



Impact of a Missed Diagnosed COVID-19 Patient on Healthcare Workers at a Private Hospital, Bangkok, Thailand, 2020

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Abstract

On 23 Mar 2020, the Situation Awareness Team of the Emergency Operations Center, Department of Disease Control, was notified that a 44-year-old Thai male, who was infected with coronavirus disease 2019 (COVID-19), had died in a private hospital in Bangkok, and there was a suspicion that some healthcare workers were infected with SARS-CoV-2 following his death. A descriptive cross-sectional study was conducted. We reviewed medical records of the index case, interviewed relatives of the index case, and performed contact tracing using a standard questionnaire. We could identify 206 high-risk contacts; they were eight household members, 104 hospital personnel, 30 inpatients and 64 community members. Twenty out of 206 high-risk contacts were then found to be infected with SARS-CoV-2. Fifteen of them were healthcare workers, two of them were current inpatients, and the other three were household contacts. The likely cause of disease spreading was the missed diagnosis of COVID-19 as the index case did not present with upper respiratory tract symptoms at the first visit to the hospital. Meal sharing among healthcare workers and sharing of a portable chest X-ray machine without proper protective equipment potentially served as other causes of COVID-19 spreading.

Keywords: COVID-19, healthcare worker, private hospital

Introduction

Coronavirus disease 2019 (COVID-19) is an emerging infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).^{1,2} As of 23 Mar 2020, globally, 332,930 patients were infected with 14,509 deaths.³ Thailand is also severely suffering from COVID-19. In February 2020, the cabinet agreed to include SARS-CoV-2 in the list of dangerous communicable disease under the Communicable Diseases Act B.E. 2558.⁴

The situation of COVID-19 among healthcare workers (HCWs) is a concern in many countries. From the Thailand COVID-19 database,⁵ as of 15 Mar 2020, a female HCW infected with SARS-CoV-2 from her workplace was notified. She was a nurse that had taken care of a missed diagnosis COVID-19 patient. Her patient was diagnosed with dengue fever, so at that time, she approached that patient without proper protection. She wore gloves but did not wear a mask

during the blood sampling. She was considered the first Thai HCW who had COVID-19. Twenty-four hospital staff were quarantined and tested negative for SARS-CoV-2.⁶

On 23 Mar 2020, the Situation Awareness Team of the Emergency Operations Center, Department of Disease Control (DDC), Ministry of Public Health (MOPH), received a notification from a private hospital in Bangkok that there was a 44-year-old Thai male dying from COVID-19 and there were a large number of HCW contacts in the hospital. A joint investigation team consisting of epidemiological staff from the DDC and the Institute of Urban Disease Control and Prevention commenced an investigation on this event from 24 Mar 2020 to 22 Apr 2020. The objectives were to confirm the diagnosis, describe the index case's epidemiological characteristics, perform contact tracing, and provide recommendations for containing further transmission of SARS-CoV-2.

Methods

The investigation comprised three sub-studies: (i) descriptive epidemiological study, (ii) laboratory study, and (iii) environmental survey.

Descriptive Study

A descriptive cross-sectional study was conducted. We reviewed the medical record and interviewed the index case's wife, who was his main caretaker. Then a contact tracing was performed using a standard questionnaire from the DDC. We searched for additional HCWs in the hospital who were patients under investigation (PUIs) by using an online questionnaire. The questionnaire collected information about personal protective equipment (PPE) usage in each activity involved with the COVID-19 case.⁷ For the definition of cases and contacts, we followed the DDC guideline (version as of 23 Mar 2020).⁸

For the case definition, the PUI was defined as a person who had a body temperature ≥ 37.5 °C with one of the following respiratory symptoms: cough, runny nose, and sore throat, accompanied with exposure risks within 14 days prior to illness onset. The exposure risks included traveling from COVID-19 affected areas and close contact with people coming from the COVID-19 prone areas.

The confirmed case was defined as a PUI who showed evidence of genetic materials of SARS-CoV-2 by Reverse Transcriptase-Polymerase Chain Reaction (RT-PCR). An asymptomatic case is defined as a person showing genetic materials of SARS-CoV-2, but without clinical signs and symptoms.

