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Investigation of a COVID-19 Cluster Suspected In-flight Transmission, December 2020

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Abstract

On 1 Dec 2020, the Thai Department of Disease Control was notified of five COVID-19 infections among passengers on a flight from Switzerland to Thailand. The objectives of this investigation were to confirm the outbreak, describe epidemiological characteristics, and identify the source of infection. We performed a descriptive study and contact tracing among the flight's passengers. We interviewed the cases and reviewed their medical records, as well as an environmental survey of the state quarantine facility. Whole genome sequencing to determine the percentage alignment identity for RT-PCR-positive cases was conducted. Thirteen infected passengers out of 107 people on the flight (12.1%) were identified. The suspected index case was a symptomatic passenger, non-mask-wearing passenger. Five of the 13 confirmed cases shared a similar genomic pattern (98–100% alignment identity), and four cases sat within one row either in front of or behind the suspected index case. The genomes of the cases were more similar to each other than those uploaded to the GISAID database from Switzerland. The symptomatic COVID-19 passenger without mask wearing was suspected to be the source. Mask wearing should be mandated on flight to prevent spreading of respiratory infectious diseases.

Keywords: COVID-19, in-flight transmission, on plane transmission, airplane transmission, coronavirus, respiratory virus

Introduction

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Human-to-human transmission occurs through nasal secretion, phlegm and saliva via airborne droplets in closed space and via fomites. COVID-19 can be prevented by mask-wearing, frequent hand-washing, and physical distancing.[1] Previous studies suggest that the virus can be transmitted during air travel.[2,3] Airlines' measures to control in-flight transmission of COVID-19 include mask-wearing, limited cabin service, in-flight cleaning of sanitary facilities, and ventilation using high-efficiency particulate absorbing filters.[4] Since 6 Jul 2020, wearing masks have been compulsory on public transport across Switzerland, including trains, buses and resort elevator systems. Switzerland's Federal Council announced that wearing masks during flights in and out of Switzerland became compulsory from 15 Aug 2020.[5] Measures to control COVID-19 in Thailand related to international flights in 2020 were as follows: travelers who had fever or respiratory symptoms on arrival would be tested for SARS-CoV-2 at the airport while other travelers would be placed in quarantine facilities for observation of symptoms for at least 14 days from the date of arrival with respiratory samples collected twice for SARS-CoV-2 testing.[6–8]

On 1 Dec 2020, staffs from the Department of Disease Control of Thailand were notified by the Office of Disease Prevention and Control Region 6 Chonburi

that there were five patients infected with SARS-CoV-2 who had traveled from Switzerland on flight LX180 arriving at Suvarnabhumi Airport on 25 Nov 2020. The objectives of this investigation were to confirm the outbreak, describe epidemiological characteristics of the cases and to identify the source of infection and mode of transmission.

Methods

We applied a descriptive study design. Data collection techniques consisted of interviews with the cases and state quarantine (SQ) center staffs, review of medical records and flight history, and an environmental survey of the SQ center. The cases were interviewed using a semi-structured questionnaire with a focus on their in-flight behaviors and their travel history in Thailand. The flight history of the cases and related passengers, including the travel history on the bus to the quarantine center, was reviewed.

We performed contact tracing of passengers on the flight and in SQ using 'Guideline for Surveillance and Case Investigation for Coronavirus Disease 2019 (COVID-19)' version 15 (on May 2020) by the Department of Disease Control, Thai Ministry of Public Health.[9] We defined a confirmed case as a passenger or cabin crew in this fight that tested positive for SAR-CoV-2 by multiplex reverse transcription-polymerase chain reaction (RT-PCR) from at least one certified laboratory in Thailand during 21 Nov to 9 Dec 2020. A close contact was defined as any person interacting with a confirmed case within a one-meter distance for at least five minutes, or being coughed or sneezed on, or seated within two rows with a confirmed case. A close contact was further categorized as high risk if they took their face mask off during the flight or low risk if they wore their face mask continuously during the flight, except while eating and drinking.

