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An Outbreak of Coronavirus Disease (COVID-19) among Healthcare Personnel in a Private Hospital Related to Delayed Detection of SARS-CoV-2 Infection Foci

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Abstract

Healthcare personnel are front-line workers for disease prevention and control. On 6 Apr 2020, the Department of Disease Control received a notification on a cluster of healthcare personnel in a private hospital infected with coronavirus disease (COVID-19). The event was investigated and a cross-sectional study was conducted to describe the epidemiological characteristics of the cluster, including risk factors for SARS-CoV-2 infection. A confirmed COVID-19 case was a person with SARS-CoV-2 virus tested by reverse transcription polymerase chain reaction in one reference laboratory; and a probable COVID-19 case was a person who died of pneumonia in the hospital, did not tested for COVID-19, and had an epidemiological linkage to a confirmed case. Among total 2,287 healthcare personnel working at the hospital, 25 were confirmed cases (attack rate 1.1%). Although the attack rate was relatively low, the specific attack rate in the inpatient ward was high (32.4%) due to delayed outbreak detection. Analytic results suggested that attending infection prevention and control (IPC) training was a protective factor for COVID-19 (Odds ratio 0.04, 95% CI 0.00-0.64). In addition, a survey on personal protective equipment (PPE) showed that 66.7% of those conducting sputum suction/drug nebulization and 83.9% of those performing cardiopulmonary resuscitation used inappropriate PPE. Therefore, IPC training, including appropriate use of PPE, should be provided to all healthcare personnel. In addition, healthcare personnel should be alert for COVID-19 infection, and protect themselves according to the standard protocols. Routine screening of healthcare personnel should be performed during the COVID-19 epidemic.

Keywords: healthcare personnel, coronavirus disease, COVID-19, SARS-CoV-2, outbreak investigation, hospital

Introduction

Coronavirus disease (COVID-19), an emerging disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus, has become a new global health threat.[1] As of 11 May 2020, over four million people were infected with SARS-CoV-2, with about 300,000 deaths reported globally.[2]

In Thailand, SARS-CoV-2 was first detected among international travelers from China, and the first case of local transmission was detected on 31 Jan 2020.[3] As of 28 Apr 2020, 2,938 people were diagnosed with COVID-19, with 54 deaths.[4]

Since COVID-19 cases have been increasingly reported, healthcare personnel become more at risk. In

the United States, the Centers for Disease Control and Prevention reported that of those who had COVID-19 infection, 19% were healthcare personnel which included frontline staffs fighting against COVID-19.[5] The reported risk of COVID-19 infection among these group is related to PPE.[6,7]

On 6 Apr 2020, the situation awareness team of the Department of Disease Control (DDC), Ministry of Public Health, Thailand, notified the operation teams about a cluster of COVID-19 cases at a private hospital (Hospital R) in Bangkok. The operation teams from the Urban Institute for Disease Prevention and Control, Bamrasnaradura Infectious Diseases Institute and DDC jointly investigated the event during 7 to 10 Apr 2020. The objectives of the investigation were to describe epidemiological characteristics, identify a possible source of transmission and factors related to SARS-CoV-2 infection, assess the practice of personal protective equipment (PPE) usage among healthcare personnel attending to COVID-19 patients, and provide recommendations for prevention and control measures.

Methods

A cross-sectional study was conducted among healthcare personnel and patients in Hospital R during 10 Mar to 13 Apr 2020. A probable COVID-19 case was a person died of pneumonia in Hospital R during 10 Mar to 13 Apr 2020, had an epidemiologic link with a confirmed COVID-19 case, and was not tested for COVID-19. A confirmed COVID-19 case was defined as a person with SARS-CoV-2 virus in a nasopharyngeal specimen tested by reverse transcription polymerase chain reaction (rt-PCR) in a standard reference laboratory, as per the national guideline for COVID-19 investigation in Thailand dated 23 Mar 2020.[8]

Data Collection

For healthcare personnel infected with COVID-19, their demographic information and activities in hospitals and communities were collected by reviewing COVID-19 epidemiologic investigation forms, interviewing via phone and conducting an online survey with a structured questionnaire. For COVID-19 patients admitted in the hospital, their medical records were reviewed and close relatives were interviewed.

The potential factors associated with COVID-19 infection, including job position, work section, PPE usage and infection prevention and control (IPC) training, were collected by interviewing via phone and performing a survey among healthcare personnel in ward A and intensive care unit A where the probable case were admitted.

