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Editorial

The End of COVID-19 Pandemic—Will It Become Endemic or Episodic?

Alden Henderson, Chief Editor

We along with the other 7.9 billion people on earth have been dealing with the COVID-19 pandemic for the past two years. During this time, we became familiar with epidemiology terms such as variant, R naught, incubation period, and community spread. We also reacquainted us terms describing the spread of disease: cluster, outbreak, endemic, epidemic, pandemic, super-spreader, and those that help control the disease: quarantine, isolation, N95 respirators, flattening the curve, social distancing, and non-pharmaceutical interventions. Two years into the pandemic, the number of people with COVID-19 is decreasing and we are now starting to hear the word “endemic.”

A disease becomes endemic when its occurrence is steady or predictable in a particular region. Steady implies the rate of the disease is not rising or falling and is at a constant level in the population. A few examples are measles, hepatitis, and malaria. An endemic disease rates can change but the rates are predictable such as seasonal increases for influenza, bacterial pneumonia, and diphtheria or occurring after heavy rains and flooding such as malaria, leptospirosis, and Rift Valley Fever.

The US Centers for Disease Control and Prevention says an endemic is “the constant presence or usual prevalence of a disease or infectious agent in a population within a geographic area.” Consequently, an endemic disease is consistently present and spreads at predictable rates. Endemicity looks at rates and does not account for whether the disease is rare or common, mild or severe. Rates of an endemic disease may be higher than desired. The rates for COVID-19 are beginning to stabilize but remain very high in many countries in the world. This is a sign that the COVID-19 pandemic is becoming endemic.

Another word to consider is episodic. This is when a disease occurs occasionally and at irregular intervals. This seems to be the pattern for COVID-19 as shown by the waves of COVID-19 that have swept through the world in the past two years. The COVID-19 waves resulted from the cycle of new variants and the tightening and then loosening of interventions. This cycle also allows SARS-CoV-2 to mutate just enough to mutate, to breakthrough vaccinations, and to reinfect people and cause another wave of COVID-19.

In the beginning of the COVID-19 pandemic, there was great hope that we would eradicate the virus through lockdowns, mask wearing, travel restrictions and finally a vaccine. All pandemics will end. The question is in what form will COVID-19 take? Elimination like SARS and H1N1 avian influenza, endemicity like influenza, or episodic like measles, dengue, and leptospirosis. What we know now is that SARS-CoV-2 is a virus that has surprised us with its route of transmission, ability to affect many organs, and cause long COVID. Only time will tell.

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Investigation of a COVID-19 Cluster in a State Quarantine Facility in Thailand and Prevention Measures for Incoming Travelers

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Abstract

Coronavirus disease (COVID-19) became a global pandemic in 2020. Thailand introduced a mandatory 14-day quarantine at government facilities for all arrivals. On 15 May 2020, the Department of Disease Control received notification concerning ten confirmed COVID-19 cases at a state quarantine center. A joint investigation led by the Department of Disease Control confirmed the diagnoses, identified the source of infection, and assessed the state quarantine's environment and procedures. The confirmed cases were all on a flight from Pakistan. The attack rate among the passengers was 9%. All had a risk history of COVID-19 infection in Pakistan, such as attending crowded areas and living in an area with a COVID-19 outbreak. On the flight, three possible clusters could be classified using the two-row rule; however, all cases wore a face mask throughout the journey. Transmission was unlikely to have occurred at the quarantine center due to a lack of contact history and appropriate preventive measures in place. This investigation provides insight into the state quarantine practices and shows gaps for improvement, such as using genomic data for cluster identification and developing a COVID-19 questionnaire for use at the quarantine center.

Keywords: coronavirus disease, COVID-19, severe acute respiratory syndrome coronavirus 2, SARS-CoV-2, State Quarantine, Thailand

Background

Coronavirus disease 2019 (COVID-19), an emerging infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first recognized in Wuhan, China at the end of 2019.[1] Subsequently, the disease spread to the rest of the country and to the whole world.[2] Due to the oppressive situation of COVID-19 outbreaks worldwide, on 15 Apr 2020, the Civil Aviation Authority of Thailand announced a ban on all incoming international flights. Thai nationals who remained in affected countries were evacuated by a charter flight followed by a 14-day mandatory state quarantine.[3,4]

The quarantine period started when the flight landed in Thailand. Detainees could be discharged on day 15. According to the regulation, the first of two nasopharyngeal specimens is collected during days 3-5, and the second is collected following recommendations of the investigation team.[5] The specimens are tested for SARS-CoV-2 using reverse transcriptase-polymerase chain reaction (RT-PCR) at a certified laboratory. People with positive SARS-CoV-2 tests are referred to a designated hospital for isolation.[5]

On 26 Feb 2020, the Pakistan government reported the first two cases of COVID-19, a student at the University of Karachi and one in Islamabad.[6,7] The number of cases increased dramatically and spread to several districts of Pakistan, including Islamabad, Karachi, and Lahore.[8]

On 15 May 2020, the Division of Epidemiology, Department of Disease Control (DDC), Ministry of Public Health received notification from the Office of Disease Prevention and Control 6 Chonburi that ten confirmed COVID-19 cases had returned from Pakistan. The joint investigation team investigated the event between 16 and 17 May in order to confirm the diagnosis, identify the source of infection, and assess the state quarantine's environment and management procedures.

Methods

A descriptive cross-sectional study was conducted on 16 May 2020. The investigation team interviewed the reported COVID-19 cases via phone regarding their travel history, symptoms, and contacts in the previous 14 days before arrival. Medical records and laboratory results of cases were reviewed. Case definition was any person who had a history of traveling from a foreign country from all flights and tested positive for SARS-CoV-2. The specimen was collected by nasopharyngeal swab and sent to the Regional Medical Science Center 6 Chonburi. Inconclusive cases were tested again two days later.

Contacts were classified into two categories: (i) high-risk, defined as any person who had contact or conversation with an index case longer than 5 minutes within 1-meter distance, stayed in a closed space with an index case within 1-meter distance, or a medical staff who had contact with an index case and did not wear adequate personal protective equipment (PPE), and (ii) low-risk, defined as any person who had a history of contact with a confirmed case but did not meet the high-risk contact criteria.[9]

We defined three sources of COVID-19 infection: (i) Pakistan, (ii) the airplane, and (iii) Thailand. Infection in Pakistan was assessed by interviewing cases about their daily schedule and PPE use 14 days before arrival in Thailand. History of contact with confirmed cases or those with respiratory symptoms were also examined. The risk of infection in the airplane was assessed by interviewing the cases about their PPE use on the flight and mapping their seats. The risk of infection in Thailand was evaluated by interviewing the cases and state quarantine staff. An environmental survey was conducted at the designated state quarantine facility focusing on infection prevention and control measures.

Statistical Analysis

Continuous data were presented using median with interquartile range (IQR), while categorical data were presented using frequency with percentage.

Ethics

Ethical clearance was waived as this study was performed as part of a Thai-DDC routine outbreak investigation.

Results

On the affected flight, 113 Thai nationals departed from Lahore, Pakistan on 6 May 2020 and arrived at Don Muang Airport, Bangkok, Thailand on 7 May. Most passengers (89%) were male and the median (IQR) age was 27 years (Q1=24, Q3=31). Most had visited Lahore (48.7%) and Karachi (38.9%).

Characteristics of Laboratory-Confirmed COVID-19 Cases

Of the 113 passengers, ten were confirmed to have COVID-19 (attack rate=8.9%) of which two were symptomatic on 8 May 2020. The asymptomatic cases were tested on 12 May (day 5) and seven tested positive. Two inconclusive cases were tested again on 15 May, of which one tested positive. The median (IQR) age of the cases was 26.5 years (Q1=23.5, Q3=27.0) and the male-to-female ratio was 9:1. Most cases (90%) were students at Karachi, Lahore, and Islamabad (Table 1).

Possible Source of COVID-19 Infection

History of daily life in Pakistan

All cases reported that they quarantined themselves at an authorized place before departure from Pakistan. However, six reported traveling outside the quarantine building, five visited a mosque, and five had contact with a confirmed case during the 14 days before departing Pakistan. There were no temperature screening devices at the mosque and social distancing measures were absent. At that time, none of the cases wore a face mask.

History of SARS-CoV-2 testing was self-reported with no documents for confirmation. All ten cases reported that they were tested for SARS-CoV-2 in Pakistan; nine cases tested negative. The positive case was tested twice; the first result was inconclusive and the second test was not reported. Seven cases were tested during 2 to 5 May (within four days before departure), while two were tested approximately one month before departure (Table 1).

History of traveling from the accommodation to the airport in Pakistan

- *Lahore (4 cases)*

The Thai consulate sent buses to transfer people from their accommodation to the hotel on 5 May. On arrival, nasal swabs were taken. Sleeping arrangements were two per room. The next day, on 6 May, they were transferred to the airport via bus. All passengers had their forehead temperature measured before boarding the buses and all wore masks en route.

- *Karachi (4 cases)*

The Thai consulate sent two buses to transfer people from their accommodation to a hotel on 5 May. Everyone wore masks during the journey. Nasal swabs were collected before the journey to the hotel. However, five passengers diagnosed with COVID-19 traveled by bus with other infected SARS-CoV-2 passengers. They arrived at Lahore airport on 6 May.

- *Islamabad (2 cases)*

One case traveled from his accommodation in Islamabad directly to Lahore airport via private car (a 5-hour drive), which was driven by a friend on 6 May. Both wore protective face masks for most of the journey. The other case traveled from a local quarantine facility by car to a university on 6 May and traveled to the airport by bus with other passengers bound for Thailand. Before boarding the bus, the staff checked the temperature of all passengers using a forehead thermometer. Face masks were a requirement for all passengers.

Table 1. Demographic data of confirmed COVID-19 cases who were returning from Pakistan (n=10)

Case No.	Gender	Age	Occupation	City	Symptoms	Date of onset	Test in Pakistan[T]	Risk factor in Pakistan	Date of confirmation
1	Male	27	Student	Karachi	Fever, rhinorrhea, diarrhea, anorexia, and myalgia	8 May 2020	NPS, neg, 4 May 2020	Contacting with COVID-19 case, going out from SQ in Pakistan	8 May 2020
2	Male	26	Student	Islamabad	Fever, cough, and sputum	28 Apr 2020	NPS, neg, 4 May 2020	Praying at mosque, going out from SQ in Pakistan	8 May 2020
3	Male	24	Student	Lahore	Asymptomatic	-	NPS, neg, 5 May 2020	Contacting with COVID-19 case	12 May 2020
4	Female	27	Housewife	Karachi	Asymptomatic	-	NPS, neg, 2 May 2020	Contacting with COVID-19 case, going out from SQ in Pakistan	12 May 2020
5	Male	27	Student	Lahore	Asymptomatic	-	NPS, neg, 5 May 2020	-	12 May 2020
6	Male	31	Student	Lahore	Asymptomatic	-	NPS, did not know the result, 5 May 2020	-	12 May 2020
7	Male	28	Student	Karachi	Asymptomatic	-	NPS, neg, 28 Apr 2020	Praying at mosque, contacting with COVID-19 case, going out from SQ in Pakistan	12 May 2020
8	Male	18	Student	Islamabad	Asymptomatic	-	NPS, neg, 4 May 2020	Praying at mosque, going out from SQ in Pakistan	12 May 2020
9	Male	23	Student	Lahore	Asymptomatic	-	NPS, neg, 5 May 2020	Praying at mosque, contacting with COVID-19 case	15 May 2020
10	Male	17	Student	Karachi	Asymptomatic	-	NPS, neg, end of April	Praying at mosque, contacting with COVID-19 case, going out from SQ in Pakistan	12 May 2020

Note: NPS=nasopharyngeal swab, neg=negative, SQ=State Quarantine

[T]Swab collection methods, results, date of test

History of traveling on the flight from Pakistan to Thailand

All 10 cases were seated in three zones; seats 9-12, 17-18, and 23-25. Two seats could not be identified due to wrong telephone numbers in the list of seat and temperature screening (Figure 1). All flight attendants wore personal protective equipment (masks, face shields, gloves, and protective suits). A face mask was given to all passengers and the flight attendants gave alcohol gel and alcohol wipes to the passengers to clean their belongings before boarding the airplane. Meals were not served on board. All passengers always wore their face masks and sat at their designated seats throughout the flight. There was no report about coughing on board among the cases. The duration of the flight from Lahore to Bangkok was 4 hours and 30 minutes.