We performed a laboratory study and a brief environmental survey. For the laboratory study, the cases undertook a nasopharyngeal swab to test for genetic materials of SARS-CoV-2 by RT-PCR from a certified laboratory designated by the Department of Medical Sciences. A positive result was defined as a cycle threshold value of less than 40. All positive samples were sent to the National Institute of Health of Thailand or Thai Red Cross Emerging Infectious Diseases Health Science Centre, Chulalongkorn Hospital for whole genome sequencing (WGS) with a genome size of 29,903 base pairs. The nucleotide sequence data of the SARS-CoV-2 viral genome of cases were extracted by the Illumina® MiSeq™ system. We created a DNA substitution and analyzed the molecular evolutionary relationship (phylogenetic tree) using the IQ-TREE program under a maximum likelihood algorithm with bootstrapping using 1,000 iterations and percent alignment identity calculation using Geneious Prime version 2021.2.2. DNA sequence alignments were compared between confirmed cases on the flight using the first case detected at the airport as the baseline. We also compared the confirmed cases with a reference sequence obtained from Swiss SARS-CoV-2 samples, which were uploaded to the Global Initiative on Sharing Avian Influenza Data (GISAID) database in November 2020.[10]

For the environmental study, we interviewed physicians at the SQ, the manager at the hotel, the SQ commander, and infectious disease nurses about their infection control processes, including transportation hygiene and cleaning methods, using a semi-structured questionnaire. An environmental survey at the SQ was done by non-participant observation using 'Guidance for Integrated Management of State Quarantine Facilities' by the Thai Ministry of Public Health.[8]

For the descriptive analysis, categorical data were presented as frequency and percentage, while continuous data were presented as median and interquartile range.

This investigation was performed under a public health emergency. The names of participants were not collected. Invasive techniques were not used and all participants willingly and verbally gave their informed consent to participate.

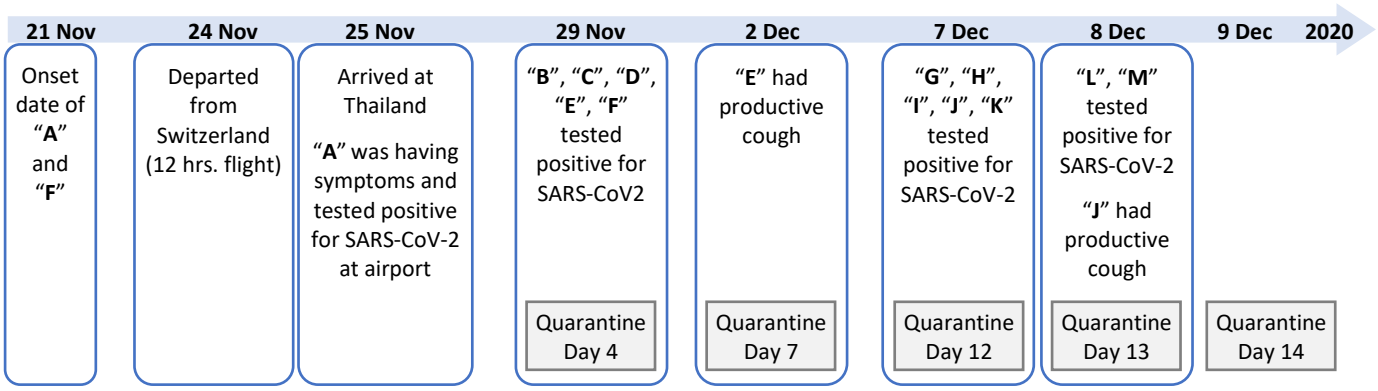
Results

Descriptive Characteristics of the Cases

Swiss airlines flight LX180 departed from Zurich Airport on 24 Nov 2020 and arrived in Bangkok on 25 November. The flight time was approximately 12 hours. One meal was served on the flight, which contained a total of 107 people including two pilots, seven flight attendants and 98 passengers, of which 11 were seated in first/business class and 87 in economy class. All passengers had negative results of COVID-19 testing via RT-PCR within 72 hours before the flight.

