and CDC to loosen their recommendations on the face protection, but we should not leave any option to put front line HCP at risk of infection. This finding warrant changing the face mask recommendation to N95 or equivalent respirators for HCP in all guidelines.

The guidelines should include a strong statement against the use of cloth or material masks, should encourage HCP to not wear two products at one time Although four guidelines recommend reuse of PPE or the HCP should wear them for an extended period, it should be noted that there are no current guidelines around this behavior, and strict hand hygiene and

donning/doffing procedures should be followed. For example, the UK guideline recommends a PPE can be used between 2-6 hours where as ECDC guidelines recommend wearing the PPE for up to 4-6 hours [80, 82]. If countries resort to these strategies, it would be useful for the wider international community that observations studies be undertaken so that the learning can be applied into future guidelines. Lastly, the WHO guidelines lack a recommendation on fit testing. It cannot be assumed that staff members have been fit tested for their respirators and so hospitals should be encouraged to fit test or at least fit check members of staff including ancillary (cleaning/support staff) and pharmacists who will frequent the wards.

The review findings also warrant updating recommendations on disposition of patients after recovery and use of standard precaution. Although all the guidelines made specific recommendation on this topic, however, some of the recommendations mismatched with our findings. For examples, the WHO guideline recommends continuing the standard precaution until a patient is asymptomatic. However, a prior study identified prolonged shedding of SARS-CoV-2 after recovery[46]. Therefore, special attention must be given to this recommendation. The discordance in the recommendations on corpse handling may increase the risk of infection among the exposed. Corpse to human transmission of Ebola and Nipah viruses has been documented in the literature [101, 102]. MERS-CoV was detected in nasal secretions of a dead human [103]. SARS-CoV-2 was detected in patients respiratory secretions, saliva and stool, and the virus may remain active in deceased's secretions and excreta at least few hours after death [27, 74, 104-108]. Direct physical contact with bodies infected with the virus may increase the risk of infection. Our findings suggest all the guidelines should include recommendations on how to handle corpse and their management in hospitals.

The increasing numbers of COVID-19 infection amongst HCPs along with evidence of ongoing transmission in some hospitals suggest there might be a gap in IPC measures that must be revisited. Low-and-middle income countries often adopt international IPC guidelines as they stand or with modifications for the local context. Therefore, we would like to recommend international guidelines need to consider the global context while recommending any IPC measures. In conclusion, our review identified that SARS-CoV-2 may spread faster than the previous SARS-CoV. IPC measures should consider SARS-CoV-2 as a droplet, aerosol, and oral-fecal infection, and all the guidelines should target these modes of transmission while recommending the control measures. As there is no drug or vaccine publicly available for SARS-CoV-2, HCP and other outbreak frontline responders should rely on IPC measures. In addition, there is always a gap between development of IPC guidelines, their introduction to target audience and implementation. During public health emergency, international agencies may target online platform to introduce the IPC guidelines to HCP in a shorter time. National authorities should provide training on the IPC guideline among people who are likely at risk of infections.

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Table 1: Basic infection prevention and control measure recommended in all international and national COVID-2019 guidelines

Issuing org/country	**CDC**	**WHO**	**ECDC**	**The Department of Health, Australia**	**Bureau of Disease Prevention and Control, China**	**Public Health England**
Title	Interim Infection Prevention and Control Recommendations for Patients with Confirmed 2019 Novel Coronavirus (2019-nCoV) or Persons Under Investigation for 2019-nCoV in Healthcare Settings[81]	Infection prevention and control during health care when novel coronavirus (nCoV) infection is suspected [78]	Infection prevention and control for the care of patients with 2019-nCoV in healthcare settings[80]	CDNA National Guidelines for Public Health Units: novel Coronavirus 2019 (2019-nCoV) [79]	新型冠状病毒肺炎防控方案（第四版）(Prevention and Control Guidelines on Novel Corona Virus Pneumonia, 5th Ed.)[22]	Guidance on infection prevention and control for COVID-19[82]
Target Audience	Hospital administrators and HCP	Hospital administrators and HCP	Hospital administrators and HCP	Public Health Unit	Hospital administrators, HCP and community members	HCP
Administrative controls						
Risk assessment	✓	✓	✓	✓	✓	✓

Train and educate HCP on IPC	✓	✓	✓	✓*	✓	✓
Patient transfer precaution	✓	✓	✓	✓	✓	✓
Source control	✓	✓	✓	✓	✓	✓
Provide surgical masks to patients	✓**	✓	✓	✓	✓	✓
Early diagnosis	✓	✓	✓	✓	✓	✓
Suspected case isolation	✓	✓	✓	✓	✓	✓
Use of dedicated/disposable medical equipment	✓	✓	✓	✓	✓	✓**
Patients should be placed in single rooms	✓	✓	✓	✓	✓	✓
Respiratory Hygiene	✓	✓	✓	✓	✓	✓
Waste management	✓	✓	✓	✓	✓	✓
Visitor management	✓	✓	✓	✓	✓	✓
Established reporting system	✓	✓	✓	✓	✓	✓
Disposition of patients	✓	✓	✓	✓	✓	✓
Contact and droplet precaution for COVID-19 patients care	✓	✓	✓	✓	✓	✓
Environmental control measures						
Negative pressure isolation room for AGPs	✓	✓	✓	✓	✓	✓
Contact, droplet and airborne precaution for AGPs	✓	✓	✓	✓	✓	✓
Routine clean and disinfect surfaces	✓	✓	✓	✓	✓	✓
Waste management	✓	✓	✓	✓	✓	✓
Personal protective equipments						
N95 or equivalent respirators for AGPs	✓	✓	✓	✓	✓	✓
Surgical masks for HCP	✓***	✓	✓	✓	✓	✓
Gloves for HCP	✓	✓	✓	✓	✓	✓
Gown for HCP	✓	✓	✓	✓	✓	✓

Face shield for HCP	✓	✓	✓	✓	✓	✓
Goggles/visor	✓	✓	✓	✓	✓	✓
Alcohol based hand sanitizer for HCWs	✓	✓	✓****	✓	✓	✓
Hand wash with soap and water	✓	✓	✓	✓	✓	✓
Precaution during donning and doffing	✓	✓	✓	✓	✓	✓

*Training for ICU staff; ** depends on area of care and risk assessment; *** only if N95 respirators are not available **** if available.

