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Successful control of COVID-19 outbreak through tracing, testing, and isolation: Lessons learned from the outbreak control efforts made in a metropolitan city of South Korea

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ABSTRACT

The first surge of coronavirus disease 2019 (COVID-19) cases began on June 27, 2020 in Gwangju metropolitan city, located in the southwestern part of South Korea, with a population of 1,501,000. Local governments and the Korean Center for Disease Control and Prevention immediately started an epidemiologic investigation and traced the contacts of patients using a wide variety of data sources, including location data from mobile devices, credit card transaction, and closed-circuit television footage. Until July 16, 2020, 138 community transmission cases and 10 infection clusters were identified across the city. Through contact tracing, epidemiologic relatedness was found in 136 (98.6%) of 138 cases. Our investigation showed how the extensive and meticulous contact tracing suppressed COVID-19 outbreak in a populated city.

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has spread very rapidly around the world since it was first reported in Wuhan, China in December 2019 because of its high infectivity, short serial interval, relatively mild symptoms, and infectivity of asymptomatic carriers [1,2]. South Korea has experienced several surges of coronavirus disease 2019 (COVID-19) cases since the first imported COVID-19 case was identified in February 2020 [3]. However, due to continuous contact tracing, extensive testing, and isolation strategies, the incidence of COVID-19 in South Korea remained relatively small compared to other countries, even without lockdown. In addition, meticulous contact tracing provided the valuable information about high-transmission events or locations. A sophisticated strategy to prevent the spread of infection has been established based on this information, and it helped avoid the complete business shut down in South Korea. Here, we reported how the extensive contact tracing and testing uncovered the epidemiological link between COVID-19 cases, and contained a COVID-19 outbreak in a metropolitan city of South Korea.

Methods

COVID-19 infection was confirmed through SARS-CoV-2 real-time reverse transcription polymerase chain reaction assay. Close contacts were defined based on the guidelines developed by the World Health Organization and Korean Center for Disease Control and Prevention (KCDC) [4,5]. Contacts who did not fulfil the criteria for close contacts were classified as other contacts [6,7]. For contact tracing, in-depth interviews were conducted with all confirmed patients. Location data from mobile devices, credit card payment history, and closed-circuit television footage were used for tracing all possible contacts if necessary. When all contacts could not be traced through these measures, emergency alert messages contain-

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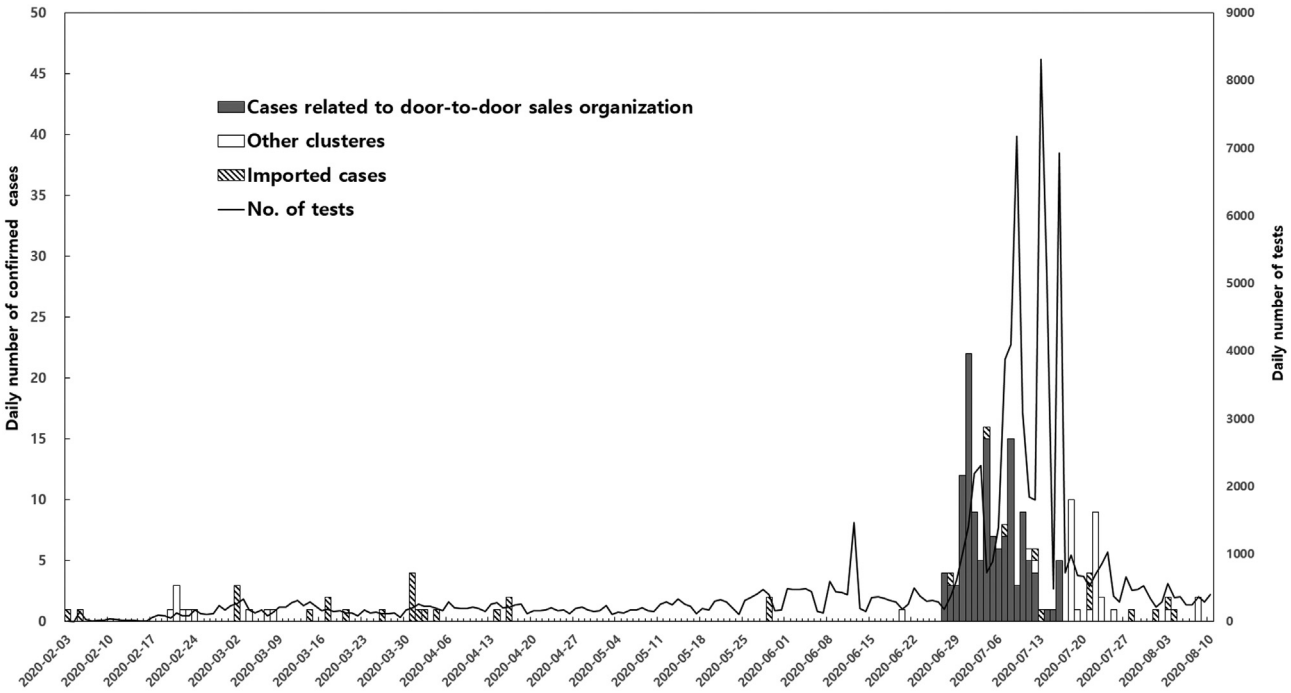