Only 13 passengers from the economy class were tested positive and diagnosed with COVID-19 during 21 Nov to 9 Dec 2020. The crude attack rate for the whole flight was 12.1% while the attack rate among all passengers was 13.3% and the attack rate among passengers seated in economy class was 14.9%. twelve of the 13 cases were female. The median (interquartile range) age among cases was 56 (48–61) years and most were housewives. All were admitted to hospital

in a COVID-19 ward and there was no intensive care unit admission. None required oxygen support. Nine of the 13 cases were asymptomatic (69.2%). The four symptomatic cases all had productive cough (30.8%). One case developed other symptoms included diarrhea, runny nose, anosmia, and fever (7.7%). At the time of our investigation, COVID-19 vaccines were not available. Two of the four symptomatic cases developed productive cough on 21 Nov 2020, three days before the flight departed. One of them was the first detected case (case "A") after she was tested positive for SARS-COV-2 at Suvarnabhumi Airport and sent to hospital. The remaining passengers were taken to a SQ center for 14 days and tested for SARS-CoV-2. Five passengers ("B"–"F") tested positive for SARS-CoV-2 on 29 November (day 4), five ("G"–"K") tested positive on 7 December (day 12), and two ("L" and "M") on 8 December (day 13). A timeline of symptoms development among these 13 cases is shown in Figure 1.



Note: SARS-CoV-2 testing of "L" and "M" on day 12 was inconclusive; their specimens were recollected on day 13.

Figure 1. Timeline of COVID-19 development among 13 passengers (A–M) on board flight LX180 from Switzerland

The flight's economy class seating plan is presented in Figure 2. Thirty-five passengers were seated within two rows of case "A". Of which, 14 had symptoms before travelling and 21 did not. Among these 14 pre-flight symptomatic and 21 asymptomatic passengers, the attack rates were 36% (5/14) and 5% (1/21), respectively.

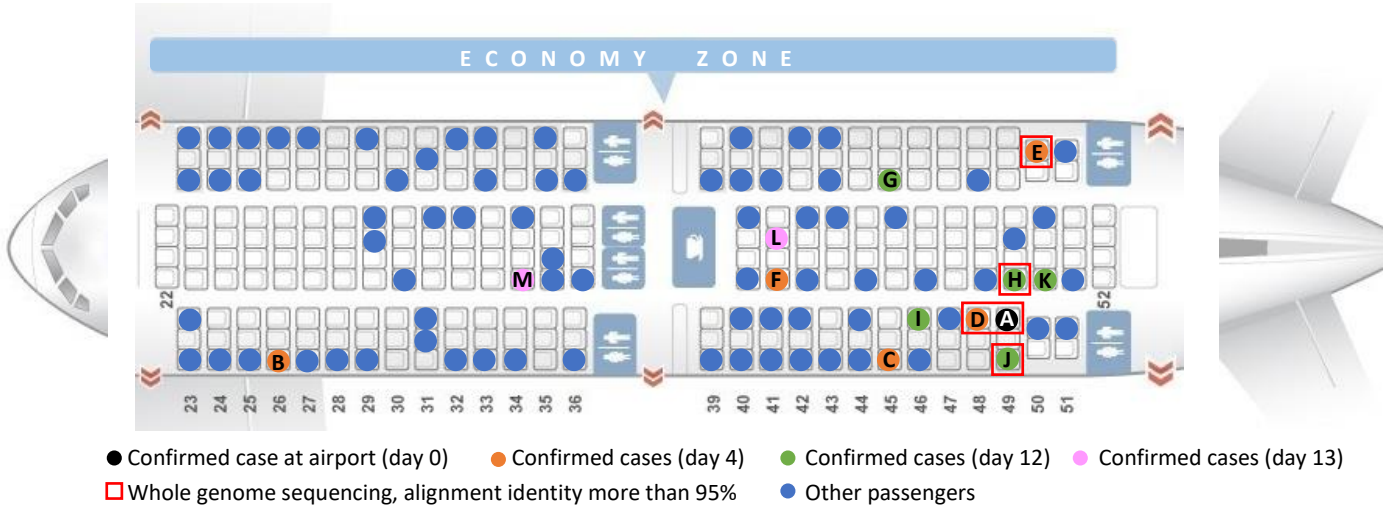


Figure 2. Seating plan of economy class on board flight LX180 from Switzerland

Exposure History

The 13 confirmed cases were from 13 different cities in Switzerland and had never known or met each other before boarding the plane. None of them had a contact history with any confirmed COVID-19 case in Switzerland. All cases visited supermarkets or department stores once or twice within two weeks before boarding the flight.