For the PPE survey, an online structured questionnaire was used for data collection among all healthcare personal in Hospital R. The collected data included PPE practice in each working process.

Data Analysis

For the descriptive study, continuous variables such as age were described by median with interquartile range, whereas categorical data were described in frequency and percentage. For bivariate and multivariate analysis, we included healthcare personnel in ward A and intensive care unit A. Potential factors associated with confirmed cases were analyzed as well. The factors included PPE usage, attending IPC training and job position at the hospital. In terms of PPE survey, the national standard guideline was used for categorization.[9]

Odds ratio (OR) with 95% confidence interval (CI) were calculated. Variables with p-value less than 0.1 in bivariate analysis were included in logistic regression analysis. Adjusted OR with 95% CI were presented as outputs of the multivariate analysis. Stata software version 14 was used for data analysis.

Results

Hospital R is a private tertiary care hospital located in Bangkok, Thailand. There are three buildings, 500 beds and 2,287 healthcare personnel. During 10 Mar to 13 Apr 2020, total 25 confirmed cases of COVID-19 were identified among healthcare personnel, and there were one probable case and three confirmed cases among patients admitted in the hospital.

Healthcare Personnel Infected with COVID-19

Of 25 confirmed cases among healthcare personnel, corresponding to an attack rate of 1.1% (25/2,287), male to female ratio was 7.3:1and median age was 26 years (Q1 = 22 and Q3 = 30 years). The highest attack rates were found among physiotherapists (5.3%) and practical nurses (4.1%). (Table 1)

The ward A was resulted with the highest attack rate (32.4%), followed by intensive care unit A (12.5%), and chest and cardiovascular outpatient department (OPD) clinic (12.5%). (Table 2)

The most common signs and symptoms were fever or body temperature higher than 37.5 degree Celsius (60%), sore throat (56%) and runny nose (40%). (Figure 1)

The outbreak began on 17 March 2020 and reached its peak during 23 to 30 March 2020, starting in ward A and spreading to intensive care unit A. The epidemic curve suggested that there was a transmission within the hospital. The index healthcare personnel cases were three females: one registered nurse, one nursing assistant and one practical nurse in the ward A. The index cases were tested one day after their symptoms developed. The first case among healthcare personnel was likely to be a male physician, Physician P, who worked at the chest and cardiovascular clinic, ward A and intensive care unit A. He had low risk of infection from the community as he lived alone or had not been to the crowed areas. He developed respiratory symptoms on 17 Mar 2020 and as his symptoms got worse on 28 Mar 2020, he was tested for SARS-CoV-2 on the same day. (Figure 2B)

About 76% of the infected healthcare personnel worked less than 70 hours per week. About 20% of the cases worked more than one unit in Hospital R, which included areas at high risk of COVID-19 infection (i.e. acute respiratory infection clinic, and chest and cardiovascular clinic). Only one healthcare worker (4.0%) attended IPC training. (Table 3)

Probable and Confirmed COVID-19 Patients in Hospital R

Among patients admitted in Hospital R, one probable case and three (patients X, Y and Z) confirmed cases of COVID-19 were identified. The probable case was admitted to ward A on 21 Feb 2020, transferred to intensive care unit A due to pneumonia on 22 Mar 2020 and had a nebulization procedure during hospitalization. The patient died on 27 Mar 2020. The probable case's two cousin shad history of contact with the probable case before and during hospitalization and were confirmed to have SARS-CoV-2 later on.

Regarding to three confirmed cases among patients, patient X was admitted to the intensive care unit A on 21 Mar 2020, the same period when the probable case was admitted. Then, patient X was transferred to ward B on 28 Mar 2020. Patient X had intubation procedures and died later on. Two other confirmed patients (Patients Y and Z) received treatment at emergency room and Ear, Nose and Throat Out-Patient Department (ENT OPD). They were confirmed to have COVID-19 before admission (Figure 2A).

Transmission Between Healthcare Personnel and Patients in Hospital R

Two sub-clusters were found in this outbreak: a sub-cluster linked with the probable case, Physician P and Patient X, and a sub-cluster associated with Patient Y.

For the first sub-cluster, the outbreak started in ward A. The probable case's cousins or healthcare personnel were likely to be the source of infection. Since the probable case were admitted for several months, the chance of COVID-19 infection from community was low. The probable case might transmit the infection to other healthcare personnel in ward A. Although the probable case was later transferred to intensive care unit A where Patient X was in admission at the same time, possibility of direct transmission between the probable case and Patient X was low since they stayed in different rooms and both were bedridden. Therefore, healthcare personnel might transmit the virus to Patient X.