Fig. 1. Daily number of confirmed coronavirus disease 2019 (COVID-19) patients in Gwangju, South Korea from February 2020 to July 2020. From February 3, 2020 to June 16, 2020, 33 confirmed COVID-19 cases were reported. Most of them were imported cases or cases that moved to the Gwangju after being infected in other regions. The community spread of COVID-19 began on June 27, 2020.

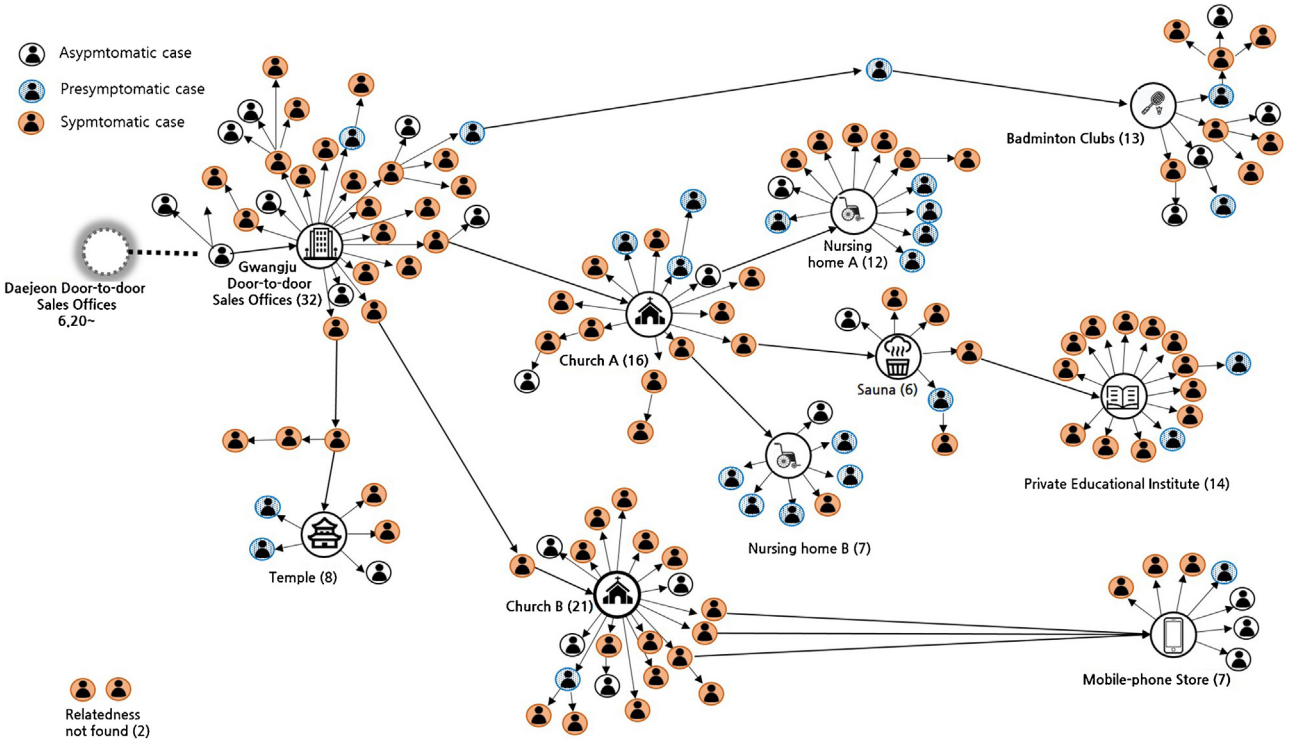

Fig. 2. Transmission route and clusters of coronavirus disease 2019 (COVID-19) in Gwangju, South Korea between June 27, 2020 and July 16, 2020. During a period of 20 days, 138 community transmission cases and 5 imported cases were identified. Through contact tracing, epidemiologic relatedness was found in 136 (98.6%) of 138 community transmission cases. Initially, people related to door-to-door sales organization contracted the infection, which then spread to 10 clusters across the city. Depending on the presence or absence of symptoms at the time of diagnosis, cases were categorized as symptomatic, asymptomatic, and pre-symptomatic cases. Patients who had no symptoms from the time of diagnosis to the end of the isolation period were defined as asymptomatic patients. Patients who had no symptom at the time of diagnosis but developed symptoms during the isolation period were defined as presymptomatic patients.

ing patient's movement route were sent to all community residents through a cell broadcast system; this allowed people who were present in the same place at the same time as the confirmed patient to voluntarily visit screening centers.