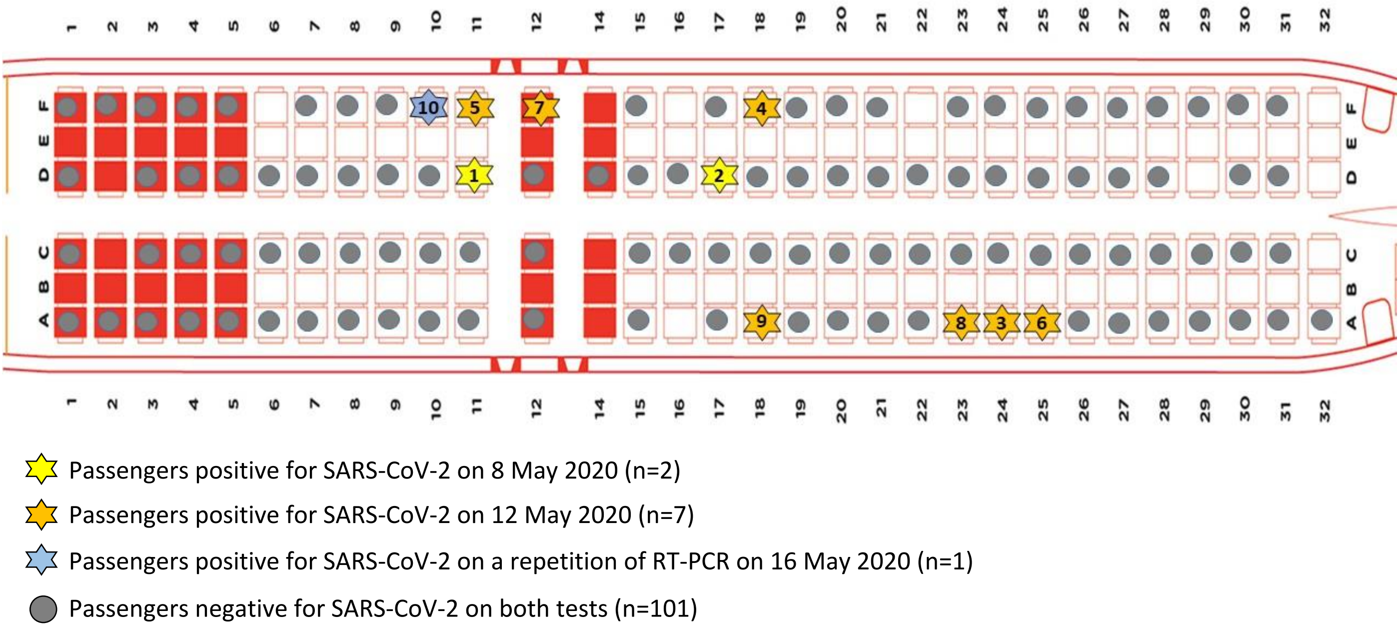

Figure 1. Map of passenger seats on a flight from Lahore Airport, Pakistan to Don Muang Airport, Thailand

History of traveling from the airport to the quarantine facility in Thailand

On arrival at the airport in Thailand, the airport staff arranged passengers to be sent directly to one of seven government-provided buses on a first-come-first-serve basis. Temperature screening was done before boarding the buses. Passengers sat with one space free in the middle position. All passengers wore face masks and all staff members wore standard protective equipment.

History of staying at the quarantine facility in Thailand

On arrival at the quarantine facility, staff brought all passengers' luggage at the front of the quarantine facility and sprayed them with disinfectant chemicals. Staff then asked passengers to alight from the buses and collect their belongings while keeping a one-meter distance between them. Passengers then proceeded to the registration center where their personal information including symptoms and fasting history were collected. Social distancing and wearing a face mask were implemented during the registration period.

After registration, returnees went directly to their room using the lift one at a time. Most were single rooms; however, two rooms were shared by more than one person. The returnees were not allowed to leave their rooms during the 14-day quarantine period. Three meal boxes were provided each day at 7.30 AM, midday, and 6 PM and the garbage was collected twice a day at 8 AM and 8 PM. Separate routes were used to deliver meals and remove garbage.

The quarantine facility was cleaned with the proper disinfectant every day. A closed-circuit television monitor was in use continuously and if anyone left their room, a warning alarm would sound.

Contact Tracing

Contact tracing identified at least 523 people as high-risk contacts of these 10 confirmed cases. Twenty had stayed with the 10 cases. At least 400 contacts were exposed in Pakistan during religious activities with three cases who visited a mosque and 103 passengers who traveled on the same flight. The remaining passengers were under 14-day quarantine with no report of new SARS-CoV-2 infection. At least 38 people were identified as low-risk contacts: six flight attendants who wore proper personal protective equipment, an unidentified number of airport screening staff and staff who escorted passengers to the buses, at least ten people who worked at the state quarantine facility, 12 laboratory staff who collected patients' specimens, and 10 medical staff who treated cases at the hospital.

Discussion

This outbreak investigation described a group of COVID-19 cases returning from Pakistan and quarantined at the Thai government's designated quarantine facility. The Thai government implemented a 14-day quarantine measure for all travelers entering Thailand from abroad.[10] Similar quarantine measures were implemented in many other countries; however, in Thailand, State Quarantine is fully supported by the government and receives cooperation from the hotels and private hospitals.[11] From our investigation, among 113 returnees from Pakistan in May 2020 who tested positive for SARS-CoV-2, 10 (8.9%) were symptomatic. This rate is slightly higher than that among the first group of 134 returnees from Wuhan in February 2020.[12,13]

Most of the confirmed cases in this cluster passed the local screening procedure, including temperature screening and lung examination for obtaining the fit-to-fly document, a required document, and a nasal swab test before traveling, which is not required. Therefore, measuring the forehead temperature and examining the lungs via x-ray might not be able to detect asymptomatic infections, which constituted the majority of confirmed cases.

Most confirmed cases had a history of visiting a mosque prior to leaving Pakistan. This corresponds to a previous study where social distancing was lacking, particularly at places of worship, which increases the risk of infection with respiratory diseases.[14,15] To prevent transmission among this high-risk group, prayer room screening measures should strictly follow the public health measures against COVID-19, such as wearing masks and screening temperature.

Returnees from Karachi reported that some of them traveled with people infected with SARS-CoV-2 on the bus from their accommodation to the consulate. We cannot confirm that this was the source of transmission, but we advise travelers to take maximum precautions, for example, wearing face mask, separating bus between suspected patients and other people, against SARS-CoV-2 infection if their trip is unavoidable.

Limitations

A limitation of this study is that the specimens were inadequate for sequencing tests. Another limitation was that contact tracing among contacts in Pakistan was not possible. However, we sent information about this investigation to the International Health Regulation unit, which then contacted the respective authorities in Pakistan for further investigation.

Public Health Recommendations

At the state quarantine facilities, we recommend that a list of all staff, including food deliverers, garbage collectors, maintenance personnel, cleaners, and all healthcare workers who may have been exposed to potential cases, be maintained for possible source investigation in case any infections among them occurs. The bus drivers and the number of passengers transported should also be recorded. For the Department of Disease Control, quarantine should be mandatory among all people traveling abroad. We recommended creating a channel for submission of electronic documents of SARS-CoV-2 laboratory results from the origin country among people returning from other countries if the origin country uses it with a fit-to-fly certificate. A guideline for sequencing tests and a state quarantine investigation form should also be developed.

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Cluster of COVID-19 Cases in a Workplace: the First Cluster of a Workplace-related Outbreak in Malaysia, 2020

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Abstract

In the early stages of the COVID-19 crisis, there was no specific guideline for handling an outbreak if it occurred in a workplace. This study aimed to describe the first and one of the largest clusters linked to a business corporate in Malaysia. A descriptive analysis was conducted using surveillance data from the Petaling District Health Office notified between 28 Feb and 22 Mar 2020. All cases and contacts were identified through surveillance, epidemiological investigation, and laboratory investigation. The total number of confirmed cases and close contacts were 63 and 1,536, respectively. The respondents were mainly Malay, male, and the mean age was 46 years. Of the 63 positive cases, 48 (76%) were reported to have symptoms during the investigation, while the remaining 15 cases (24%) were asymptomatic. The main clinical manifestations were fever (52%), cough (37%), sore throat (27%) and shortness of breath (27%). The mean incubation period was 3.5 days. Due to the timely prevention and control measures carried out by the Petaling District Health Office, the chain of transmission was interrupted as the last case was reported on 19 Mar 2020.

Keywords: COVID-19 outbreak, workplace, cluster, Malaysia

Introduction

An outbreak of pneumonia was reported in Wuhan city, China at the end of December 2019.[1] This pneumonia is caused by a new type of coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[2] Following the report of the outbreak, the virus quickly spread to many other countries including Thailand, Japan and Korea.[1] By the end of January, the coronavirus disease 2019 (COVID-19) was declared public health emergency of international concern, as it has been detected in as many as 19 countries, mostly in Asia.[3]

The first COVID-19 case in Malaysia was a foreigner from China and reported on 25 Jan 2020.[4] The next seven cases were also foreigners.[5] The ninth case was the first Malaysian and was reported at the beginning of February 2020.[6] He was a 42-year-old businessman who had travelled to Singapore from 16 to 23 Jan 2020. He was the index case of the first local transmission cluster in Malaysia.[7]

The Ministry of Health (MOH) of Malaysia established a COVID-19 surveillance system prior to the report of the first case in Malaysia. The guidelines defined persons under investigation (PUI) of COVID-19 as having fever or acute respiratory infection (sudden onset of at least one of shortness of breath, cough, or sore throat); and a travel history to affected countries (China, South Korea, Japan, Italy, Iran) in the 14 days before the onset of illness or having close contact within 14 days before illness onset with a confirmed COVID-19 case. The latter denoted a person with laboratory confirmation of SARS-CoV-2 infection. This case definition was used at all international points of entry, clinics and emergency departments, and hospitals in Malaysia.[8] All COVID-19 PUI and detected cases must be notified to the relevant District

Health Office (DHO) within 24 hours.[8] Once a notification is verified, the DHO would then proceed with an epidemiological investigation.[8] For surveillance of overseas returnees, thermal scanners are used at airports to screen inbound passengers. Those who have fever are then held for further investigation.

Malaysia was free of COVID-19 cases from 15 Feb 2020 for 11 days before the second wave of the disease arrived in late February 2020.[9] Most of the early cases in the second wave were initially imported and sporadic.[10] However, a case notified on 28 February to Petaling DHO in Selangor State, Malaysia, was later found to be linked to a cluster from a business corporate in Malaysia.[11]

As of 27 Feb 2020, there were only 25 positive cases in Malaysia. However, by 15 March, 428 cases had been reported.[9] These cases were mostly related to two big clusters, namely the "Tabligh cluster" and a corporate cluster–the one we report here. At that time, there was no specific guideline from the Ministry of Health for corporate companies on handling disease outbreaks. There was no movement restriction or order to work from home until the Movement Controlled Order (MCO) was initiated on 18 Mar 2020. This decision was made after a large increase of cases during the second wave.

The objective of this study was to describe the detection and management of this COVID-19 corporate cluster in Malaysia by the Petaling DHO to control the transmission. We also report the socio-demographic and clinical characteristics of the positive cases in this cluster.

Methods

Study Design

We describe all positive cases and their contacts linked to the first known case notified from 28 Feb to 22 Mar 2020 that were related to the workplace cluster. All contacts of these notified cases were traced and investigated. All cases and contacts were identified through surveillance, epidemiological investigation, and laboratory investigation.

Study Area

The area of this study was Petaling District in Selangor State, Malaysia. This district is about 25 kilometers from Kuala Lumpur. The outbreak occurred at a company in Kuala Lumpur but most of the cases lived in Petaling District. Thus, the cases were notified under Petaling DHO based on their home addresses.