For the second sub-cluster, Patient Y was detected early due to high risk of COVID-19 infection. Only one nurse was exposed in emergency room when collecting blood specimens from Patient Y before confirmation of COVID-19 infection. The nurse was later confirmed to have COVID-19 infection.

Regarding to Patient Z, since he informed the risk of COVID-19 infection early, healthcare personnel protected themselves appropriately and no subsequent infected healthcare staff related to Patient Z was detected.

Two other healthcare personnel infected with COVID-19 were not epidemiologically linked with COVID-19 confirmed cases. However, they worked at a medical screening point in the hospitaland might have exposed to unidentified COVID-19 patients.

Factors Associated with COVID-19 Infection

Bivariate analysis found that being a practical nurse was a significant risk factor for COVID-19 infection (OR 3.9, 95% CI 1.4-10.9) compared to other job positions. Multiple logistic regression showed that attending IPC training significantly reduced the odds of COVID-19 infection (Adjusted OR 0.04, 95% CI 0.00-0.64) (Table 4).

PPE Survey

Of 1,687 healthcare personnel participated in the survey, 337 (20.0%) reported contact with COVID-19 confirmed cases or patients at risk of COVID-19 infection. According to the national standard guideline on PPE in hospitals, appropriate PPE usage for medical screening include face shield and surgical mask while appropriate PPE for blood specimen collection and drug injection included hair net, goggle or face shield, surgical mask, gloves and protective gown. For aerosol generating procedures, hair net, goggle, face shield, N95 mask, gloves, and protective gown are required. For cardiopulmonary resuscitation, hair net, goggles or face shield, N95 mask, gloves, protective gown and leg cover are recommended.[14] About 66.7% (52/78) of those conducting sputum suction/drug nebulization and 83.9% (47/56) of those performing cardiopulmonary resuscitation used inappropriate PPE. (Table 5)

Table 1. Job positions of healthcare personnel with COVID-19 in Hospital R between 10 and 29 Mar 2020 (n=25)

Job position	Number of cases	Total population[a]	Attack rate (%)
Physician	2	301	0.7
Registered nurse	9	386	2.3
Practical nurse	3	74	4.1
Nursing assistant	7	261	2.7
Medical assistant	2	326	0.6
Physiotherapist	1	19	5.3
Maid	1	N/A[b]	N/A[b]
Total	25	2,287	1.1

Note: [a] The total number of people employed in each occupation. It was not the number of being tested.

[b]Total number of hospital maids were unknown, therefore the attack rate among hospital maids could not be calculated.

Table 2. Designated work stations of healthcare personnel with COVID-19 in Hospital R between 10 and 29 Mar 2020 (n=23)*

Hospital section	Number of cases	Total number of staff working at the section[a]	Attack rate (%)
Ward A	11	34	32.4
Ward B[b]	1	40	2.5
Intensive care unit A	5	40	12.5
Emergency room	1	44	2.3
Physical therapy department	2	39	5.1
OPD- chest and cardiovascular clinic	1	8	12.5
OPD- gastrointestinal clinic	1	22	4.6
OPD- diabetes clinic	1	16	6.3
Total	23	243	9.5

*Note: * Two physicians were excluded as. they worked more than one location.*

[a] The total number of healthcare personnel worked in each section; It was not the number of being tested.

[b] Denominator included hospital maids working in the ward.

