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Brief Communication

Taiwan’s COVID-19 response: Timely case detection and quarantine, January to June 2020

Hao-Yuan Cheng a, Yu-Neng Chueh a, Chiu-Mei Chen a, Shu-Wan Jian a, Shu-Kuan Lai a, Ding-Ping Liu a,b,*

a Taiwan Centers for Disease Control, Taipei City, Taiwan
b National Taipei University of Nursing and Health Sciences, Taipei City, Taiwan

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The coronavirus disease 2019 (COVID-19) pandemic has become severe threats to economic, societal, and healthcare systems. To analyze the epidemiological characteristics of the COVID-19 outbreak in Taiwan and evaluate the key interventions, we conducted a retrospective cohort study during January 17 to June 30, 2020. As of June 30, the COVID-19 outbreak, including 447 laboratory-confirmed cases, was eliminated by mixed approaches: border control, enhanced surveillance, case detection with contact tracing, quarantine, and population-based interventions like face mask use. The improvement of median time from disease onset to notification (5 days [range 3 to 27] before March 1 to 1 day [range 0 to 2] after March 1) suggested the timeliness and comprehensiveness of surveillance and contact tracing. Travel restrictions with quarantine, resulting in fewer clusters, were also complementary to minimize disease spread. Under combined interventions, Taiwan successfully contained the COVID-19 spread within the country and minimized its impact on the society.

Introduction

After the coronavirus disease 2019 (COVID-19) outbreak identified in Wuhan city, China in December 2019, it has spread worldwide within three months. Before March 2020, in response to the outbreak in China, Taiwan relied on sensitive surveillance systems and timely interventions like contact tracing to contain the community outbreak. From the beginning of the outbreak, Taiwan Centers for Disease Control (Taiwan CDC) gathered epidemic intelligence via the event-based surveillance systems.1,2 The daily-updated epidemic intelligence worldwide and corresponding risk assessment were tailored down to the sub-national level if...
necessary. Visualization dashboards were used to monitor the progress of the outbreak in individual areas. The criteria of announcing travel alerts for countries/areas with widespread community outbreaks included: the surge of daily increase in newly-confirmed cases, the increase of cumulative number of confirmed cases, outbreaks in congregated settings (e.g., prisons, long-term care facilities, and hospitals), particular interventions taken by local governments (e.g., lockdown or shelter in place), and the travel volume between Taiwan and the individual countries/provinces/areas. Using this framework, the Central Epidemic Command Center (CECC) gradually announced the travel notice to Guangdong and Zhejiang province and eventually announced level 3 travel notice to the whole mainland China, Hong Kong, and Macau on February 6, 2020. For citizens returning from countries with level 3 travel notice, they required to undertake 14-day quarantine, at home or quarantine centers. The entry of foreigners from countries with level 3 travel notice was temporarily banned.

In Taiwan, the case detection relied on adapting the extant surveillance systems. The case definition of notifiable disease surveillance, especially the epidemiological criteria, evolved corresponding to the progress of both the pandemic and epidemic situation in Taiwan (Fig. 1). When the number of locally-acquired cases accumulated in February, enhanced laboratory surveillance, which tested the respiratory samples from clusters of respiratory diseases and patients with suspected novel influenza A infection and severe influenza infection, were implemented. Eventually, ongoing community transmission ceased by timely case detection and comprehensive contact tracing efforts in February–March. However, the epidemic rapidly spread to European countries and the United States from March. On March 19, the CECC banned the entry of foreigners with few exceptions and announced level 3 travel notice to the whole world two days later. The number of imported cases peaked in mid-March and soon declined after these measures were implemented. This report analyzed the epidemiological characteristics of the confirmed patients in COVID-19 outbreak in Taiwan and evaluated the key interventions, such as enhanced surveillance and corresponding quarantine measures.

Patients and methods

We conducted a retrospective cohort study and enrolled the laboratory-confirmed COVID-19 cases in Taiwan during January 17–June 30. All cases were laboratory-confirmed by polymerase-chain-reaction (PCR) test. The demographic, epidemiological, and clinical information were retrieved from the National Notifiable Disease Surveillance System database and the epidemiological investigation reports. To evaluate the timelines of COVID-19 surveillance, we calculated the elapsed time from disease onset to notification (time to detection). The time to detection smaller than zero suggested pre-symptomatic detection. The number of the following clusters and the cluster size were calculated to compare the impacts of these interventions.