Epidemiological Investigation

The epidemiological investigation included case investigation and active case detection through contact tracing. All cases and close contacts of the cases in this study up to 14 days from the dates of diagnoses were interviewed via phone to obtain details of their socio-demographic characteristics, symptoms and date of onset, movement and travel history including date of exposure, and comorbidities. Date of onset was self-reported and defined as the date any symptoms related to COVID-19 developed, such as fever, cough, sore throat, abdominal discomfort, shortness of breath and diarrhea. Date of exposure was defined as the last date of contact with a known COVID-19 case or last date of travelling, if any. Confirmed cases were additionally asked for details of all their close contacts. In the subsequent 14 days, all cases and the close contacts were monitored daily for their condition via phone calls.

For this cluster, the PUI were defined as any person (symptomatic and asymptomatic) that was related to the confirmed case within 14 days before the case was diagnosed positive. PUI also included contacts of the cases. A cluster was defined as an unusual aggregation of health events that are grouped together in time and space and reported to a health agency.[12]

All contacts that were traced were asked to have a throat or nasal swab done regardless of whether they were symptomatic or not. They were given a quarantine letter until results of the swab was known. If the result was positive, the person was admitted to hospital and isolated. Those who were asymptomatic and had a negative result were quarantined in their house for 14 days and asked to have a second swab performed on day 13 from the last exposure if they developed symptoms. An order to work from home was given by the employer to those who needed to work during the quarantine period after discussing with the health team. If a contact had two consecutive negative results, they were issued a quarantine release order.[8]

Laboratory Investigation

All PUI were asked to provide a nasopharyngeal and oropharyngeal swab samples. Symptomatic persons were asked to have a repeat test performed if the first was negative. For those who remained asymptomatic for 14 days, a single test was performed. For confirmed cases notified by private institutions, the initial test sample was repeated for confirmation. All specimens were tested in public health and hospital laboratories capable of running reverse transcriptase polymerase chain reaction (RT-PCR) for SARS-CoV-2.[8]

Management of PUI and Cases

All PUI identified through contact tracing were given a quarantine order for 14-day home surveillance. However, those who were clinically ill, immunocompromised, or pregnant, with uncontrolled medical illnesses, younger than 2 years or older than 65 years, not suitable for home surveillance, or a symptomatic close contact of a confirmed case regardless of disease severity, were admitted. Those who fulfilled the admission criteria, or were under home surveillance and tested positive for SARS-CoV-2, and all confirmed COVID-19 cases referred from private hospitals, were transported by a rapid response team using a designated ambulance to one of the nearest COVID-19 designated public hospitals.

The affected workplace was disinfected by the Petaling DHO and closed down for two weeks between 28 Feb and 13 Mar 2020.

Data Analysis

Descriptive statistics were used to describe all COVID-19 cases in this corporate cluster. The attack rate was calculated by dividing the number of confirmed cases by the number of cases and close contacts. The incubation period (in days) was calculated from the date of last exposure to the date of onset for symptomatic cases and presented using the mean with standard deviation (SD) and median with interquartile range (IQR). An epidemic curve was created using Microsoft Excel. A transmission network showing the chains of transmission in the cluster was created using R Software.

Results

The first notified case in the cluster was a 53-year-old male who developed symptoms on 27 Feb 2020. He visited a private hospital in Petaling District on the same day. His swab sample was taken and a positive result was reported on 28 February. Contact tracing was done starting on 29 February where one of his contacts (later determined to be the index case) was discovered to have symptoms on 18 February, making him the first generation of contacts in this cluster. The first notified case was exposed to the index case on 24 February during an office meeting. Both of them were working in the same company. The index case was diagnosed on 2 March, but developed symptoms on 18 February. The first notified case had a history of going to Shanghai, China on 14 to 17 January, which was more than a month before he developed symptoms, while the index case had a history of going to Surabaya, Indonesia on 24 to 28 January, which was three weeks before he developed symptoms. He also went to Sarawak in early February (2 to 4 Feb 2020).

During the investigation, the total number of people at the meeting that was held in the company on 24 February was 19. Out of these, 13 were board members and six were presenters. All of the board members were sitting in the meeting room together for two hours while the six presenters were called on one at a time to give a presentation. The total time for each presentation was 10–15 minutes. Among the 19 attendees, 16 were diagnosed positive forSARS-CoV-2, which included all of the board members and three presenters. The index case was one of the board members. Some of the presenters had body contact with each other, such as hand shaking, and all had stayed close (less than one meter) to the index case, which included conversations during the presentations.

From 28 February to 22 March, 1,536 people were traced by the Petaling DHO and were linked to the cluster. These individuals were identified after they were notified to the DHO. The total number of COVID-19 cases from this cluster was 126 resulting in an attack rate of 8.2%. Half of the positive cases (n=63) lived in Petaling District while the others were transferred to a DHO according to their house addresses.

Table 1 shows the socio-demographic characteristics of the 63 positive cases who lived in Petaling District. All but one was Malaysian nationals, 51 were of Malay ethnicity and the mean (SD) age as 46 (16.2) years.

Table 1. Socio-demographic characteristics of COVID-19 cases of a workplace cluster in Petaling District, Malaysia (n=63)

	n	%
Nationality		
Malaysian	62	98
Others	1	2
Gender		
Male	31	49
Female	32	51
Ethnicity		
Malay	51	81
Chinese	6	10
Indian	5	8
Others	1	2
Age (years), mean (SD)	**46 (16.2)**	
Age groups (years)		
<30	13	21
30-39	8	13
40-49	9	14
50-59	19	30
60 and above	14	22

Table 2 shows the distribution of clinical characteristics. Most (76%) were symptomatic with common symptoms being fever (52%) followed by cough (37%), sore throat (27%) and shortness of breath (27%). The mean incubation period was 3.5 days and most of the cases developed symptoms during the peak of the epidemic (26–28 February). Most were admitted to a general ward with only one requiring intensive care due to shortness of breath and oxygen desaturation. No fatalities were seen up until 22 March.

Table 2. Clinical characteristics of COVID-19 cases of a workplace cluster in Petaling District, Malaysia (n=63)

	n	%
Symptom status		
Symptomatic	48	76
Asymptomatic	15	24
Symptoms		
Fever	33	52
Cough	23	37
Sore throat	17	27
Shortness of breath	17	27
Runny nose	7	11
Arthralgia	4	6
Diarrhea	4	6
Myalgia	3	5
Lethargic	2	3
Headache	0	0
Abdominal Pain	0	0
Incubation period (days)		
Mean (SD)	3.5 (3.0)	
Median (IQR)	3.0 (3.0)	
Comorbidities		
Hypertension	14	22
Diabetes mellitus	4	6
Dyslipidaemia	3	5
Heart Disease	1	2
Cancer	1	2
Lung disease	1	2
None	40	63
Ward		
General	62	98
Intensive care unit	1	2
Outcome		
Alive	63	100
Death	0	0

Figure 1 illustrates the epidemic curve of this cluster. For symptomatic cases, the date of onset of illness was used while the date of diagnosis was used for asymptomatic cases. The peak occurred on 27 February and the last case was reported on 19 Mar 2020.

Figure 2 depicts the transmission chains among positive cases. Each of the generations are differentiated by a different color. There were 17 cases confirmed in the first generation of contacts, 22 in second generation, 15 in the third, six in the fourth and two in the fifth generation. The first generation included cases from the company meeting in which the index case attended on 24 February and his family members. The attack rate for the first generation was 83%.

Discussion

We reported the first COVID-19 cluster in a workplace population in Malaysia. The index case was reported to have a travel history oversea to Surabaya, Indonesia from 24 to 28 Jan 2020. At that time, there was no reported positive cases in Indonesia. He developed symptoms after returning to Malaysia on 18 February, suggesting that if he was infected before returning to Malaysia, then thermal scanning devices in the airport may miss some inbound passengers who are infected and asymptomatic. During our investigation, the index case also mentioned that his previous office area was closed for disinfection of unknown reason. He claimed that some of the staff were not feeling well and that the office's clients were mostly foreigners.

From the history taking, the index case was already symptomatic when he attended the meeting on the 24 February. He then infected the other 15 people in that meeting despite the fact that some did not have a close conversation nor body contact with the index case. This showed that being in a close environment for a certain period of time will render a person susceptible for infection; being less than a meter from the index case is therefore not a necessary requirement. This is because coronaviruses can be transmitted indirectly as they can persist on fomite surfaces for at least 3 days, especially if the environment is conducive, such as lack of sunlight.[14] A study from China reported that strong airflow from an air conditioner may have propagated the droplets of an infected person to other people in the confined space.[15]

From the result of this outbreak, the mean incubation period was 3.5 days, suggesting that a person will develop symptoms 3 to 4 days after being exposed. A study in China reported a median incubation period of 3 days,[16] a result similar to ours. The World Health Organization states that the average incubation period of COVID-19 ranges from 1-14 days.[17] In this Petaling cluster, 48 (76%) of the 63 positive cases developed symptoms while 15 (24%) were asymptomatic. In a report of COVID-19 cases in China, only 1% were asymptomatic.[18] Asymptomatic cases are still infective and able to transmit the disease to others.[19] In another study, it was shown that asymptomatic cases may develop symptoms during their hospital admission while some will remain asymptomatic.[16]

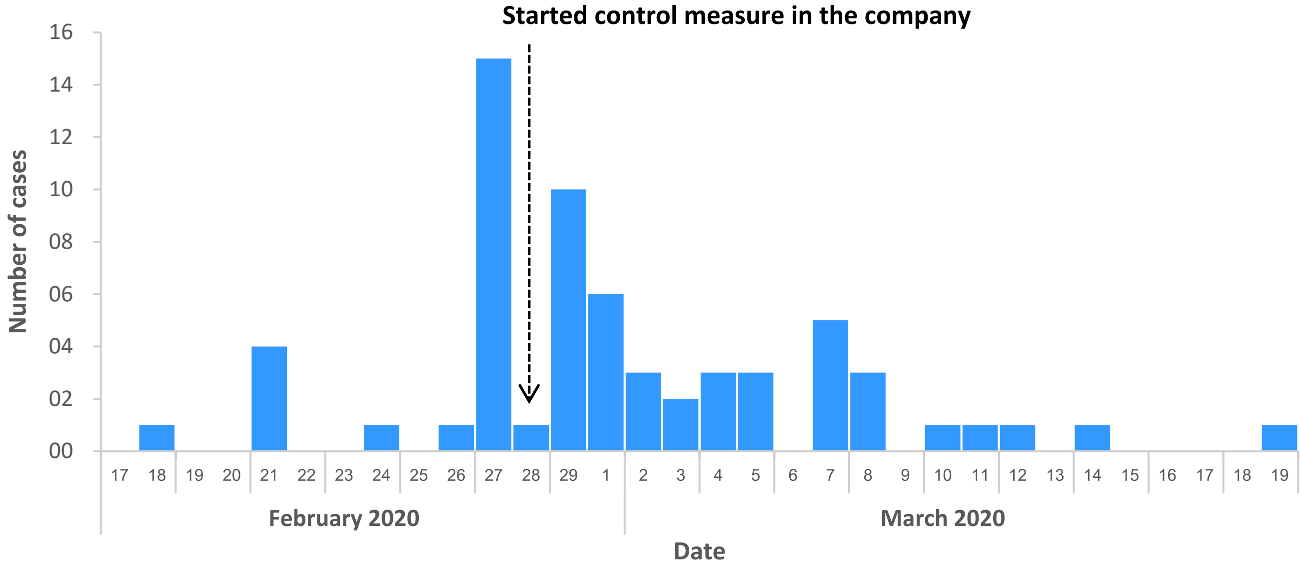

Figure 1. Epidemic curve of COVID-19 cases of a workplace cluster in Petaling District, Malaysia (February – March 2020) (n=63)