Case "A" had productive cough and sneezing during the flight. She often took off her face mask during mealtimes, after coughing and sneezing, and while she was talking to other passengers. Other passengers said that she talked to other passengers on the airplane frequently. Other passengers wore their face masks all the time, except during mealtimes. Case "F", the other case who had symptoms before travelling, did not talk to any passengers or go to the toilet. Passengers seated

in row 46 and behind used toilets at the back of the airplane, while the others used the ones in the middle.

The passengers travelled to the SQ center by bus, adhered to physical distancing restrictions, and always wore their face mask. At the quarantine center, none of the cases had any physical contact with each other. All stayed in their room, except during the registration process and specimen collection when they met SQ staffs, who were wearing full personal protective equipment (hair net, face-shield, N95 mask, gown or coverall, gloves, shoes or leg covers). Everyone had to self-monitor their symptoms and report if they developed any symptoms to SQ staff by phone. Communal places were cleaned every one to two hours. The SQ staff supervisor worked to prevent transmission within the SQ. None of SQ staff developed any symptoms within 14 days after contacting with those cases.

Laboratory Result

Ten of 13 were tested by WGS. Nine of them had results of CT values less than 30. Laboratory results showed that all 13 cases had the GH clade. The first case, "A", was most like case "D", who was seated directly behind and talked to case "A" on the plane, with 100% identity. The likeness of case "A" with cases "E"," H", and "J" was 98%. The sequences of cases "D", "E", "H", and "J" were closer to case "A" than other Swiss SARS-CoV-2 sequences that were uploaded to the GISAID database. The phylogenetic tree of cases "A", "D", "E", "H", and "J" are shown in Figure 3, and the laboratory results are shown in Table 1.