![Figure 1: Daily number of confirmed COVID-19 cases by date of onset — Taiwan, January 17–June 30, 2020 (n = 421). Twenty-six asymptomatic cases were not included.](https://example.com/figure1.png)

COVID-19, coronavirus disease 2019; travel hx, travel history. The case definition, especially the epidemiological criteria, evolved corresponding to the progress of the COVID-19 pandemic and epidemic situation in Taiwan. The list of level 1 and level 2 epidemic areas were adjusted according to the risk of exporting COVID-19 cases to Taiwan. Level 1 epidemic areas included Hubei (from January 25, 2020), Guangdong (February 8), Henan and Zhejiang (February 15); level 2 epidemic areas included Guangdong (February 2), Zhejiang (February 5), and the whole mainland China (February 6).
As part of the public health response and surveillance purposes, information collection was done by the pronouncement of the CECC. Institutional review board approval and informed consent were waived. All data were de-identified before analyzed.

Results

On January 21, the first COVID-19 case, a 55-year-old female returning from Wuhan, was identified. As of June 30, 447 COVID-19 cases were confirmed; 7 died (case fatality ratio: 1.6%). Of the 447 cases, 356 were imported, 55 were locally-acquired, and 36 were in an outbreak of naval crew members (Table 1). The median age was 31 years (range 4–88 years). Among these, 308 (68.9%) were asymptomatic or had a mild illness, 101 (22.6%) had pneumonia, and 38 (8.5%) had severe pneumonia or acute respiratory distress syndrome (ARDS). Thirty-nine cases (8.7%) were asymptomatic at diagnosis, and 13 cases (2.9%) developed symptoms afterwards (pre-symptomatic diagnosis). Twenty-six (68.4%) of the patients with severe pneumonia or ARDS had underlying diseases. A total of 59 clusters accounted for 235 (52.6%) cases; Fifty-four clusters (91.5%) were related to imported cases. Five locally-acquired clusters without linkage to imported cases or other infection sources were contained soon after detection and resulted in cluster sizes ranging from 2 to 9 cases. No locally-acquired cases had been found after April 11, except for an outbreak with 36 cases on a Taiwanese navy ship in late April.

By onset dates, cases peaked during Mar 16–20 (Fig. 1). In the first stage (response to the outbreak in China, during January to February), among the 46 confirmed cases, 20 (43%) were imported, mostly from China (12 of 20, 60%), especially Wuhan city; In the second stage (response to pandemic after March 1), of the 336 (92.1%) imported cases, 91 (27.1%) were from the United States and 72 (21.4%) from the United Kingdom. Patients found in the first stage were older, had more underlying diseases, more severe, and had a longer time to detection, compared to those identified in the second stage (Table 1). The median of time to detection for confirmed cases was 1 day (range –8 to 27 days); For imported cases, the median time to detection decreased from 2 days (range 0–10 days) at the first stage to 1 day (range –7 to 26 days) at the second stage; For locally-acquired cases it decreased from 10.5 days (range –7 to 26 days) to 3.5 days (range –3 to 27 days). For those found by case detection, the time to detection of the imported case was shorter than that of locally-acquired cases (median 2 days [range 0–22] vs. 6.5 days [range 0–27]).

Table 1  Demographic and clinical characteristics of confirmed COVID-19 patients — Taiwan, January 17–June 30, 2020 (N = 447).

|                          | Total       | 1st stagea  | 2nd stagea  | Naval crew members |
|--------------------------|-------------|-------------|-------------|--------------------|
|                          | (Jan 17–Feb 29) | (Mar 1–Jun 30) |             |                    |
| No. (%)                  | 447 (100)   | 46 (10.3)   | 365 (81.7)  | 36 (8.0)           |
| Age, median (range)      | 31 (4–88)   | 52 (11–88)  | 31 (4–80)   | 24.5 (21–41)       |
| Gender                   |             |             |             |                    |
| Male                     | 223 (49.9)  | 18 (39.1)   | 173 (47.4)  | 32 (88.9)          |
| Female                   | 224 (50.1)  | 28 (60.9)   | 192 (52.6)  | 4 (11.1)           |
| Source of infection      |             |             |             |                    |
| (n = 411, 36 naval cases were excluded) |           |             |             |                    |
| Imported                 | 356 (86.6)  | 20 (43.5)   | 336 (92.1)  | —                  |
| Locally-acquired         | 55 (13.4)   | 26 (56.5)   | 29 (7.9)    |                    |
| Underlying diseasesb     |             |             |             |                    |
| Yes                      | 103 (23.0)  | 24 (52.2)   | 72 (19.7)   | 7 (19.4)           |
| No                       | 341 (76.3)  | 22 (47.8)   | 290 (79.5)  | 29 (80.5)          |
| Unknown                  | 3 (0.7)     | 0 (0)       | 3 (0.8)     | 0 (0)              |
| Clinical severity at diagnosis |         |             |             |                    |
| Mild illness/Asymptomatic| 308 (68.9)  | 23 (50.0)   | 252 (69.0)  | 33 (91.7)          |
| Mild pneumonia           | 101 (22.6)  | 17 (37.0)   | 81 (22.2)   | 3 (8.3)            |
| Severe pneumonia or ARDS | 38 (8.5)    | 6 (13.0)    | 32 (8.8)    | 0 (0)              |
| Death                    | 7 (1.6)     | 3 (6.5)     | 4 (1.1)     | 0 (0)              |
| Days from onset to notificationc, median (range) | 1 (–8 to 27) | 5 (–3 to 27) | 1 (–8 to 22) | — |
| Days from confirmation to be released from isolation, median (range) | 24 (–1 to 79) | 26 (–1 to 79)d | 24 (5–74) | 22 (7–48) |