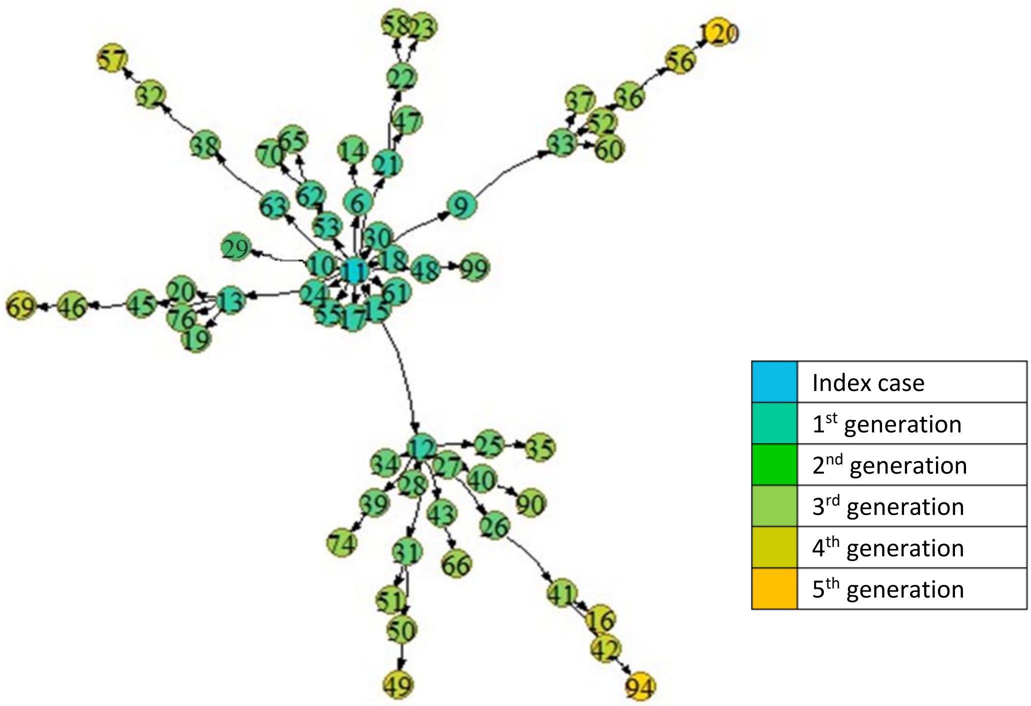

Figure 2. Generations of transmission based on the epi-link (n=63)

In our study, the majority of cases (52%) were aged 50 years or above. This is possibly due to the characteristic of the cluster as most were higher level executives. One third of the cases had comorbidities such as hypertension and diabetes mellitus. Other studies reported that the severity of the disease will increase if the infected person has underlying comorbidities.[20] In this cluster, only one case required intensive care. This patient had a history of hypertension and diabetes mellitus.

Petaling DHO was able to trace cases up to the 5th generation of contacts suggesting that SARS-CoV-2 is a highly infectious virus. One study reported that the average amount of secondary cases that one case can infect in a completely susceptible population (known as the basic reproduction number, R_0) ranges from 2.0 to 3.1[21] and while another study reported an R_0 value of 2.68.[22]

This workplace cluster ended within a duration of less than a month. The DHO carried out a workplace risk assessment and identified workers deemed as close contacts with the confirmed COVID-19 index case. Based on the hierarchy of control measures, from the most effective to least effective, each of these workers were issued a quarantine letter and isolated from the hazard. Isolation is a form of engineering control and is effective as it prevents workers from exposure to the given biological hazard (SARS-CoV-2) and also further prevents disease transmission.[23] Administrative control in the form of job rotation was also implemented in which workers took turns to work from home. Besides that, both employer and employees were engaged for hazard communication including advice on social distancing and proper hand hygiene using hand sanitizers. The workplace was put under temporary closure to allow for disinfection by the DHO and the company was closed for two weeks. The employers were allowed to work from home and also advised to practice gate keeping, involving screening all workers for fever and acute respiratory symptoms before entering the office premises. The quarantine letter was issued to all contacts of the positive cases, thus reducing the risk of disease transmission. This is consistent with the local regulations, the Occupational Safety and Health Act (OSHA) 1994, where it is the duty of employers to ensure the safety, health and well-being of their employees.[24] The control measures taken in this outbreak focused on the prevention of further spread and breaking the chain of transmission. All these measures can be employed when similar outbreaks occur in other workplaces.

There were limitations for our study. First, we did not follow up the cases once they were admitted to the hospital. Patients might have developed symptoms in the hospital and the descriptive report was based on the positive cases registered in Petaling District and not for the whole of the cluster due to data availability. Second, no environmental samples were taken to assess for the presence of the virus on the surfaces of fomites at the workplace.

Conclusion

A cluster of COVID-19 in a workplace setting was curbed within three weeks due to control efforts by the Petaling DHO with mutual co-operation by the employer and other related DHO. They did all the necessary measures to prevent the outbreak from escalating.

Recommendations

From this study, outbreak control measures have to be done quickly and efficiently to minimise disease transmission. Health authorities must strictly enforce the regulations. It is advisable for the government to close all international borders until the number of cases has reduced to an acceptable level, or at least after herd immunity against SARS-CoV-2has been achieved. After more than a year of the pandemic, the residents are advised to practice new norms such as wearing face masks, performing hand hygiene and maintaining physical distancing, even after vaccination.

Conflict of interest

The authors declare there is no conflict of interest for this publication.

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Ethic approval

Ethical approval for the study was obtained from the Medical Research and Ethics Committee (MREC) and registered with our National Medical Research Registry with registration number NMRR-20-720-54598.

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An Outbreak Investigation of COVID-19 among Furniture Factory Workers at Kuala Langat District, Selangor, Malaysia

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Abstract

On 9 Dec 2020, a coronavirus disease 2019 (COVID-19) case was reported in Telok Datuk Panglima Garang, Kuala Langat District, Selangor, Malaysia. The findings revealed that the virus originated from a distributing site of a furniture factory, where the index case worked as a lorry driver. The outbreak investigation was conducted by health district officers using a COVID-19 public health risk assessment. We determined the exposure risk of the index case, and close contacts (families, relatives, work colleagues, and segments of the population) that were likely to be infected. One hundred furniture factory workers were screened and five workers, including the index case, were confirmed positive using real-time polymerase chain reaction. Those who tested positive were lorry drivers and lorry attendants who were stationed at loading area A. No workers from the other areas were tested positive, suggesting localized transmission in the factory. The COVID-19 public health risk assessment, isolation of index cases and quarantine of close contacts have enabled effective control measures in preventing further spread and community transmission.

Keywords: COVID-19, health risk assessment, lorry driver, factory, workplace, Malaysia

Introduction

In December 2019, the first severe respiratory disease of an unknown origin reportedly emerged from a hospitalized patient in Wuhan, the capital city of Hubei, China.[1] The disease was caused by a novel coronavirus (termed 2019-nCoV), having 96% gene similarity with a bat coronavirus RaTG13 previously reported in China, and 70% homology with severe acute respiratory syndrome coronavirus (SARS-CoV).[2] In January 2020, the 2019-nCoV changed its name to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[3] Being highly transmissible, the SARS-CoV-2 virus spread rapidly to other countries and a pandemic was declared in March 2020. Up till March 2021, the SARS-CoV-2 has infected more than 117 million people and over 2.6 million deaths worldwide have been reported.

On 23 Jan 2020, Singapore reported an imported case of coronavirus disease 2019 (COVID-19) case from Wuhan.[4] A few days later, the first index COVID-19 case was reported in Malaysia, which was known to have close contact with the reported case in Singapore. Eight confirmed COVID-19 cases were reported within six days in Malaysia and were identified as imported cases.[4] The first Malaysian who was infected by the SARS-CoV-2 was reported on 3 Feb 2020. This person had traveled to Singapore for a business meeting that was also attended by delegates from China.[4]

In September 2020, Malaysia experienced three COVID-19 waves.[5] Since January 2020, the Ministry of Health has been working tirelessly on preventing and controlling the spread of SARS-CoV-2 at all levels based on the risk assessment criteria.[6] Risk assessments have been developed by many countries,[7,8] particularly for healthcare workers and travelers.[9,10,11] Certain occupations such as lorry drivers are required to travel long distances, which increases their risk of infection. On 9 Dec 2020, the Kuala Langat District Health Office received a notification that one furniture factory worker had tested positive for SARS-CoV-2. He was a lorry driver who had transported furniture from the manufacturing site to the distribution site. An outbreak investigation by the district health office was initiated to understand the mechanism and magnitude of disease transmission and to establish preventive measures at the workplace.

This study aimed to investigate the COVID-19 outbreak in a furniture factory in Telok Panglima Garang, Kuala Langat District, Selangor, Malaysia by describing the characteristics of the outbreak, determining the source of infection, investigating close contacts and formulating preventive measures to be employed at the workplace.

Methods

Location and Timeframe

The factory under investigation was located in the Telok Panglima Garang Subdistrict, 15 kilometers from Banting Town. The factory is under the preview of the Telok Panglima Garang Health Clinic (Figure 1), which has a population of 5,000 people in an area covering 60 hectares. The outbreak investigation was conducted from 9 to 19 Dec 2021.

Figure 1. Map of Telok Panglima Garang Subdistrict, Kuala Langat District, Selangor

Study Population

The entire cohort of 100 workers (including the index case) at the factory was screened and monitored over 10 days between 9 and 19 Dec 2020. According to the Malaysian Ministry of Health Guidelines, the index case is the first identified case in a group of related cases of a particular communicable or heritable disease.[12] Close contact is defined as a person who was in close proximity with the index case, either by staying together, working together, sharing the same environment or traveling together in any kind of conveyance.[12]

Study Design

This was a cross-sectional study. The factors that were investigated include the exposure history of the factory workers and their close contacts, personal hygiene of the subject's factory, and home environment.

Data Collection

Descriptive study

We reviewed the factory workers' records. Information regarding the demographic characteristics of the potential suspect or likely exposure to the index case was obtained from the general manager of the factory. These variables include age, gender, geographic location, date of symptoms onset, course of illness, and laboratory examination results.

The general manager was interviewed via phone and WhatsApp to secure a list of names of the workers. We retrieved their places of residence, and contact numbers to enhance the investigation of family contacts, friends, and close contacts for 14 days following the standard operation procedure (SOPs) by the Ministry of Health, Malaysia, using COVID-19 public health risk assessment.[12] All likely or suspected non-close contacts (family members, relatives, and friends) were subjected to active fever surveillance for 14 days. All information was kept confidential.

Laboratory tests

Real-time polymerase chain reaction (RT-PCR) tests for the SARS-CoV-2 virus were done for all close contacts. Postnasal specimens were collected, such as nasopharyngeal swabs, oropharyngeal swabs or nasopharyngeal wash/aspirate. All samples were placed in a viral transport media and kept at 2-8°C before further processing and testing. The processing and testing were carried out at the Institute for Medical Research and the National Public Health, Malaysia as designated COVID-19 laboratories.

Environmental study

An ocular survey was conducted to observe the entire workflow and work process in the factory. We observed the furniture delivery process from the factory to the distribution site. A spot map of the affected area was prepared (Figure 2).

Data Analysis

Descriptive statistics, count and percentage, were used to summarize the cases' distribution by place, time and person.

Ethical Approval

This study was registered under the National Medical Research Register, Malaysia, and ethical approval to conduct the study was obtained from the Medical Review and Ethics Committee, Malaysia.