For the definition of contacts, a high-risk close contact was an individual who lived in the same household as a COVID-19 case, HCW who visited COVID-19 case or handled and processed specimens collected from COVID-19 case without wearing proper PPE, other patients who were hospitalized in the same room and at the same time with the COVID-19 case. A low-risk contact was a healthcare worker, who dealt with a COVID-19 case with proper PPE.

We used median with inter-quartile range (IQR) to present continuous data. For categorical data, we used frequency and percentage. Epi info version 7.2.3.1 was used for all calculations.

Laboratory Study

For all high-risk contacts and HCWs being screened by an online questionnaire, we collected phlegm in a sterile container. For PUIs, a nasopharyngeal swab

and a throat swab were conducted. Each sample was delivered to the Department of Medical Sciences, Ministry of Public Health and the Thai Red Cross Emerging Infectious Diseases (TRC-EID), Chulalongkorn Hospital to test for SARS-CoV-2 by RT-PCR. A positive test was confirmed if one of the two reference laboratories reported a positive result.

Environmental Study

We performed a walk-through survey and observation of the behavior of HCWs on 24 Mar and 22 Apr 2020 to explore the hospital's environment, including patients' beds, decontamination equipment, medical devices shared across patients, dining areas, and workstations of HCWs.

Results

Description of the Index Case

The index patient (patient A) was a diabetic 44-year-old male working as a security guard at a famous nightclub in Bangkok. The nightclub was reported to have presented with 17 confirmed COVID-19 cases. On 6 Mar 2020, he started to have dry cough, low-grade fever, and fatigue. On 9 Mar 2020, he started to have dyspnea, anosmia, ageusia, and loss of appetite. He stayed at his home all the time since the symptom started. On 13 Mar 2020, his wife took him to a private hospital due to his high-grade fever and vomiting. His blood sugar was high at the outpatient examination room. The diagnosis at that time was diabetic ketoacidosis (DKA). Then he was transferred without a surgical mask to the emergency room to prepare for admission in the intensive care unit (ICU) (Figure 1).

Patient A was treated in ICU for a day. His clinical symptoms later improved. He was moved to a general inpatient ward (ward 2/7) and was treated there from 14 until 16 Mar 2020. Later, on 16 Mar 2020, the patient's condition got worse. He received nebulization to alleviate breathing difficulty. The doctor intubated and relocated him to a separate room in ICU. Chest radiography showed alveolar infiltration in both lungs. The diagnosis now changed to severe pneumonia. On 17 Mar 2020, his doctor sent a sputum suction sample to Ramathibodi Hospital for SARS-CoV-2 testing. On 19 Mar 2020, the laboratory result showed positive for SARS-CoV-2. The patient received oseltamivir (13 Mar 2020), chloroquine (19 Mar 2020), azithromycin and darunavir (19 Mar 2020), and favipiravir (22 Mar 2020). The patient's condition did not improve after treatment. He later died on 23 Mar 2020 due to severe progressive pneumonia and respiratory failure (Figure 1).