Values are no. (%) except as indicated. COVID-19, coronavirus disease 2019.

a  Outbreak stages were classified according to the global epidemic situation. In the first stage (January 17–February 29, 2020), COVID-19 cases were more likely linked to China or locally-acquired cases. In the second stage (March 1–June 30), cases were majorly imported from European countries or U.S. due to the global pandemic. An outbreak among naval crew members was excluded from the group of second stage because of its different characteristics.

b  Information retrieved from preliminary case investigation.

c  Some cases were tested positive for SARS-CoV-2 as asymptomatic cases and developed symptoms during isolation.

d  One case was confirmed after death.
A total of 11 clusters were caused by the 55 locally-acquired index cases. For the locally-acquired cases detected through contact tracing or during home quarantine, no further transmission was found. Among the 392 imported cases, 260 were detected outside airports and resulted in another 11 clusters. Of the 260 cases, 65 were detected through surveillance and caused 7 clusters; the other 195 cases were detected during home quarantine, and led to 4 clusters. Those imported-related clusters had smaller cluster sizes compared to locally-acquired-case-related clusters (median 2 persons [range 2–3] vs. 3 persons [range 2–9]).

Discussion

Our experience showed that through a timely case detection (median time to detection: 1 day) and the following contact tracing efforts, the ongoing community transmission could be minimized at the early stage of the outbreak. However, stricter border control and quarantine measures might still be required to prevent the surge of imported cases and the overload of the public health workforce in the pandemic.

The shorter time to detection for COVID-19 patients in Taiwan compared to other countries suggested the better sensitivity of the surveillance system.6,7 The improved timeliness of case detection for locally-acquired cases contributed to the containment of ongoing community transmission, when local outbreaks, which might be caused by undetected imported cases, occurred in February. Cases in pre-symptomatic phase, whose time to detection was less than zero, were detected by testing the contacts in high-risk settings such as household and hospitals. The detection of pre-symptomatic infections revealed the comprehensiveness and effectiveness of case investigation and corresponding quarantine for contacts. These interventions, especially in long-term care facilities and hospitals, played a key role in outbreak control during January–February, when more general travel restrictions and quarantine were not yet implemented.4,6–9

Nevertheless, the surging capacity of contact tracing almost overwhelmed the public health workforce when the number of imported cases surged in March. Besides, travel restrictions alone only reduced multiple introductions but did not stop community spreads completely.10,11 Although the time to detection could be kept short in those imported cases found via case detection, the number of accumulated secondary cases might still pose threats to the community. Our experience showed the home quarantine measures corresponded to the travel restrictions effectively limited the number and magnitude of the following clusters. Previous modeling studies also suggested more general physical distancing measures might be required despite comprehensive contact tracing and corresponding quarantine measures.5,12,13 Besides, our study did not provide the effectiveness evaluation of other population-based interventions, for example, face mask use. In Taiwan, the supply of face mask was secured by implementing a name-based distribution system, control of exportation and increase of domestic production.14 This policy supported the widely face mask use, especially in enclosed space, and had collateral effects on other respiratory disease. By combining travel restrictions, timely case detection, appropriate quarantine measures, and population-based interventions, we could contain the community spread and minimize the health system’s burden.15,16 However, drastic border control with quarantine resulted in tremendous economic damages. When developing the strategy of responding to the next wave, every country should maintain sensitive surveillance systems and consider to establish its grading criteria for calibrating travel restrictions and corresponding quarantine measures to preserve the capacity of public health and health care systems.

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Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article.

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