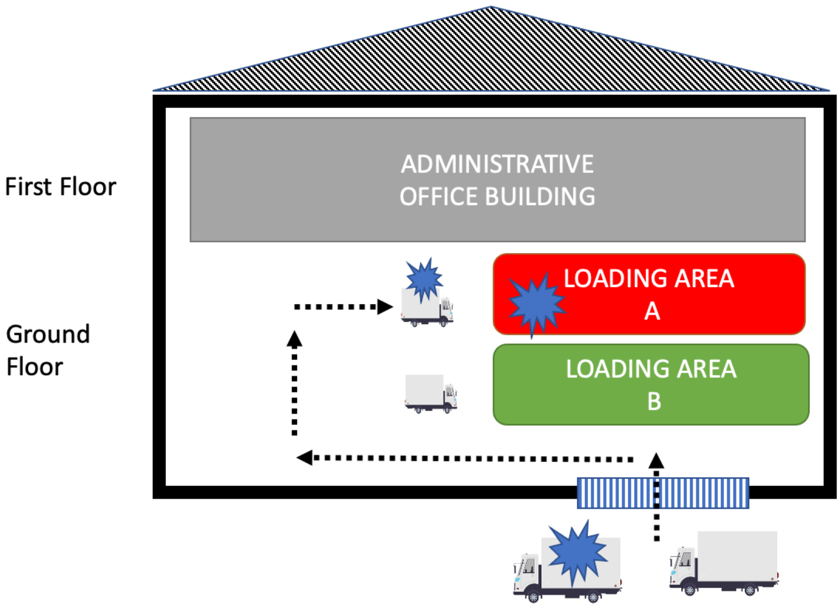

Figure 2. Spot map of the affected area at the furniture factory

Results

Descriptive Results

The district health office received a notification that one transport driver working at the furniture factory tested positive for SARS-CoV-2 on 9 Dec 2020. He had transported furniture from factories to retail stores within the sub-district. Further investigation revealed that he had also distributed furniture to other states in Malaysia, namely Perak, Selangor, and Johor.

The findings from the outbreak investigation showed that of the 100 workers screened, five (5%) tested positive (Table 1). The district health officials concluded that it was a new emerging cluster in the district.

Table 1. Attack rate of furniture factory employees in Telok Panglima Garang Subdistrict, Kuala Langat District, December 2020 (n=100)

	Characteristic	Number of employees examined	Number of RT-PCR tests	Number of employees who tested positive	The attack rate (%)
Area	Office area	58	0	NA	0
	Loading area A	17	12	5†	29.4%
	Loading area B	25	0	NA	0
Total	Employees	100	12	5	5.0%

†*Including the index case*

After the discovering of the index case, the COVID-19 risk assessment revealed 11 employees were close contacts to the index case. These 11 close contacts were subjected to the SARS-CoV-2 RT-PCR test and four were tested positive (36%) on 10 Dec 2020. The positive cases were transferred to a designated hospital for quarantine while the other employees were subjected to home quarantine. The remaining 88 factory workers were non-close contacts of the index case. They were given a wrist band (indicating the Home Surveillance Order) and quarantined for 10 days as per the Ministry of Health's protocol. The outbreak resulted in a 5% SARS-CoV-2 positive rate without symptoms and required zero transfers to an intensive care unit. The population of Kuala Langat Health District was 44,653. Thus, district incidence was 11 per 100,000 population of the Kuala Langat District (5/44,653), while the incidence rate for COVID-19 in the furniture factory was 5% or 5,000 per 100,000 population.

The factory was closed for 10 days and allowed to reopen on 19 Dec 2020 as per the SOP issued by the Ministry of Health, Malaysia (Figure 3). There was no evidence of the occurrence of community cases as a result of the outbreak that happened in the factory at the end of the 10-day active surveillance period.

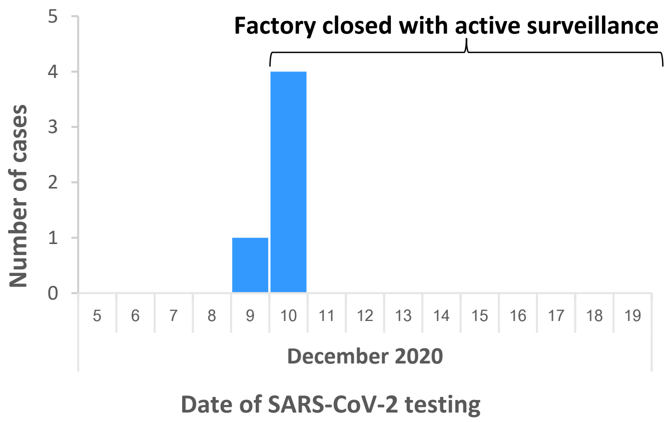

Figure 3. Number of confirmed COVID-19 cases in the furniture factory by date of SARS-CoV-2 testing

Environmental Assessment

The furniture factory had a working area of two hectares with 100 workers, making the crowding index 50 persons per hectare. There were two loading areas, which we designated as areas A and B with the administrative office located on the upper floor. Loading area A had five positive cases, while both loading area B and the administrative office had zero cases. All positive cases were lorry drivers (n=3) and lorry attendants (n=2) in loading area A. There was evidence that the risk of SARS-CoV-2 transmission was only among close contacts of drivers and attendants at the loading area A. Thus, an epidemiological link was established between the cases, the drivers and attendants at loading area A. There was an association between loading area A and the lorry driver with lorry attendants. All positive cases were asymptomatic. Loading area A has a 29% attack rate following the exposure of one positive case, while loading B and the administrative office had an attack rate of zero.

Discussion and Recommendations

COVID-19 public health risk assessment was utilized to determine the exposure risk of the index case and close contacts who were likely to be infected. Appropriate control measures were instituted to prevent transmission among these close contacts. Immediate isolation of the index case, and quarantining close contacts and factory workers prevented transmission of SARS-CoV-2 among family members, relatives, and members of the community. This contributed to a localized cluster at loading area A without community or household transmission.

It is hoped that the investigation of the epidemic will reveal ways to reduce the transmission risk at the factory. A major accomplishment would be the identification of close contacts who are likely to be infected and could further spread the disease; thus, they should be isolated and quarantined accordingly. The resignification of transmission risk factors that lead to the spreading of diseases includes demographic factors, socioeconomic conditions, physical distance, mask-wearing, and hand hygiene.

For public health control and preventive measures, unregistered workers with the company need to be identified and subjected to RT-PCR screening together with home quarantine for 10 days. At work, it is important to maintain the recommended one-meter physical distance. Continuous education on wearing face masks and practicing hand hygiene needs to be regularly enforced to prevent re-infection in the furniture factory, preventing another outbreak at the workplace. The living condition of the factory workers, living in hostels and housing areas, should be inspected and monitored, to ensure the workers are not living in crowded spaces as each person needs to always have at least a 1-meter radius. Regular disinfection at each loading station after each loading activity is advised. All common meeting areas such as bathrooms, meeting rooms, rest areas, and work areas should be disinfected every 4-8 hours.

Conclusion

Although the index case was a lorry driver, there was no community and within-family transmission reported, as evidenced by the epidemiological curve that showed there were no cases seen in the community at the end of 10 days. At the workplace, the transmission was localized only at the loading area where the index case was stationed. This suggests that immediate action taken by the employer and staff from the health office to identify and investigate those who had close contact with the index case was important in preventing further transmission. Furthermore, strict SOPs and enforcement imposed by the government of Malaysia to balance economic and health sectors might have effectively controlled the transmission. Preventive measures such as wearing face masks, good hand hygiene and regular disinfection are needed to prevent the spread of this disease.

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An Injury Investigation of a Bus-Train Collision, Chachoengsao, Thailand, October 2020

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Abstract

On October 2020, there was a bus-train collision at Chachoengsao Province with 18 fatalities. The Division of Epidemiology conducted a joint investigation during October 2020 to describe characteristics of the event and deaths, and identify factors associated with fatalities. A descriptive study was conducted by interviewing officers, witnesses, policemen, rescuers and survivors. We also reviewed medical records and closed-circuit television and performed environmental survey of the roads and bus wreckage. A retrospective cohort study was performed with multiple logistic regression and Haddon matrix analyses. The bus collided with a cargo train at an illegal road-railway crossing intersection. Eighteen people died (25.4%). Most deaths were caused by lethal injuries to the head and neck (17/18, 94.4%). The bus was overloaded and turning on loud music. The intersection did not have crossing gates and the warning signal was broken. This bus-train collision resulted in high fatality. Standing on the overloaded bus was the significant risk of death. Regulations of noise limits, number of passengers, limit standing on the buses, and improvement of safety controls for all road-railway intersections should be strictly implemented for injury prevention.

Keywords: bus-train, collision, risk, death

Introduction

Road traffic injury (RTI) is one of the leading causes of death worldwide.[1] The global status on road safety 2018 by the World Health Organization reports about 1.35 million RTI deaths annually and the RTI rates are highest in Africa and South-East Asia.[1] In 2018, Thailand was ranked first in Asia and was among the top ten countries in the world for RTI, with 32 deaths per 100,000 population per year.

Collisions between a bus and a train are rare events,[2,3] but can result in a significant loss. Reports of collisions from many parts of the world describe the number of deaths ranging from one to 20 per event.[2-5] In Thailand, during 2002–2018, there were five events of bus-train collisions reported to the State Railway of Thailand. The most recent event occurred in 2018, which resulted in three deaths.[3]

According to the Thailand Ministry of Transport, in 2019 there were 2,684 road-railway intersections in the country, most of which (2,278, 84.9%) were at ground level (i.e. not tunnels or bridges).[4] Among the ground-level intersections, about 27% were illegal, defined as an intersection created by local administrators, but not officially registered under the State Railway of Thailand. Illegal intersections are not regulated and so often lack adequate safety control measures, like traffic signals, road signs, sufficient visibility, and safe design.[4] Almost half (39/86, 45.3%) of road-railway intersection injuries in 2019 occurred at illegal intersections in Thailand.[4] Injury investigation including host, agent, and environmental factors in pre-crash, crash, and post-crash by Haddon's matrix is needed for systematic primary, secondary, and tertiary prevention.

The Division of Epidemiology, Ministry of Public Health was notified of a bus-train collision, resulting in 18 fatalities in Chachoengsao, in October 2020. The Division of Epidemiology and local health authorities conducted a joint investigation to describe characteristics of the event, injured cases, and deaths, identify factors associated with fatalities, and provide recommendations for injury prevention and mitigation of similar events in the future.

Methods

Descriptive Study

We reviewed medical records of patients involved in the collision from six hospitals to determine demographic data, injury characteristics, outpatient or admitted patients, and treatment outcomes using a case report form. We interviewed 53 survivors of the collision using a semi-structured questionnaire to collect data about seat position, activity before and during crash, and use of seat belts. We also reviewed interview-video-clips from news reports to gather information from the train driver about the collision.

For this investigation, 'survived' was defined as any person who was traveling on the bus, and was alive within 30 days after the collision. Any person traveling on the same bus who died at the scene or died within 30 days as a result of the road injury accident was defined as 'died'.

The Injury Severity Score (ISS) was calculated based on injury characteristics.[6] The ISS is an anatomically based, consensus-derived, global severity scoring system that classifies an individual injury, and is calculated as the sum of the squares in each of the three most severely injured body regions. The median and interquartile range were calculated for continuous variables, and ratio and proportion were calculated for categorical variables.

Analytic Study

We performed a retrospective cohort study to identify risk factors related to fatalities. The cohort included all who traveled on this bus on 11 Oct 2020. The dependent variable categories were 'died' and 'survived', as defined above. Independent variables were gender, age, race, standing on the bus (yes/no), and drinking alcohol before the collision (yes/no). Bivariate analysis was conducted using the chi-square test or Fisher's exact test. To adjust for confounders, we performed multivariable analysis using multiple logistic regression.[7] The variables with p-value less than 0.1 in univariable analysis were included in the model and reported adjusted odds ratio with 95% confidence interval (CI) as a result. STATA-14 was used for data management and analyses.

Environmental Study

We surveyed the environment at the collision site and reviewed recorded video from a nearby closed-circuit television. We measured the distance between the crash site and the bus wreckage, yaw mark, warning signals, and assessed the drivers' visibility. We interviewed disaster prevention and mitigation officers and witnesses to collect data about the environment at the time of the collision.

The bus wreckage was inspected to assess its general appearance, external and internal damage, impact sites, seatbelts, and driver's visibility. We also reviewed reports from the Department of Land Transport to gather additional information about the bus including the number of seats, license plate expiration date, and information about the train such as type, size, and emergency braking distance. In addition, we interviewed the policemen and rescuers who were at the collision site to describe the timeline of the event, identification of fatalities, and triage and rescue procedures. Haddon's matrix, a field model of injury prevention to reduce the morbidity and mortality,[8] was used for the analysis to identify human, vehicle, and environmental risks before, during, and after the collision.