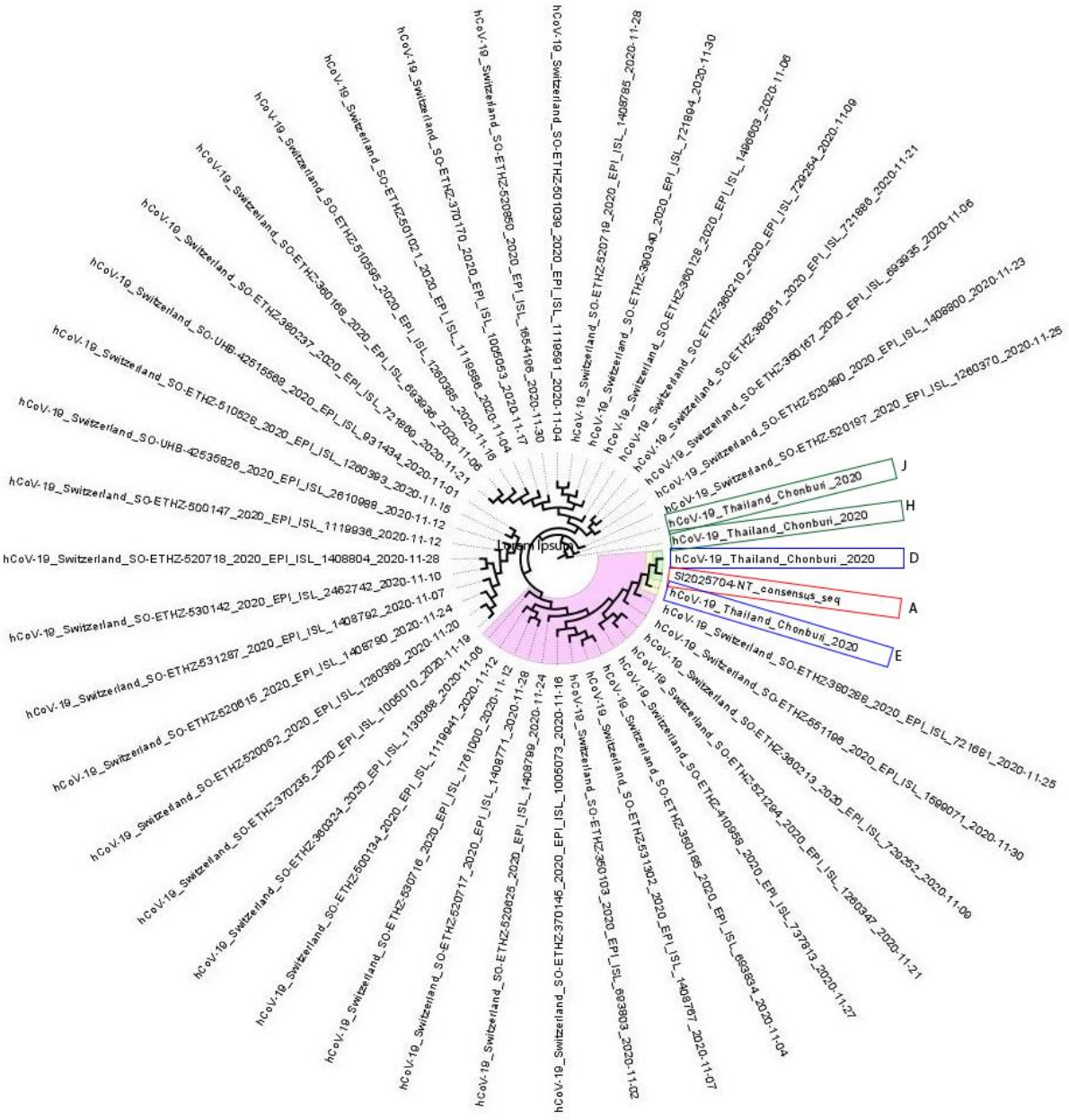


Figure 3. Phylogenetic tree of five positive COVID-19 cases on board flight LX180 from Switzerland

Table 1. Laboratory results of 13 COVID-19 cases on board flight LX180 from Switzerland

Case	Laboratory positive date in 2020	Day after arrival	N gene	ORIF1ab gene	Seat	Onset of symptoms	Alignment identity	Departed city
A	25 November	0	21.61	E gene=18.23	49C	21 November	Baseline	Solothurn
B	29 November	4	17.33	17.89	26A	-	85%	Rheinfelden
C	29 November	4	27.7	27.2	45A	-	85%	Zurich
D	29 November	4	11.35	11.84	48C	-	100%	Martigny
E	29 November	4	18.33	17.95	50K	29 November	98%	Bern
F	29 November	4	30.38	30.17	41D	21 November	85%	Lausanne
G	7 December	12	25.46	22.56	45H	-	85%	Montreux
H	7 December	12	24.76	22.47	49D	-	98%	Neftenbach
I	7 December	12	24.47	22.27	46C	-	92%	Wurenlos
J	7 December	12	24.62	22.36	49A	8 December	98%	Grenchen
K	7 December	12	32.60	30.81	50D	-	85%	Bern
L	8 December	13	38.68	36.47	41F	-	-	Schwyz
M	8 December	13	38.69	34.86	34D	-	-	Zurich

Discussion

This COVID-19 outbreak on a 12-hour flight consisted of 13 confirmed cases seated in economy class with limited in-flight service. Five of these 13 cases shared both epidemiological (seated in the same row or 1 row in front or behind and talking to a symptomatic case) and laboratory linkages to the index case (case "A"). All of their samples had the GH clade and nine were asymptomatic. This in-flight cluster was slightly different from that reported by Hamed et al on the global dynamics of SARS-CoV-2 clades and their relation to COVID-19 epidemiology where 49% of cases found to be infected with GH clade were mild or asymptomatic.[11] On the other hand, all cases in this outbreak were mild or asymptomatic, probably because the severe cases could not travel abroad.

Two of the 13 cases had symptoms before travelling. Thus, these cases were likely to be infected before they boarded the plane. The attack rate among close contacts (passengers seated within two rows in front and behind) of the index case was higher than the attack rate among close contacts of another symptomatic case (case "F") seated eight rows back. Case "A" was therefore the most likely person to have spread the disease to the other passengers. This passenger had symptoms such as productive cough and sneezing during the flight and talked to other passengers without wearing a mask. A study in China suggested that symptomatic cases were more likely to spread COVID-19 than asymptomatic cases.[12]

A meta-analysis suggested that face mask wearing could significantly reduce the risk of SARS-CoV-2 infection (odds ratio 0.44, 95% CI 0.21–0.93, I^2 52.0%).[13] An experimental study of respiratory virus shedding in exhaled breath and efficacy of wearing face masks reported that coronavirus in respiratory droplets and aerosols in samples collected from ten infectious participants who were not wearing face masks, while they did not detect any of the virus in respiratory droplets or aerosols collected from the participants when they were wearing face masks.[14] These studies suggest that wearing a face mask is a key for preventing the spread of contagious diseases.[15] Moreover, they support the evidence that the first case who often taking mask off could be the cause of the spreading in this flight.