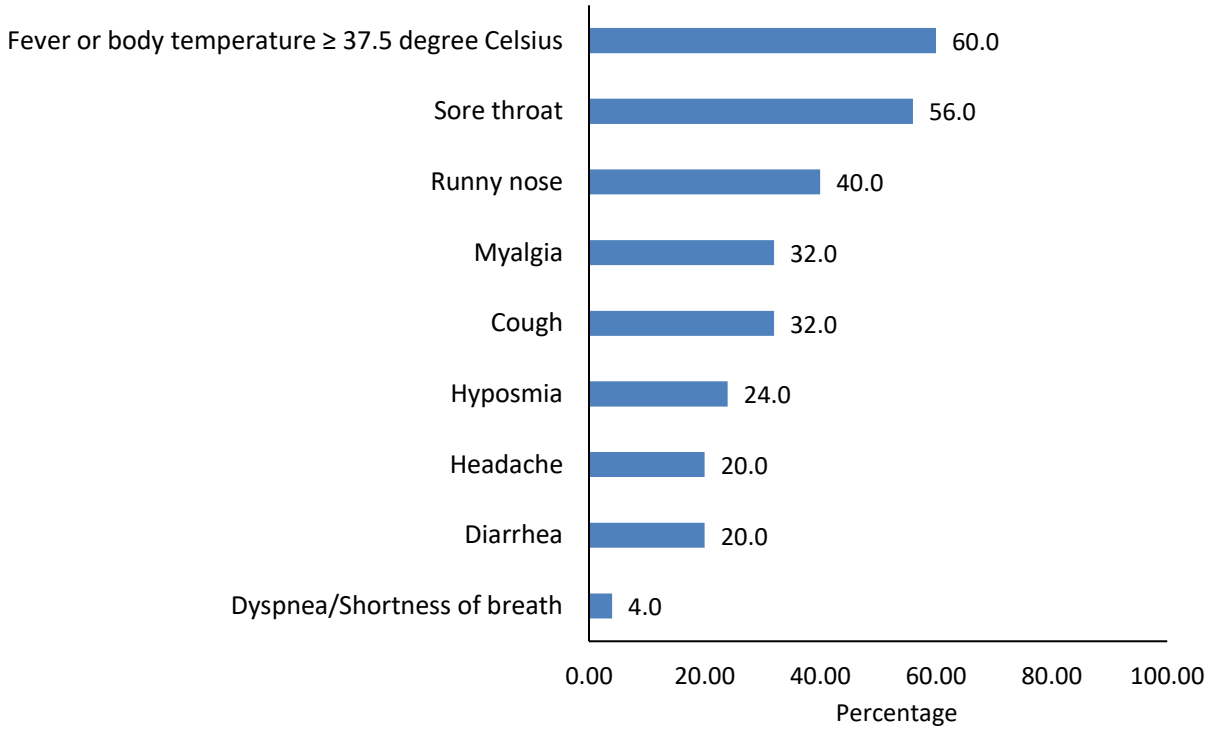

Figure 1. Clinical signs and symptoms of healthcare personnel with COVID-19 in Hospital R between 10 and 29 Mar 2020 (n=25)