Results

Event Description

On 11 Oct 2020, a single deck inter-provincial bus carrying 70 passengers and one driver departed from Factory P at 6.30 a.m. heading to Bang Pla Nak Temple in Bang Toey Subdistrict in Chachoengsao Province (63 kelometers from Factory P). On this group tour bus, they opened loud music, sang songs, danced, and drunk alcohol. When the bus crossed a ground-level road-railway intersection near Klong Kwaeng Klan Train Station (60 kelometers from the Factory P), a cargo train heading to Bangkok collided into the bus at 8.05 a.m. (Figure 1). The bus was moving at a speed of 40 kilometers per hour (km/h), according to GPS tracking, as it crossed the railroad tracks and was struck by the train from its right side. Close-Circuit Television revealed the speed of the bus remained consistent while crossing the railroad track. The bus overturned onto its right side, the back of the bus scraped against the moving train and its roof was ripped off. The bus was pushed by the train for 13 meters and stopped in a one-meter-wide groove between the two railroad tracks.

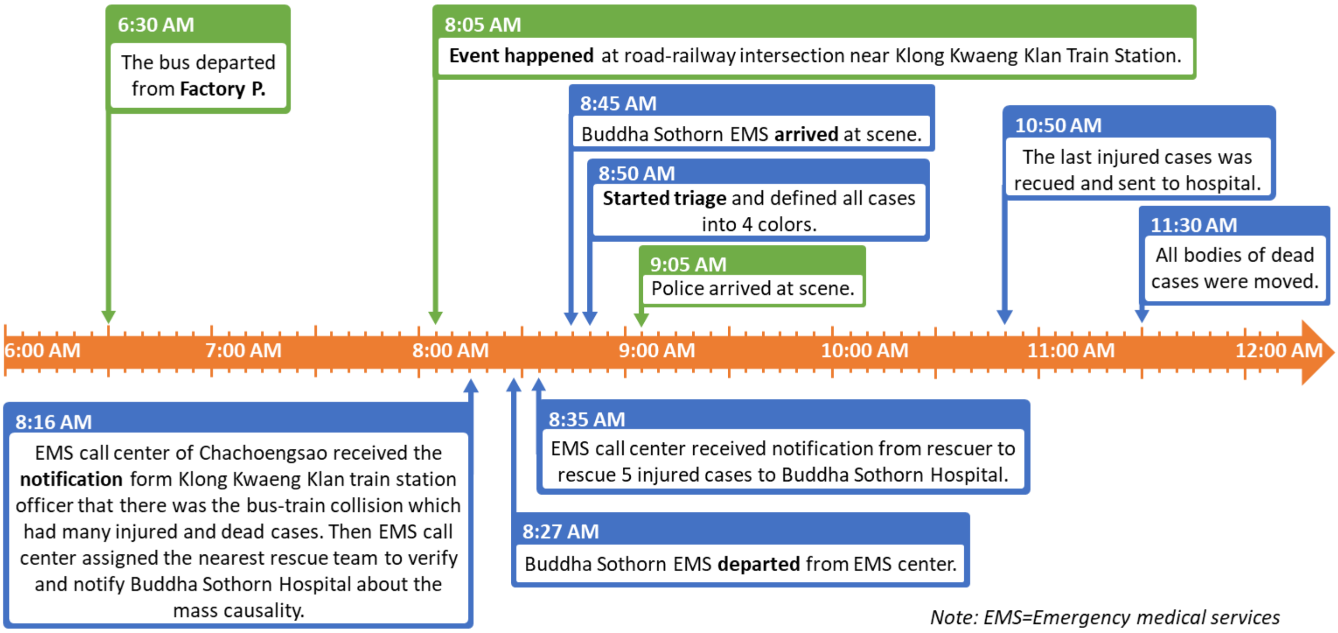

Figure 1. Timeline of the bus-train collision in Chachoengsao Province, 11 Oct 2020

Characteristics of Individuals Who were Injured and Died

All 71 people in the bus, consisting of 70 passengers and one driver, were injured and 18 died, including the driver, giving the case-fatality rate (CFR) of 25.4%. Seventeen people died at the collision scene, and one died during transfer to Buddha Sothorn Hospital, which is a tertiary hospital. Out of 53 survivors, 33 (62.3%) were treated as out-patients, 14 (26.4%) were admitted, and 6 (11.3%) did not go to the hospital. There were no pedestrians injured, neither was the train driver. Most of the 71 people on the bus were female (69.0%) and Thai (71.8%), and the median age was 32 years (Q1=27, Q3=40). Characteristics of individuals who died in the collision were shown in Table 1. A significantly higher rate of fatality was observed in males (45.5%) than females (16.3%). Individuals who stood on the bus had a significantly higher rate of fatality (61.1%) than those sitting on the bus (13.2%). Drinking alcohol on the bus was also significantly associated with fatality. Of 71 individuals on the bus, only the bus driver fastened his seat belt. There were no significant associations between fatality and age or race.

Table 1. Characteristics and outcome of individuals in the bus-train collision, Chachoengsao Province, October 2020 (n=71)

Characteristics	Total	No. died (%)	Odds ratio (95% CI)	*p*-value
Gender				
Male	22	10 (45.5)	4.27	0.009
Female	49	8 (16.3)	(1.38,13.23)	
Age (years)				
≤30	34	8 (23.5)	1.20	0.737
>30	37	10 (27.0)	(0.41,3.52)	
Race				
Non-Thai	20	6 (30.0)	1.39	0.570
Thai	51	12 (23.5)	(0.44,4.42)	
Standing on the bus when crashed				
Yes	18	11 (61.1)	10.33	<0.001
No	53	7 (13.2)	(3.00,35.58)	
Drinking alcohol on the bus before the crash				
Yes	22	11 (50.0)	6.00	0.002
No	49	7 (14.3)	(1.89,19.08)	

Most of the injured body regions were extremities, followed by head and neck, face, thorax, and abdomen, respectively. Autopsy reports indicated that most deaths were caused by lethal injuries to the head and neck (17/18, 94.4%) and the remaining one had a severe abdominal injury (1/18, 5.6%). Higher proportions of head, neck, and face injuries were observed among the deaths than the survivors. The median of ISS among the deaths was 61, compared to 8 among the survivors (Table 2).

Table 2. Body region of injury and Injury Severity Score of the victims who survived and died in the bus-train collision, Chachoengsao Province, October 2020 (n=71)

Injury characteristics	No. died (%)	No. survived (%)
Body region of injury[+]		
Head & neck	17 (94.4)	27 (50.9)
Face	15 (83.3)	15 (28.3)
Thorax	5 (27.8)	19 (35.8)
Abdomen	6 (33.3)	11 (20.8)
Extremities	14 (77.8)	42 (79.2)
Total	**18 (100.0)**	**53 (100.0)**
Injury severity score		
Median (Q1, Q3)	61 (61, 75)	8 (4, 17)

[+]*Some had more than one body region injuries*

The passenger seat map and crash site are shown in Figure 2. The collision occurred at the right site of the bus. Those who were on the right side of the bus were more likely to die than those on the left side. During the crash, 18 passengers were standing on the bus and 11 died (61.1%) whereas 7 of 53 (13.2%) who were sitting died in this collision.

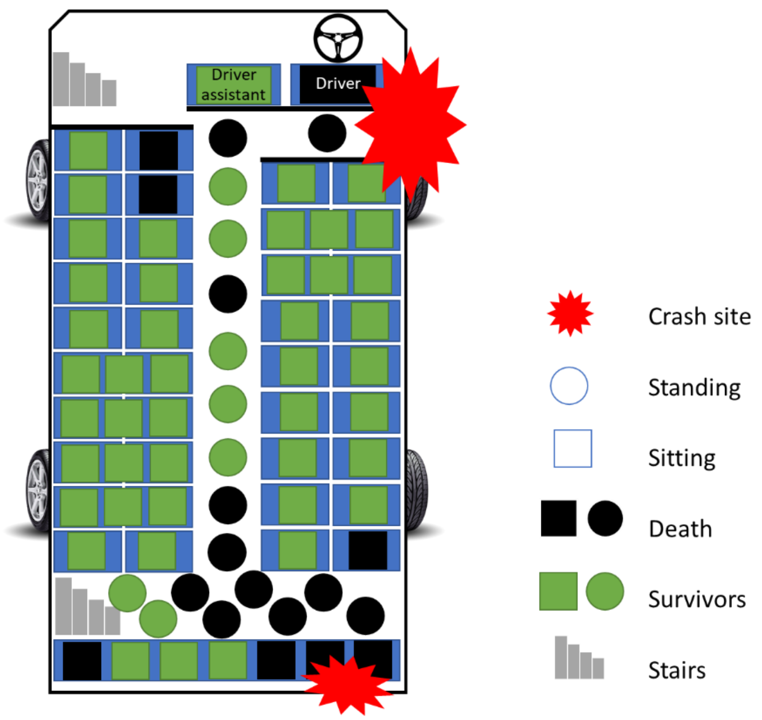

Figure 2. Seat map of all passengers and driver on the bus of the bus-train collision in Chachoengsao Province, 11 Oct 2020 (n=71)

Analytic Study

Table 3 shows multivariable analysis of the determinants of fatality in the bus-train collision. Only standing on the bus was significantly associated with fatality (Adjusted odds ratio=6.46; 95% CI 1.65-25.20), after adjusting for gender and drinking alcohol on the bus.

Table 3 Multivariate analysis of the determinants of fatality in the bus-train collision, Chachoengsao Province, October 2020

Factors	Adjusted Odds Ratio	95% CI
Gender (male/female)	2.68	0.71-10.03
Standing in the bus (yes/no)	6.46	1.65-25.20
Drinking alcohol in the bus (yes/no)	2.37	0.60-9.39

Environmental Study

Site of collision

The collision occurred at an illegal crossing intersection where a two-lane road with opposing traffic crossed three parallel railroad tracks that ran perpendicular to the road. The collision occurred on the third track (Figure 3). The road leading up to the tracks had a 30-degree incline, was made of smooth asphalt, and was approximately 4-6 meters wide. The road-railway intersection did not have a road-railway barrier (a crossing gate). There were two train warning signs approximately 300 meters and 10 meters in front of the railroad tracks. However, the warning light signal was broken. The bus driver's visibility was obstructed by trees and shrubs, which were removed after the event. (Figure 3). At the time of the collision, it was drizzling, and yaw marks were not observed. The distance from the crash site to the bus wreck was approximately 90 meters and to the train-engine was approximately 600 meters. This event occurred 20 kilometers from the Buddha Sothorn Hospital. It took 30 minutes for the first emergency medical services (EMS) to get to the scene after receiving notification. However, there was a long iron fence blocking the rescue team from getting access to the collision site. Rescue cars were obstructed by a nearby traffic jam. Some survivors were trapped under the wreckage or bodies of the deceased.

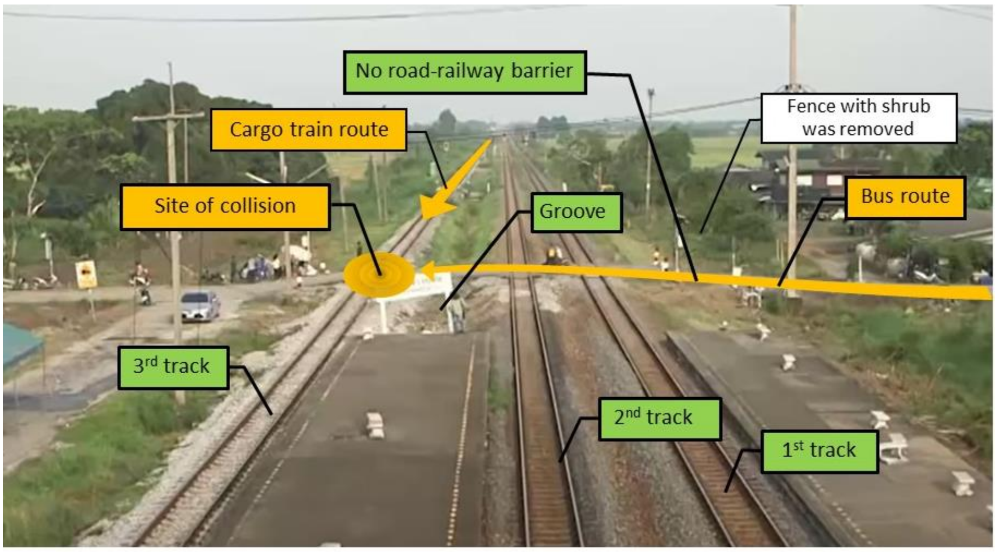

Figure 3. Site of the bus-train collision in Chachoengsao Province, 13 Oct 2020[9]

Vehicles

The bus was registered as a bus with 42 seats, one floor, two doors, six wheels, and no toilet. The license had already expired on 30 Sep 2020, and the last documented maintenance was on 30 Sep 2019 which should be annual maintenance. We found the leaf spring (load resisting part of the bus) was adapted to transport more passengers. Every seat had its own belt. The driver's window had limited visibility due to stickers and black film used for sunscreen. After the collision, six of 19 bottom seat cushions had been separated from their seat base. Large significant damage in front of the bus was observed. The back roof was torn off and seats in the back were destroyed by a 1-meter-deep groove between the 2nd and 3rd railway that kept the back of the bus crashing on the railway from reviewing the closed-circuit television. Nearby witnesses heard the train whistle and loud music from the bus. The survivors reported the bus turning on loud music while crossing the intersection. A passenger sitting next to the driver did not hear the train whistle.