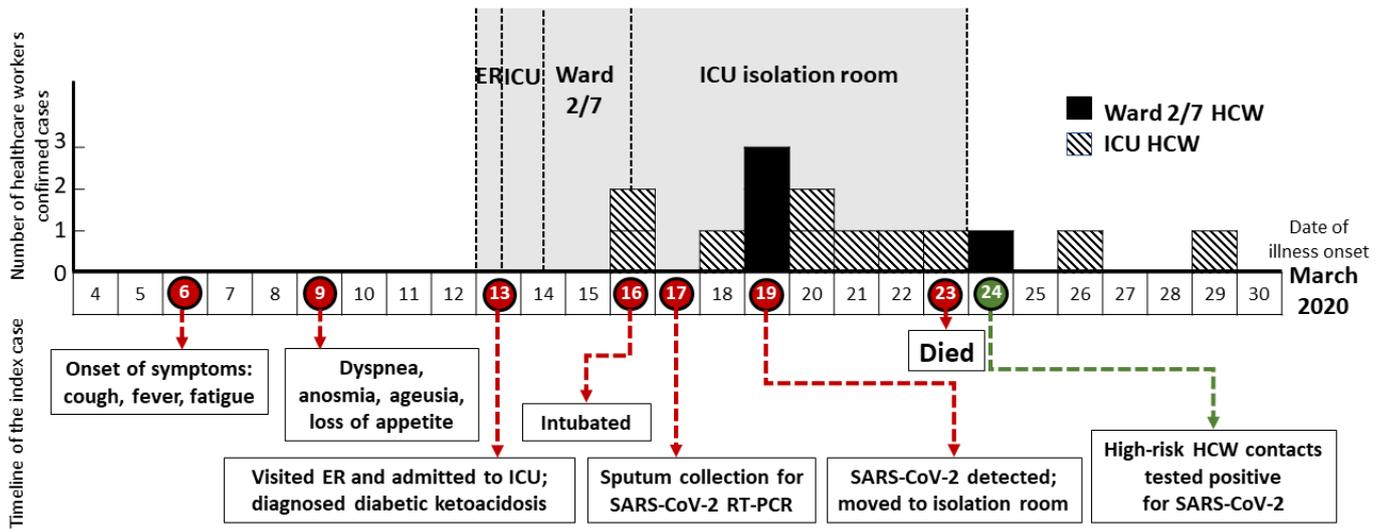
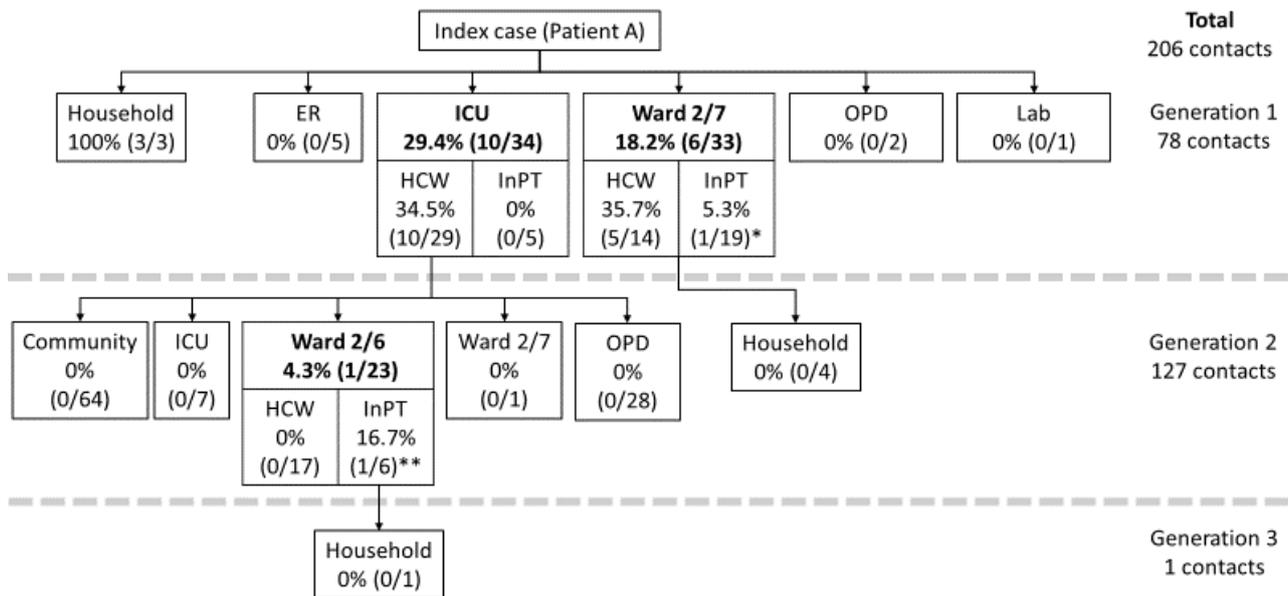


Figure 1. Epidemic curve of healthcare workers infected with SARS-CoV-2 sorted by hospital subunits and timeline of the index patient

Contact Tracing

A total of 206 high-risk contacts were identified from the investigation. Seventy-eight of them had direct contacts with patient A. The attack rate among those with direct contact was 24.4% (19/78). The rest of them were second- and third-generation contacts, with one contact who showed a positive SARS-CoV-2 test

(attack rate=0.8% [1/128]). In total, twenty contacts were detected for SARS-CoV-2 (overall attack rate=9.7%). Three of them were his household members, fifteen of them were HCWs who took care of patient A, and two of them were inpatients concurrently admitted in the hospital at the same time with patient A (Figure 2).