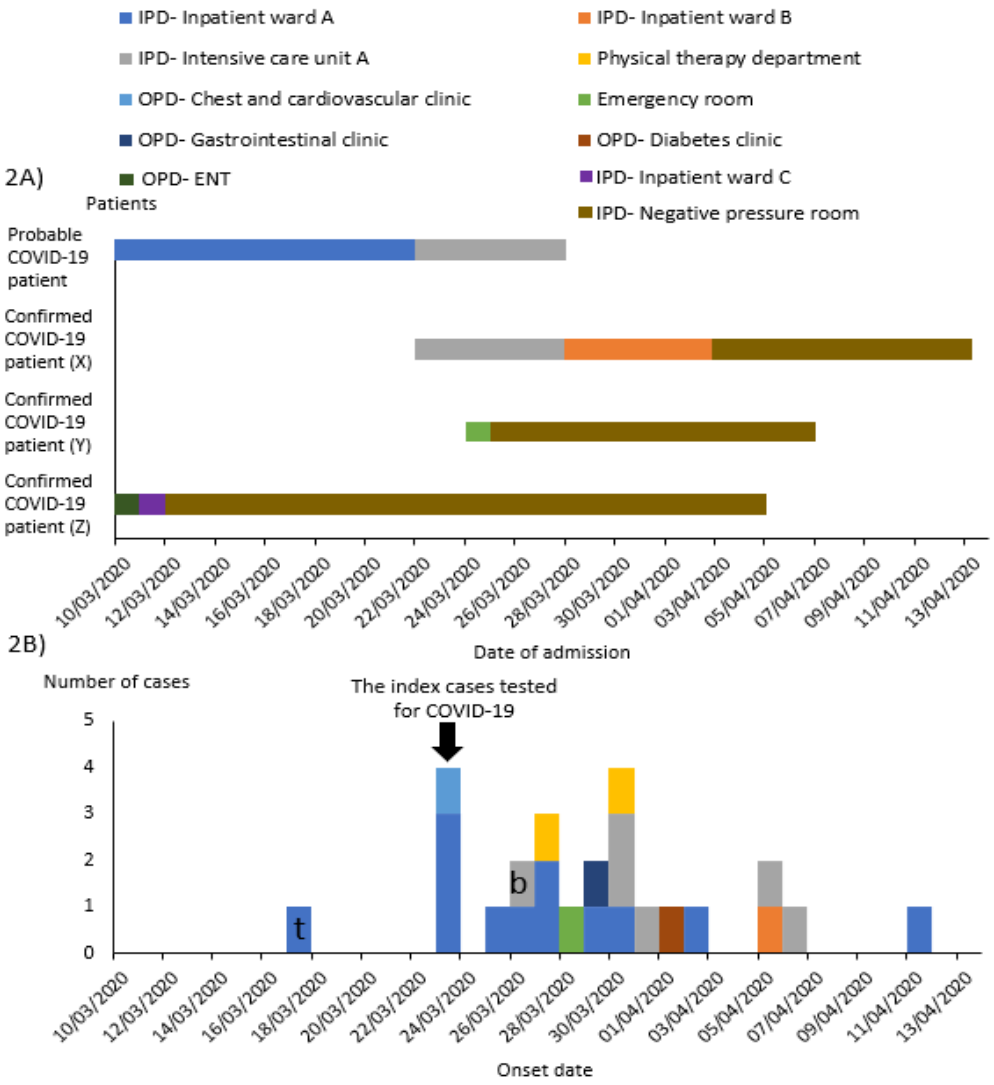

Figure 2A. Duration of probable and confirmed COVID-19 patients admitted to Hospital R classified by hospital subunits between 10 March 2020 - 6 April 2020 (n=4), Figure 2B. Epidemic curve of healthcare personnel with COVID-19 classified by locations, between 10 and 29 March 2020 (n=25)

Note: [t] The Physician P worked at inpatient ward A, intensive care unit A, and OPD-chest and cardiovascular clinic.
[b] The Physician Q worked at intensive care unit A and OPD-chest and cardiovascular clinic.

Discussion

This event was a confirmed COVID-19 outbreak among healthcare personnel in a private hospital, Bangkok, Thailand. The overall attack rate among healthcare personnel was considerably low; however, the specific attack rates in ward A and intensive care unit A were relatively high compared with the previous outbreaks among healthcare personnel in other countries. In China, the attack rate among healthcare staff ranged 2.1-29.0%.[10-12] This might be due to delay in outbreak detection since the first case among healthcare personnel (Physician P) developed the symptoms about one week before the outbreak was detected. In addition, he was still working in several wards during symptomatic period.

In addition, the probable case and Patient X were admitted for several months in the wards which were not designated for COVID-19 patients. The risk of infection was increased by inappropriate or inadequate use of PPE for COVID-19 protection; none of healthcare personnel in wards A and B and intensive care unit A used full PPE, especially N95 mask, face shield, gloves and gown during the outbreak period. Additionally, the likelihood of COVID-19 transmission in healthcare personnel increased with procedures of intubation and nebulizing. Full PPE or at a minimum of N95 mask with face shield are needed for these procedures while surgical facemask is adequate to prevent COVID-19 transmission for routine clinical practices.[9,13,14]

Table 3. Characteristic of work among healthcare personnel with COVID-19 in Hospital R between 10 March 2020 - 29 March 2020 (n=25)

Epidemiological characteristics	Number of cases	(%)
Work time per week		
Less than 40 hours	2	(8.0)
41 to 50 hours	7	(28.0)
51 to 60 hours	4	(16.0)
61 to 70 hours	6	(24.0)
71 to 80 hours	3	(12.0)
More than 80 hours	2	(8.0)
No information	1	(4.0)
Work sections		
Work only at one ward	20	(80.0)
Work more than one ward	5	(20.0)
- Inpatient ward A, IPD- intensive care unit A and OPD- chest and cardiovascular clinic	2	(40.0)
- Inpatient ward A and acute respiratory infection clinic	1	(20.0)
- Inpatient ward A and OPD- medical clinic	1	(20.0)
- Inpatient ward A and othernon-specific wards, depending on assignment	1	(20.0)
Infection prevention and control (IPC) training		
Yes	1	(4.0)
No/Not sure	8	(32.0)
No information	16	(64.0)
Attending COVID-19 conference		
Yes	0	(0.0)
No/Not sure	9	(36.0)
No information	16	(64.0)
Level of PPE		
Cloth mask with gloves	2	(8.0)
Surgical face mask without gloves	4	(16.0)
Surgical face mask with gloves	9	(36.0)
No available information	10	(40.0)

Table 4. Factors associated with COVID-19 among healthcare personnel worked at inpatient ward A and intensive care unit A