Cargo train number 5102 was 493 meters long and weighed 2,000 tons. Its speed before the crash was 70 km/h. The train had an emergency brake distance of 600-1,000 meters.

Drivers

The bus driver was a 50-year-old Thai man, with 30 years of driving experience, and no history of underlying disease nor history of drinking alcohol. A tour manager reported that the route was not the driver's regular route.

From reviewing the interview-video-clips from the news, the train driver saw the bus driving slowly across the intersection at 300 meters distance before the crash, then he turned on a warning light and blew the train whistle as well as started the emergency brake.

Haddon's matrix applied to this bus-train collision is shown in Table 4.

Table 4. Haddon's matrix applied to the bus-train collision, Chachoengsao Province, October 2020

	Human	Vehicle	Environment

Pre-crash	**Driver**
	• Unusual route for the driver
	• Driver may not hear the train whistle
	  • Loud music on the bus
		Bus
		• Limited visibility from the driver's window
		  • Stickers and black film
			• Broken warning signal
			• No railway barrier
			• Obstructed visibility (trees & shrubs)
			• 30° slope of uphill road

Crash	**Passenger** • Used alcohol • Standing and dancing • No seat belt	**Bus** • Passengers overloaded • Back roof ripped off **Train** • Heavyweight with speed of about 70 km/h	• 1-meter-deep groove between the 2nd & 3rd railway (making the back of the bus crashed on the railway)
Post-crash		**Bus** • Bus flipped right side down • Collapsed bus structure	• Drizzling • Appropriate life support (ALS) arrived on the scene 30 minutes after crash • Long iron fence obstructed rescue team • Rescue cars stuck in heavy traffic

Discussion

Almost half of road-railway intersection accidents in Thailand have occurred at illegal crossings.[2] Our findings were concordant with previous reports showing factors related to road-railway intersection accidents included less awareness while crossing the intersection, limited or obstructed visibility, and the crossings had improper safety controls.[4] The rainy weather may have reduced the train drivers' visibility. Once he noticed the bus and switched on the train whistle, the distance to the bus was too short to completely stop the train, even with the emergency brake. Since we observed the bus was traveling at a steady speed crossing the railroad tracks and a passenger nearby the bus driver reportedly did not hear the train's whistle, together with limited visibility from the bus window, we believe the bus driver may not have been aware of the train.

The case fatality rate in this event (25.4%) was higher than the 5-year median case fatality rate of total road traffic injuries in Thailand (14.8%)[2] and was the most fatal bus-train collision event in Thailand since 2002.[2,3] The bus from this event was carrying almost double the number of passengers allowed for the bus registration. Hence, the passengers sitting on the bus were not seated properly and 18 passengers had to stand while traveling. We found passengers who were standing on the bus during the crash were over six times more at risk of death than those who were sitting. None of the passengers fastened seat belts, despite their availability. Not wearing a seat belt has been found to be associated with severe head injury and death,[10] similar to previous studies of bus collisions[11,12] in which the head and neck were the most commonly injured area of the body. One study showed wearing a seat belt could reduce the probability of being killed by 25% for passengers.[13]

The site of the collision was 20 kilometers from the provincial hospital. The time between the crash and the first EMS arrival was 30 minutes. It was late compared to the standard response time in Thailand, which is eight minutes for EMS to reach an emergency patient after being notified.[14] The delayed EMS arrival might have contributed to the high fatality rate. However, given the severity of the injuries and causes of death, rapid resuscitation still might not have increased their chances of survival.

There were some limitations in our investigation. First, information about passengers who died was mainly provided by the survivors. This might lead to information bias including misclassification of exposure, nonetheless we validated the information with several passengers. In addition, the autopsy did not explore internal organs, which might result in lower ISS among the deaths. Lastly, information gathered from the train driver was limited to what was available from interview by the news reporters, and it was not possible to validate the responses.

Conclusion and Recommendations

This bus-train collision resulted in 18 deaths and 53 injured cases. Multiple factors, including the unusual route for the bus driver, loud music, low visibility and lack of safety measures at an illegal intersection, probably contributed to this event. The Chachoengsao event demonstrates that bus-train collisions can be substantially more fatal than other types of road traffic injury,[15] and as such, adequate safety measures should be implemented for all road-railway intersections in Thailand.

We recommend additional safety regulations for noise limits on public transportation to ensure drivers and passengers can maintain optimal levels of awareness of the surroundings. In addition, regulations regarding public bus licensing, number of passengers, seatbelt use, and driver's visibility should be strictly implemented. Office of Land Transport should promote fastening a seat belt on public transportation (especially long-distance routes) and limit standing on the buses (especially inter-city buses). Local administrations and State Railway of Thailand should jointly improve safety control for all illegal road-railway intersections including warning signs, adequate visibility, and intersection barriers. The local emergency response protocol should be reviewed to address the delayed response.

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Misperceptions about the Impact of Lockdown on the Number of Newly Reported COVID-19 Cases

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Abstract

Thailand, along with many other countries, was hit by coronavirus disease 2019 (COVID-19). The COVID-19 vaccines were known to be effective in mitigating the spread and preventing deaths. However, Thailand faced a crisis in mid-2021 before the vaccines could disseminated to the population. Thus, the Government introduced a lockdown policy to control the outbreak. However, many questioned the effectiveness of the policy as it did not immediately result in favorable outcomes. Therefore, this study aimed to unravel results of the lockdown using deterministic system dynamics and compartmental models. We found that there was a misperception surrounding the idea that the lockdown policy could reduce the number of newly reported cases within few days. In addition, the epidemic would always continue as long as there were susceptible people remaining in the system. Therefore, the Government needs to consider other supporting policies alongside the lockdown and communicate with the wider public about its objectives.

Keywords: COVID-19, lockdown policy, compartment model, system dynamic, Thailand

Thailand and COVID-19 at a Glance

Coronavirus disease 2019 (COVID-19) has caused many unprecedented consequences to the global population, in terms of health and economic sequalae.[1,2] Thailand is amongst many nations that have been severely hit by the COVID-19 pandemic. It was the first country outside of China to report the presence of cases.

During the first wave of the epidemic, Thailand seemed to be successful in containing the disease through various non-pharmaceutical interventions (NPI). The number of new daily cases in early 2020 never exceeded 200. By the end of the year, the cumulative number of cases was 6,884 with only 61 deaths.[3] However, after the introduction of the alpha and delta variants in 2021, the number of daily cases increased from about 200 in early April to more than 22,000 in August. This caused much concern to the society and many worried that the national health system would collapse.

The COVID-19 crisis in Thailand was exacerbated by the delay of both imported and domestically produced vaccines. Although the national Government regularly delivered campaigns to promote NPI, including social distancing, regular handwashing and face-mask wearing, it appeared that these NPI were not sufficient to contain the outbreak. As a result, the Government introduced a "lockdown" policy on 19 Jul 2021 in the epicenter (Bangkok and its vicinity). The essence of the lockdown was a strict restriction of human mobility, such as prohibition of inter-provincial travel and the closing of schools, restaurants and all public spaces, in addition to rigorous NPI on individuals (100% face-mask wearing in public places).

Prior to the lockdown, the number of cases ranged from about 11,000-12,000 per day with approximately 50-80 deaths. However, on 19 August, a month after the lockdown policy, the number of new daily cases exceeded 20,000 with around 300 deaths per day.

This worsening situation created contentious public debates with many asking if the lockdown measure should be continued. Many scholars and policymakers wondered how a lockdown policy, which has proven to be effective in the past, could be so ineffective. We, therefore, aimed to unravel this mystery through an analysis on a hypothetical dataset.

Model Analysis

We developed a compartmental epidemic model in combination with a system dynamics concept. A susceptible population would be infected once by coming into contact with infectious individuals, hereafter labeled as "exposed". Within an incubation period, the exposed individuals would become infectious. The infectious could then recover with a rate determined by the recovery time.

In any given population, the number of individuals becoming infected each day is difficult to determine accurately. The number of newly reported cases is determined from the number of positive results of the COVID-19 RT-PCR test. A person with a positive RT-PCR would be isolated. Therefore, we added the testing and isolation process into the model.

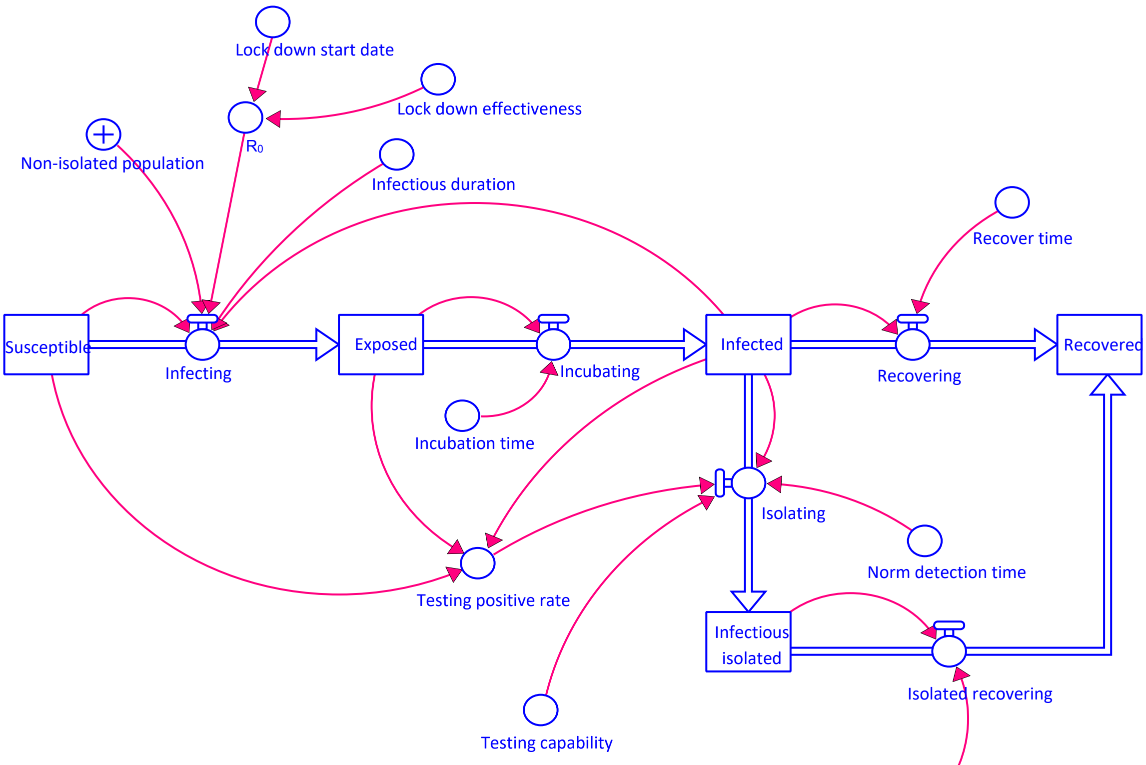
The number of newly reported cases was determined by the following factors: first, the average duration to tracing and testing, and second, the testing capacity. The impact of a lockdown was put into the model through the change in the basic reproductive number (R_0). We added the impact of the lockdown as a percentage reduction in R_0.