Table 2: Discordance in extended administrative infection prevention and control measure recommended in international and national COVID-2019 guidelines

Issuing org/country	CDC	WHO	ECDC	The Department of Health, Australia	Bureau of Disease Prevention and Control, China	Public Health England
Administrative controls						
Covid-19 preparedness and response committee			✓		✓	
Plan for surge capacity			✓			✓
IPC focal point/Group		✓			✓	
Spatial separation between patients	✓*	✓**		✓***		
Separate area for respiratory /suspected COVID-19 patients			✓	✓***		
Install physical barriers at hospital reception	✓					✓
Rapid Triage	✓	✓		✓		
Triage outside facility	✓					
Cough etiquette	✓	✓		✓		
Separate toilet for patient	✓		✓			✓
Assess/ensure onsite availability of PPE			✓			✓
Provide hand and respiratory hygiene and cough etiquette supplies	✓	✓	✓			✓
Place known or suspected patient in AIIR/negative pressure room			✓	✓****	✓****	✓****
Cohorting confirmed patients	✓*****	✓*****	✓*****	✓	✓*****	✓*****

in a ward with dedicated staff						
Decontaminate equipments if needed to share/reuse	✓	✓		✓	✓	✓
Visitor keep a distance of at least one meter from a patient			✓			
HCP wash hands after doffing			✓	✓		
Incinerating/sterilize clothing/bedding/utensils				✓	✓	✓
Monitor and manage Ill and exposed HCP	✓		✓	✓	✓	
HCP training on use of PPE	✓			✓******	✓	✓
Establish surveillance		✓		✓	✓	
Monitoring IPC compliance		✓			✓	
Patient education		✓		✓	✓	✓
Family caregiver/visitor education		✓				✓
Risk communication					✓	
Cleaning and disinfecting medical equipments	✓	✓			✓	✓
Maintain a register for visitor and follow up for 14 days		✓	✓			
Post sign in public areas reminding symptomatic patients to HCWs	✓	✓		✓		✓
Disposal of PPE	✓			✓	✓	✓

*One meter distance between patients; ** Six feet (2meter) distance between patients; ***Included in State level policies; ****Depends on availability; ***** If single room is not available, patients are recommended to share a large room; ******Training for ICU staff

Table 3: Discordance in extended environmental and personal protective equipment infection prevention and control measure recommended in international and national COVID-2019 guidelines.

Issuing org/country	US CDC	WHO	ECDC	The Department of Health, Australia	Bureau of Disease Prevention and Control, China	Public Health England
Environmental control measures						
Staff engaged in environmental cleaning and waste management should follow contact and droplet precautions			✓	✓	✓	
Ensure adequate ventilation	✓	✓			✓	✓
Air disinfection					✓	
Cleaning and disinfecting medical equipments	✓	✓		✓	✓	✓
Disinfecting septic tanks					✓	
Pressure steam sterilization					✓	
Incinerating/sterilize clothing/bedding/utensils		✓		✓	✓	✓
Cleaning and disinfection electronic equipments			✓	✓*		
Decontamination of transport means/patient trolley			✓		✓	✓
Personal protective equipments						
Cloth mask for HCP	✓**				✓	
Reuse use of PPE	✓	✓	✓	✓		✓
Cough etiquette	✓	✓		✓		
Decontaminate equipments if needed to share/reuse	✓	✓		✓	✓	✓
Use of PPE during patients transfer		✓		✓	✓	✓
Patient wear surgical mask during transfer		✓		✓		
N95 or equivalent respirators for routine care	✓***		✓***		✓	✓****
N95 Fit testing	✓		✓	✓	✓	✓
N95 seal check	✓	✓		✓		

HCP should wear scrubs			✓			✓
Injection safety practices		✓				
Use clean cloth towels			✓*****			
Use cloth masks for patients	✓					
Family caregivers/visitor should use PPE	✓	✓	✓			✓
Visitor wear a surgical mask		✓	✓			
Visitor wear a cloth mask	✓					
Visitor wear gloves		✓	✓			
Visitor wear visor/goggles		✓	✓			
Visitor wear gown			✓			
PPE for social workers						✓
Dead body disposal standard precaution	✓	✓	✓	✓*	✓	✓
Use of corpse bags				✓*	✓	✓
USE of PPE during handling body	✓	✓	✓	✓*	✓	✓
Use of PPE during postmortem procedure	✓			✓*	✓	✓
Contact and airborne precaution during postmortem autopsy	✓	✓	✓	✓*		✓
Autopsies should be performed in Airborne Infection Isolation Room	✓					✓

- Included in state level guidelines; **When facemasks and N95respirators are altogether unavailable; ***If available; **** Only in higher risk acute inpatient care ***** If paper towels are not available; included in a separate/state level policy