Note: *Patient B, **Patient C

Figure 2. Number of high-risk contacts of the index case classified by places

Household contacts and contacts at the workplace

Patient A lived with his wife and two children. Laboratory tests detected SARS-CoV-2 in all family members. During the contact period, his wife went to a supermarket while his two children stayed at home. Other than that, they did not go elsewhere. One of the supermarket staff members was identified as a low-risk contact. No additional high-risk contacts were identified at the workplace of the index case.

Contacts at the Outpatient Department (OPD) and Emergency Room (ER)

There were high-risk contacts identified at OPD and ER, including one doctor and six nurses. The RT-PCR results showed negative for SARS-CoV-2 in all of these contacts. All of them reported that they wore surgical masks all the time during working hours.

Contacts in General Ward 2/7

There were 34 high-risk contacts identified in General Ward 2/7 (20 inpatients and 14 HCWs). SARS-CoV-2 was detected in one inpatient and five HCWs. The infected inpatient was a 61-year-old man (patient B). He was admitted to General Ward 2/7 next to the index case (14 to 16 Mar 2020) and was diagnosed with acute right cerebellar hemorrhage. He underwent venous puncture by the same HCW as the index case. Five HCWs were later found positive for SARS-CoV-2. Patient B was discharged on 18 Mar 2020. After he was discharged, he started to develop respiratory symptoms and was re-admitted on 25 Mar 2020, and then was found to be infected with SARS-CoV-2. All of the infected HCWs were nurses who provided care for patient A. The care activities involved mobilizing the patient, cleaning the patient's waste products, performing blood punctures, and accompanying doctors to examine the patient.

Contacts at ICU and General Ward 2/6

There was a total of 64 high-risk contacts in ICU and general ward 2/6 (11 inpatients and 53 HCWs— [48 nurses, two doctors, two cleaning employees, and one X-ray technician]). Laboratory tests detected SARS-CoV-2 in ten ICU HCWs—eight nurses, one physician, and one X-ray technician, contributing to an attack rate of 27.8% among HCWs in ICU (10/36). For inpatients, SARS-CoV-2 was detected in a 53-year-old female (patient C) who was admitted simultaneously with patient A but was in another ward (General Ward 2/6). She was admitted during 10 to 19 Mar 2020 due to urinary tract infection and sepsis, and then she turned to septic shock. She undertook a chest X-ray by the infected X-ray technician—the same person that performed the X-ray for the index case. None of the high-risk contacts from patient C circle were infected with SARS-CoV-2.

History of healthcare worker's illness

The first infected HCW was a nurse who treated patient A. She contacted patient A on 13 Mar 2020. Her duty was to perform blood sugar testing on patient A every 4 hours. She always wore gloves and a surgical mask. Also, she assisted the doctor in intubating patient A. She had meals with her colleagues during working hours. She developed fever and respiratory symptoms on 16 Mar 2020. Then, six additional nurses developed symptoms. All of these nurses were on duty when the symptoms appeared. Then the disease began to spread to General Ward 2/7.

Among the 15 infected HCWs, eight (53.3%) were female. The median age of these patients was 28 years (IQR=31 years). One of them was asymptomatic. The

most common symptoms were fever 64.3% (9/14), followed by coughing 50.0% (7/14), and sore throat 42.9% (6/14) (Table 1). Of these 15 infected HCWs, 13 (86.7%) reported that they had worn substandard PPE^s as they were not aware that the patient was infected. The patient's chart was touched by many ICU nurses including the confirmed COVID-19 HCWs. Two HCWs had a history of meal sharing with other infected staff, and one HCW had a history of talking to patient A's wife while wearing only a loose surgical mask.

Table 1. Demographic characteristics and symptoms among healthcare worker infected with SARS-CoV-2

Characteristic	No (%)
Gender (n=15)	
Male	7 (46.7)
Female	8 (53.3)
Symptoms (n=14)	
Fever	9 (64.3)
Cough	7 (50.0)
Sore throat	6 (42.9)
Muscle aches	4 (28.6)
Sputum	4 (28.6)
Headache	3 (21.4)
Runny nose	3 (21.4)
Difficulty breathing	2 (14.3)
Diarrhea	1 (7.1)

The portable X-ray technician always wore a surgical mask, gloves, and a raincoat for protection. He informed that he took off his gloves and raincoat after finished imaging each patient at the ward and washed hands with alcohol gel, but sometimes he did not wash hands before touching the patient. A plastic sheet was used to cover the X-ray pad and was removed after each use. The X-ray technician then wiped the X-ray pad with alcohol paper. There was only one portable chest X-ray machine in this hospital, which was used in all wards.