A study investigating the transmission of SARS-CoV-2 during a long flight in 2020 found that among the 16 persons in whom SARS-CoV-2 infection was detected, 12 were passengers seated in business class together with the only symptomatic person and the attack rate was 62%. Seating proximity was strongly associated with increased infection risk (risk ratio 7.3, 95% CI 1.2–46.2).[3]

In this study, we assumed that transmission of SARS-CoV-2 during a flight could occur within one row in front and behind of the index case. In-flight transmission occurs due to laminar airflow in which air enters the cabin from overhead inlets and flows downward toward the floor level outlets at the same and nearby rows. A study by Pombal and Hosegood showed that, in a modern airplane used in commercial flight nowadays, air flows mostly within the rows—the amount of air flowing between the rows is low. Thus, the chance of transmission between rows on a plane is minimal.[3] Another study investigating in-flight transmission of SARS-CoV-2 in Hong Kong suggested that cases from different countries belonged to the

same in-flight transmission chain with 100% identity across the near full-length viral genomes (sequence length ≥29,760 nucleotides).[2] Another study found that the risk of infection in aircraft lavatories is low.[16]

On this flight, cases "D", "E", "H", and "J" were closer to case "A" than other Swiss SARS-CoV-2 sequences uploaded to the GISAID database. They all had alignment identity 98% and 100% matched. Therefore, they were likely to be infected by case "A". For other cases, we could not determine the source of their infection. They could have been infected during the flight or before boarding the plane because all of their samples belonged to the GH clade and they all came from Switzerland.

According to the interviews, the SQ staff followed the standards of the Guidance for Integrated Management of State Quarantine Facilities of the Thai Ministry of Public Health. There was no high-risk contact in the facility since there were no confirmed cases that met other passengers.[7] The risk of infection on the way to and at the SQ was low and less likely to be a source of infection.

Limitations

There are a few limitations in this study that should be mentioned. First, there is a lack of agreement concerning the cut-off value for alignment identity of WGS for SARS-CoV-2 for determining the source of infection. We assumed that as the percentage of alignment increases, the likelihood that the infection was from the same source increases. Second, we could not conduct a direct environmental survey on the plane nor interview airline staff. However, we did interview some of the passengers, although memory bias might be an issue as some activities, especially mask wearing and hand washing, happened long before the diagnosis was confirmed. We attempted to minimize this bias by triangulating the interview data with various other sources which were other passengers and state quarantine staff.

Public Health Recommendations

The governments of all countries should communicate with their citizens abroad and emphasize the importance of risk-minimizing behaviors such as mask wearing and physical distancing at all times, particularly during the flight and upon arrival in the destination country. Mask wearing on the flight should be mandatory to reduce the risk of spreading any respiratory infectious diseases.[17] In-flight high-risk contact tracing for any respiratory infectious disease should be performed on passengers seated within one row in front and one row behind the index case, including passengers seated across the aisle. Symptomatic cases should be screened on arrival at the airport to isolate suspected cases. Contact tracing of high-risk contacts should also be conducted. Even though COVID-19 may not be a serious public health threat anymore due to the vaccination, these control measure could be adapted to other emerging respiratory infectious diseases. SQ prevented transmission of the new emerging respiratory infectious diseases from abroad to community. SQ centers during the early of pandemic without vaccination or specific and effective treatment such as antiviral drugs would prevent the emerging of large clusters of cases.[18]

Conclusion

We investigated a cluster of COVID-19 cases on a 12-hour flight from Switzerland to Thailand in December 2020. There were 13 passengers infected, giving a crude attack rate of 12%. All of the cases were from different cities in Switzerland. Five of the cases shared a very similar genomic pattern (98–100% WGS alignment identity). A symptomatic COVID-19 passenger not wearing a mask was suspected as the source, supported by epidemiological and laboratory findings. The Thai government should communicate with its citizens to emphasize the importance of mask wearing and practicing social distancing when living abroad. Mask wearing on all flights should be mandatory during the early of pandemic where effective vaccination or specific and effective treatments are not available.

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Suggested Citation

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