Factors	Number of cases (%)[a]	Crude OR	95% CI	Adjusted OR[t]	95% CI
Occupation (n=69)					
Practical nurse	3 (60.0)	8.3	1.1, 60.3*	0.2	0.0, 7.2
Nursing assistant	6 (24.0)	1.7	0.5, 6.2	0.2	0.0, 2.9
Registered nurse	6 (15.4)	Reference		Reference	
Number of wards (n=69)					
Work more than one ward	8 (27.6)	1.8	0.6, 5.7		
Work only at one ward	7 (17.5)	Reference			
Infection prevention and control (IPC) training (n=25)					
Yes	1 (9.1)	0.08	0.0, 0.8 *	0.04	0.0, 0.6*
No/Not sure	8 (57.1)	Reference		Reference	
Level of PPE (n=32)					
Surgical face mask /Clothes mask with glove	6 (60.0)	2.2	0.47, 9.9		
Surgical face mask with gloves	9 (40.9)	Reference			

Note: *[a] Number of cases among exposed participants, * P-value was less than 0.1, [t] Twenty-five participants were included in the multiple logistic regression analysis.*

Table 5. PPE use among healthcare personnel working with COVID-19 patients or patients at risk of COVID-19 infection (n=337)

Type of work	PPE level	Number of healthcare personnel (%)
Screening	Appropriate PPE[£] or higher level than recommended PPE	83 (56.8)
Blood specimen collection/ drug injection	Appropriate PPE[¥] or higher level than recommended PPE	66 (71.0)
Sputum suction/drug nebulization	Appropriate PPE[€] or higher level than recommended PPE	26 (33.3)
Cardiopulmonary resuscitation	Appropriate PPE[π] or higher level than recommended PPE	9 (16.1)

Note: [£]Appropriate PPE for screening included face shield and surgical mask.
[¥] Appropriate PPE for blood specimen collection/ drug injection included hairnet, goggles or face shield, surgical mask, gloves, and protective gown.
[€] Appropriate PPE for sputum suction/drug nebulization included hairnet, goggles, face shield, at least N-95, gloves, and protective gown.
[π] Appropriate PPE for cardiopulmonary resuscitation included hairnet, goggles, face shield, at least N-95, gloves, protective gown, and leg cover.

IPC training could be useful for protection of infection. IPC training was found to be a significant and independent factor associated with reduced risk of COVID-19 infection in Hospital R. IPC training not only provide knowledge of PPE use, but also includes other activities for healthcare personnel to prevent transmission, including cleaning, hand washing and information on risky medical procedures.[15,16] Our findings were similar to a previous study which suggested that receiving appropriate PPE training reduced risk of COVID-19 infection.[17,18] In addition, our PPE survey suggested that PPE usage in the hospital was mostly inappropriate. Therefore, IPC training, including PPE, should be conducted among healthcare personnel, especially among those dealing with COVID-19 confirmed cases and patients at risk of COVID-19 infection.

There were several limitations. Information bias, including memory recall, might occur in this investigation due to social desirability and long recall period. The routine activities of healthcare personnel during the outbreak period could not be observed; therefore, some risk behaviors might not be captured. As the sample size was small, the power to detect significant risk factors was limited. All contacts were not tested for SARS-CoV-2; therefore, information bias might occur, and magnitude of healthcare personnel infected with COVID-19 might be underestimated. In addition, since whole genome sequencing was not performed, the transmission routes of COVID-19 cases could not be identified.

Recommendations

To control and prevent COVID-19 outbreaks in hospitals, IPC training should be performed among all healthcare personnel, especially physiotherapists, registered nurses, practical nurses and nursing assistants. In addition, all healthcare personnel should monitor their symptoms, have access to PPE, be vigilant to consider COVID-19 infection in patients and protect themselves appropriately, according to the national guidelines by the Ministry of Public Health.

Conclusion

A COVID-19 outbreak was confirmed among healthcare personnel in one hospital. There are important steps that can be taken to protect healthcare personnel from acquisition and transmission of COVID-19 infection including early outbreak detection and access to, and appropriate use of PPE in the health care setting. The most likely source case was patients' cousins or healthcare personnel who worked at risk area. Limiting areas of hospital work by hospital employees and daily screening for respiratory symptoms among healthcare personnel may limit spread within the hospital during outbreaks and detect the outbreak early. IPC training on appropriate PPE use should be provided to all hospital employees, especially those working in COVID-19 risk sections.

Suggested Citation

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