Online Questionnaire Screening

According to the online questionnaire on 24 Mar 2020, the total number of respondents was 498 (response rate=60.7%). The results revealed that 149 people (29.9%) had upper respiratory tract symptoms between 5 and 24 Mar 2020, and 22 (4.4%) met the PUI definition. None of these 22 respondents who met the PUI definition showed positive results for SARS-CoV-2 by RT-PCR.

According to the interview, HCWs used appropriate PPE during taking medical histories from patients

62.4% (58/93), followed by venous puncture 41.4% (29/70) and intubation 31.5% (23/73). Activities that showed the least percentage of appropriate PPE were cardiopulmonary resuscitation 23.5% (24/102), cleaning of the patient's secretion 17.8% (18/101), and bed bathing 0.0% (0/81).

Environmental Study

This facility was a 400-bed private hospital with a total of 820 HCWs. All patients were screened for fever before entering the hospital. If fever or respiratory symptoms were detected, the patient would be transferred to either (i) Acute Respiratory Infection (ARI) Clinic (for non-PUI cases); or (ii) PUI clinic (for PUI cases).

In ER, there was a negative pressure room for high-risk patients. The patient beds were separated from each other by a curtain. Nebulization was done in the headboard position. In ICU, there were 11 beds (seven in shared areas and four in isolation rooms) and two washing basins. An alcohol-based hand sanitizer was available at each bedside. General Ward 2/6 and General Ward 2/7 were arranged as a combined unit. Both wards had the same structure. The layout of the room was divided into blocks. Each block contained eight beds with a curtain separating between beds. The dining rooms of the staff were approximately 2x2 meters in size with supplied air-conditioning, causing poor air ventilation. There was a dining table in each room. The distance between seats was less than one meter. The equipment that was circulated in all wards was a portable chest X-ray machine. At the time we observed HCW behaviors, all HCW wore surgical masks, but some HCW pulled the mask down under the chin during the talk. Some nurses were treating patients without gloves and did not wash their hands after touching the patients.

Control Measures

All high-risk contacts were ordered to quarantine themselves at home for 14 days after the last date of exposure with the patients. All were re-tested for SARS-CoV-2 before returning to work. All related wards were temporarily closed and underwent intensive disinfection. We recommended the hospital director to establish a clear policy that required all staff to wear proper PPE and separate the dining times of the staff to avoid over-crowding.

Discussion

One of the key lessons of this outbreak was the misdiagnosis. The index case should have been identified as suspected COVID-19 by the DDC criteria since the first hospital visit. However, in reality, he

was diagnosed with DKA without an in-depth investigation of the disease that might aggravate DKA. Thus, he was admitted to a general ward instead of the other wards prepared for COVID-19 cases. Previous studies have suggested an association between COVID-19 and DKA.^{10,11}

Another risk of SARS-CoV-2 spreading among HCWs was improper PPE application. This happened because of the unawareness of the disease status of the index case. A prior study in China found a significant positive association between improper PPE wearing and SARS-CoV-2 infection.¹² Furthermore, the portable X-ray equipment might cause disease spreading. The X-ray technician was also infected with SARS-CoV-2. This might be attributed to inadequate PPE application and frequent contacts with the index case. A study about the SARS outbreak in Taiwan in 2003 showed supportive evidence of the relationship between X-ray activity and viral spreading.¹³⁻¹⁵ Regarding personal hygiene, some HCWs did not wash their hands every time after touching the patients. An urgent training that emphasizes proper prevention and control against COVID-19 is recommended for all hospital staff. Also, risk communication on COVID-19 prevention and control should be delivered for hospital staff, patients, and caretakers.