We set up a hypothetical dataset with various essential parameters, which are shown in Table 1, to simulate the results. The model framework is demonstrated in Figure 1.

Table 1. Essential parameters of the model

Parameter	Value	Unit
R_0 (hypothetical value)	2	Dimensionless
Number of initial infectees (hypothetical value)	5,000	Persons
Total population of Thailand	60,000,000	Persons
Recovery time[†]	7	Days
Testing capacity[†]	50,000	Persons/day
Detection time[†]	3	Days
Infectious duration[4]	3	Days
Incubation period[5]	5	Days

[†]*Based on the operation of the Thai health system*



Note: Box represents stock (volume) of interested unit (in this case, persons); Blue arrow represents flow of the interested unit between stocks (persons per day); Blank circle represents the value of each external variable (such as R0, infectious duration, and incubation period); Plus circle represents the value of many external variables combined (in this case, non-negative population equates the combination of susceptible, exposed and recovered groups); Red arrow represents the influence of external variable on the flow.

Figure 1. Model framework

Analysis of the Impact of a Lockdown Policy

First, we simulated a model without a lockdown policy and no NPI. Figure 2 presents the results of the model. The solid line represents the number of new daily reported cases (left axis), and the dash-dotted line represents the R_0 (right axis). The figure shows that the number of newly reported cases would increase to about 35,000 on day 75 and then gradually decrease to fewer than 10,000 on day 90.

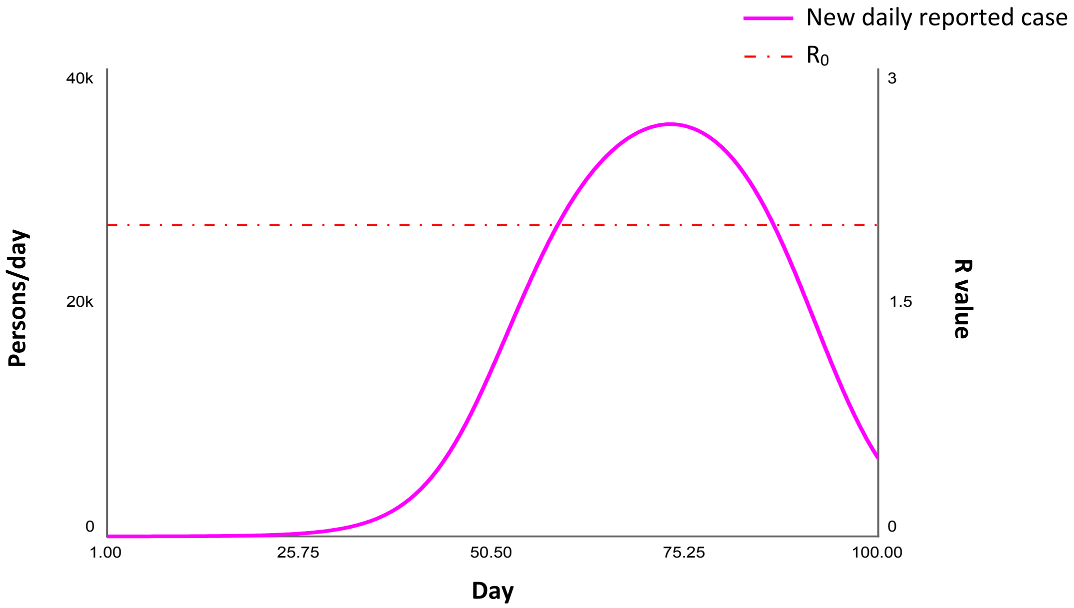


Figure 2. Distribution of new daily reported cases without a lockdown policy

We assumed that on day 45, there were 7,000 newly reported cases. We then simulated another model in which the Government implemented a lockdown policy, which would reduce the R_0 by 30%. Figure 3 presents the results of this model. The number of new daily reported cases would initially increase and reach a peak of about 25,000 cases by about day 70, 25 days after the lockdown started after which the number of cases would begin to decrease.

We performed a sensitivity analysis on the effectiveness of the lockdown policy by varying the percentage reduction in R_0 by 0%, 30%, 50%, and 70%, as shown in Figure 4. In the scenario where R_0 reduced by 50%, the new daily reported cases would reach a peak on day 68 and then start to decline. The time to observe the peak would be put off to later than day 70 with no lockdown policy, if there were susceptible people remaining in the population pool, and R_0 did not decrease below the epidemic threshold value of 1.

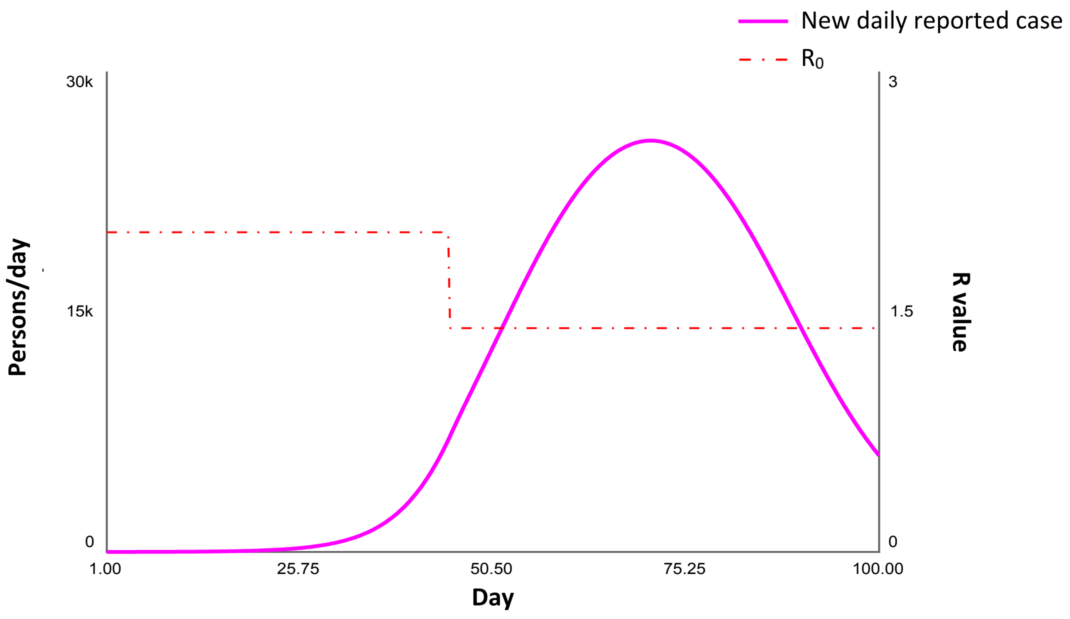
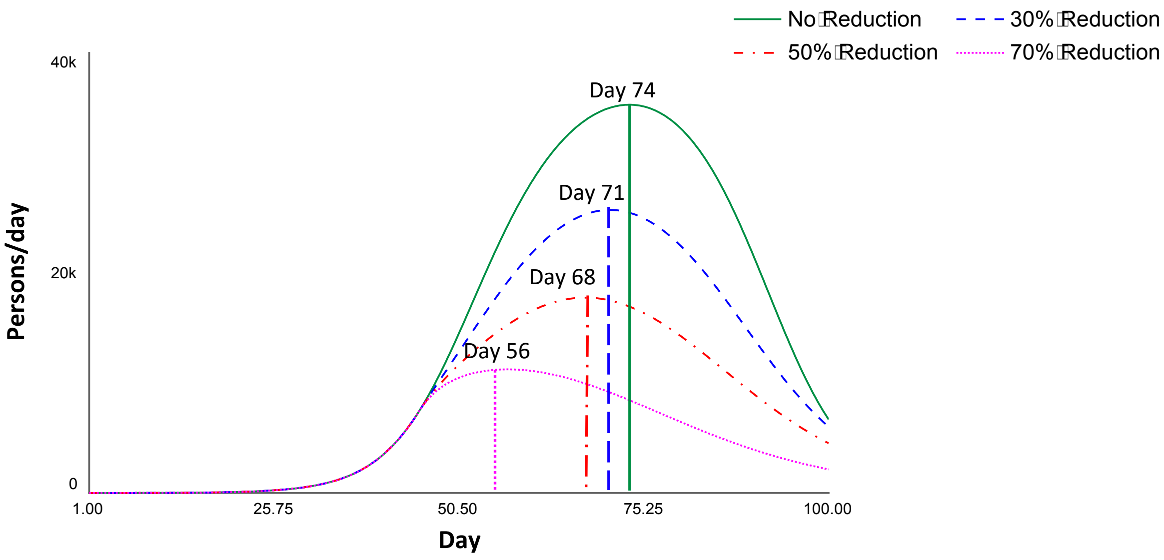


Figure 3. Distribution of new daily reported cases given the implementation of a lockdown policy (effectiveness = 30%)



Note: The peak day of the epidemic for a 0%, 30%, 50%, and 70% reduction occurred on days 74, 71, 68, and 56, respectively.

Figure 4 Distribution of new daily reported cases with the implementation of a lockdown policy by various reductions of R_0

What We have Learnt from the Analysis and Conclusion

Many believed that the lockdown policy in Thailand would reduce the number of newly reported cases within a few days. Our finding shows that this perception is incorrect. In addition, we found that as the effectiveness of the lockdown increases, the peak will not only reduce in magnitude but will occur earlier. In other words, the epidemic will always continue as long as R_0 is larger than one and as long as there is a susceptible population. The bottom line is that if the objective of the lockdown policy is "to buy time" and to delay the period when health resources are used up, the Government needs to consider other supporting policies. These may encompass a massive screening on COVID-19 like in other countries, such as China and South Korea,[6,7] or a rapid scaling up of field hospitals and intensive care units to ensure the health system is better prepared for the coming peak.[8] Thus, the Government should communicate with the wider public about the objectives of the lockdown and set a clear plan on the lockdown policy. This will help enhance the effectiveness of the policy, and at the same time, help harness the collective effort from all sectors in the society to curb the outbreak in the long run.

Ethical Approval

Not required in this study

Competing Interests

Authors declare no conflict of interests

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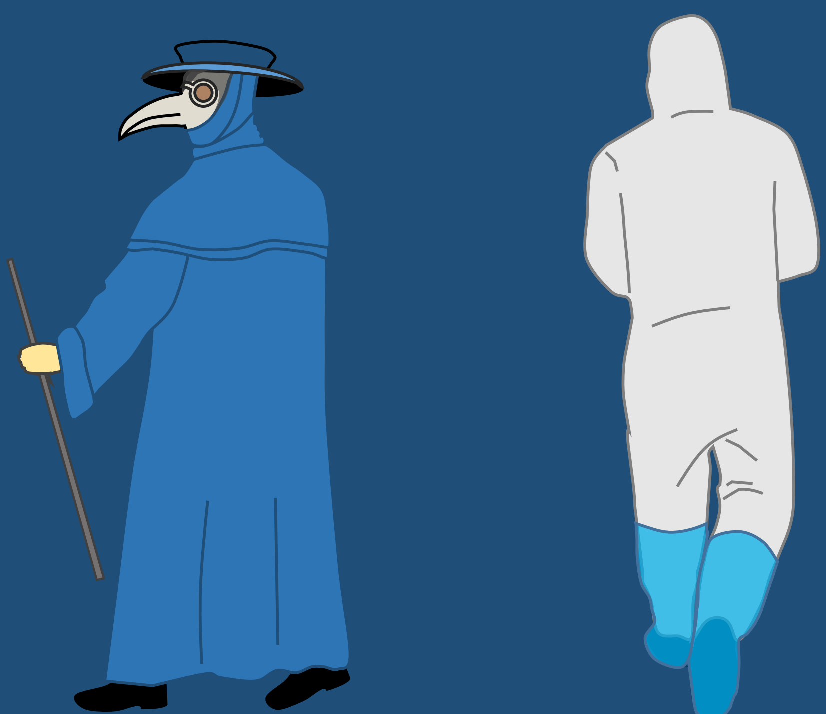

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