A lack of social distancing during mealtimes might also contribute to the disease spreading. According to the interview, some HCWs were seated close to each other during the dining periods. Besides, it is not possible to wear a face mask all the time during mealtimes. This activity thus allowed viral particles to spread without protection.¹⁶ Another potential cause of disease propagation was a failure to quarantine HCWs at risk of COVID-19. Some HCWs still came to work despite the presence of symptoms.

In terms of methodological discussion, this study faced some limitations. First, the investigation took place sometime after the onset of the first case. Hence, memory bias was inevitable. Second, due to time and resource constraints, we neither performed laboratory testing on environmental samples nor whole-genome sequencing from the patients and infected HCWs samples. This undermined the confidence in drawing a conclusion if the wide spreading of COVID-19 in this setting solely originated from within the hospital. Third, not all HCWs in the hospital participated in the online survey. Therefore, the generalization power of the findings was limited. Last was the information bias, as some patients or infected HCWs might not be willing to disclose their entire history of exposure. This phenomenon was possibly caused by a fear of stigmatization and social undesirability.

Recommendations

The hospital director should establish policies that required all hospital staff to wear standard PPE in all areas (Table 2).^{7,16} Moreover, regular cleaning of the X-ray machine, and handwashing practice of all staff

should be emphasized. A separation of dining time for HCWs was recommended to avoid over-crowding. Lastly, all staff should attend a refreshing course in infection prevention and control to increase awareness of the proper hygiene practice.

Table 2. The minimum requirement of personal protective equipment for disease investigations depending on patient's symptoms and related activities

Personal protective equipment	Patient interview without specimen collection		Collection of respiratory tract specimens	Garbage collection
	Patient has no cough or slight cough	Patient has severe cough		
Head cap	-	+/-	+	+/-
Goggles/face shield	-	+	+	-
Surgical mask	+	-	-	+
N95 respirator or higher	-	+	+	-
Disposable gloves	+/-	+	+	+
Full-length gown/coverall	+	+	+	+
Boots	-	-	-	+

Conclusions

In conclusion, this outbreak was a cluster of confirmed COVID-19 cases in a private hospital. There were three inpatients and 15 infected HCWs from 6 to 29 Mar 2020. The possible causes of disease spreading were a lack of awareness of COVID-19 patients during work and having a meal together among HCWs. Portable X-ray machine is another potential source of the spread of SARS-CoV-2. Policies that require HCWs to adhere to infection and control protocol, such as proper PPE application and frequent hand washing, should be implemented. Some more recommendations included the separation of dining areas and dining periods across wards to avoid over-crowding. Regular and thorough cleaning of the X-ray machine was recommended. A refreshing course to emphasize the prevention of infection in the context of COVID-19 should be urgently implemented to all hospital staff.

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Suggested Citation

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Supplementary Table 1. Case definition of coronavirus disease 2019 (COVID-19) as of 22 Mar 2020

Type	Definition
Patients under investigation (PUIs)	<p>Based on signs/symptoms, along with risk factors as follows:</p> <p><u>Scenario 1: Surveillance at Points of Entry Quarantine Stations</u></p> <p>A patient has the following signs and symptoms: documented temperature ≥ 37.5 °C, accompanied by any of the following respiratory symptoms, i.e., cough, runny nose, sore throat, tachypnea, or dyspnea.</p> <p><u>Scenario 2: Hospital-based surveillance</u></p> <p>A patient has the following signs and symptoms:</p> <p>2.1. Documented temperature ≥ 37.5 °C, or history of subjective fever during current illness, accompanied by any of the following respiratory symptoms, i.e., cough, runny nose, sore throat, tachypnea, or dyspnea.</p> <p>2.2. Pneumonia case of unknown etiology.</p> <p>Both 2.1 and 2.2 must be accompanied by one of the following histories of exposure risks within 14 days prior to illness onset:</p> <ol style="list-style-type: none"> 1) Having a history of travel to or from or living in the areas reported having been affected by ongoing outbreaks of COVID-19. 2) Individuals whose occupation subjected themselves to close contact with travelers from the areas reported having been affected by ongoing outbreaks of COVID-19. 3) Having a history of close contact with or exposure to a probable or confirmed case of COVID-19. 4) Healthcare worker who has contacted with a confirmed case of COVID-19 infection 5) Has been to a place at the same time as a confirmed case of COVID-19 infection <p>Note: Please refer to the areas reported to have been affected by ongoing outbreaks of COVID-19.</p> <p><u>Scenario 3: Hospital-based surveillance</u></p> <p>A patient has the following signs and symptoms:</p> <p><i><u>Pneumonia case</u></i></p> <p>Scenario 3 must be accompanied by one of the followings:</p> <ol style="list-style-type: none"> 1) Is a healthcare worker. 2) Unidentified cause or does not improve within 48 hours after treatment. 3) Has severe symptoms or death with unknown cause. 4) Chest radiography compatible with COVID-19 infection. <p><u>Scenario 4: Acute severe pneumonia case of unknown etiology or fatal case of severe acute pneumonia of unknown etiology</u></p> <p>Clusters of patients or health care workers with acute respiratory tract infections with negative rapid tests or PCR influenza results.</p> <p><i>Health Care Workers</i></p> <p>More than three health care workers in the same ward during the same week (If the health facility is small, such as a small clinic, use the same criteria - more than three health care workers in the clinic during the same week).</p> <p><i>Non-Health Care Workers</i></p> <p>More than five people in the same place* during the same week.</p>
Confirmed case	A PUI who has tested positive for genetic materials of SARS-CoV-2 by PCR from one of reference laboratory, by genetic sequencing, or by culture.
Asymptomatic case	A person who has tested positive for genetic materials of SARS-CoV2 by PCR from one of reference laboratory, by genetic sequencing, or by culture, but has shown no signs and symptoms.

Note: *place is defined as a house, medical or veterinarian facility, sanatorium, or a business facility

Supplementary Table 2. Classification of close contacts based on different levels of exposure risks

High-risk close contact	Low-risk close contact
<p>Household contacts</p> <ol style="list-style-type: none"> 1. Family members, relatives, and caregiver of symptomatic COVID-19 case. 2. Individuals who live in the same household as a confirmed case of COVID-19. 	
<p>Healthcare-associated contacts</p> <ol style="list-style-type: none"> 1. Medical and clinical staff, other hospital staff, and those were visiting a hospitalized COVID-19 case without wearing personal protective equipment (PPE) according to standard precautions. 2. Other patients (with other medical conditions) who are/were hospitalized during the same period as, in the same room as, and in the same row as the COVID-19 case and visitors of those patients who visited the patients when the COVID-19 case had yet to be moved to an isolation room. 3. Laboratory staff who did not wear PPE according to standard precautions while handling and processing specimens collected from the COVID-19 case. 	<p>Hospital staff or laboratory staff whose job was related to COVID-19 case or visitors of hospitalized PUI, who were wearing PPE according to standard precautions.</p>
<p>Travel-related contacts</p> <ol style="list-style-type: none"> 1. In case of symptomatic COVID-19 case traveling onboard a commercial flight: <ul style="list-style-type: none"> • Passengers onboard the same flight as the case; passengers in close proximity to and in the same row as the case, and in the immediate two front and back rows: • All flight attendants in the same section of the plane where the case was sitting. • Co-travelers in the same group as the case, e.g., passengers in the same tour group. 2. In case of symptomatic COVID-19 case traveling on other types of public transportation: <ul style="list-style-type: none"> • Individuals traveling with the case • Passengers or crew members who were exposed to respiratory secretions, cough, or sneeze from the case. • Passengers who were within 1 m of the case. 	<p>All passengers traveling in the same vehicle (except commercial flight) as COVID-19 case do not meet the criteria for high-risk close contacts. Note: In the case of large vehicles such as train, double-decker bus, and passenger ferry, only passengers in the same car or deck as the case will be treated as close contacts.</p>
<p>Close contacts at school, workplace, and community</p> <ol style="list-style-type: none"> 1. A student or co-worker including a close friend who was mingling with symptomatic COVID-19 case; or who may have been exposed to respiratory secretions, cough, sneeze from COVID-19 case. 2. An individual living in the same community as COVID-19 case or in another community, who has been exposed to respiratory secretions, cough, sneeze of the case. 	<ol style="list-style-type: none"> 1. Those who have studied or worked on the same floor/room/department as COVID-19 case, whose symptoms have yet to meet the criteria for high-risk close contact. 2. Individual who lived in the same community as a COVID-19 case, who was found to be within 1 m. of the symptomatic case and do not meet the criteria for high-risk close contact.