Results

From February 3, 2020 to June 26, 2020, only 33 COVID-19 patients were reported in Gwangju metropolitan city. Most of them were imported cases or cases that moved to Gwangju after being infected in other regions; thus, true community spread had not been reported until June 26, 2020. The surge of COVID-19 cases began on June 27, 2020. Local government and the KCDC formed a joint response team immediately, launched an epidemiologic investigation, traced the contacts of patients, isolated patients with confirmed COVID-19, quarantined close contacts, and performed large-scale testing all over Gwangju and the surrounding area to identify potential cases. Subjects for tests included contacts identified through investigation, all residents who reported themselves having overlapped movement route with confirmed patients, all citizens with any suspicious symptoms, and high risk groups such as all residents and workers in nursing homes, long term care hospitals, the disabled residential facilities, mental health facilities, and closed wards of mental hospital. From June 27, 2020 to July 16, 2020, 63,175 tests were performed, and a total of 3,630 close contacts were identified and asked to self-quarantine for 2 weeks. During quarantine period of close contacts, subjects were monitored for symptom development and compliance with self-quarantine rules by assigned local government case officers twice a day via phone. "Self-quarantine safety protection" smart phone app developed by Ministry of the Interior and Safety were also utilized for monitoring. In addition, 9,554 other contacts were monitored actively for symptoms twice a day by local health authorities without quarantine. Due to these multifaceted containment efforts, the number of COVID-19 patients declined sharply since July 16, 2020. Until July 16, 2020, there were total 143 confirmed cases, including 138 community transmission and 5 imported cases. Among the 138 cases of community transmission, 9 (6.5%) patients, including the index patient of the outbreak, were identified after visiting hospitals or screening centers because of their symptoms, regardless of the epidemiologic link; the other 129 cases (93.5%) were identified by contact tracing. After this period, few new cases were reported in Gwangju until mid-August 2020 when a new nationwide surge started (Fig. 1).

The extensive epidemiological investigation found relatedness in 136 (98.6%) of 138 community transmission cases identified from June 27, 2020 to July 16, 2020. Early in the epidemiologic investigation, several contacts of the first identified case tested positive for COVID-19. A common feature of these cases was that they met each other often, mainly in the office of a door-to-door sales organization. Several of them reported having symptoms of COVID-19 even before the first identified case reported the symptoms. The location data of the patients' cell phones was obtained from mobile network operators with patients' consent, and it revealed that one of the confirmed patients, who was a door-to-door salesperson in Gwangju, had met an infected person working in door-to-door sales business in Daejeon metropolitan city around June 20, 2020. Daejeon, a city located in the central region of South Korea, had experienced the outbreak related to a door-to-door sales organization in mid-June 2020. Considering the timing of the outbreak in Daejeon (mid-June 2020), the date of their meeting (June 20, 2020), and the beginning of COVID-19 surge in Gwangju (late-June 2020), it seemed that the meeting between these two people started the outbreak in Gwangju. The outbreak started in door-to-door sales organization (n = 32), and transmitted to 16 people in Church A, 12 in Church B, 8 in a temple, and 13 in two badminton clubs. Next, 12 people in nursing home A, 7 in nursing home B, 6 in a sauna facility, and 13 in a private education institute were infected to SARS-CoV-2 due to the patients who were infected in Church A. Seven customers of a mobile-phone store contracted COVID-19 through three patients who were infected in Church B (Fig. 2).

Conclusion

This outbreak investigation showed that 98.6% of COVID-19 patients who were detected during a period of 20 days in a populated city were linked by one epidemiologic link. Moreover, this epidemiologic relatedness was detected through immediate and meticulous contact tracing. The infection clusters identified in our investigation included door-to-door sales organization, religious facilities, nursing homes, sauna, private education institutes and hobby sports group meetings, which represented the hot spots for COVID-19 transmission in South Korea [8]. After South Korea had experienced a large-scale COVID-19 outbreak starting with cases related to a religious group called Shincheonji from February 2020 to March 2020, strong social distancing was enforced. Furthermore, even after restrictions had eased off, people were very careful about mass gathering. However, small-scale gathering then became the key factor in COVID-19 spreading [9,10]. In addition, during the investigation, we found that most of patients were not able to follow key principles for preventing infection, such as keeping distance and wearing a facial mask at all times, because they had been working together for long period of time in confined spaces and ate together often. Knowing the transmission pattern of infectious diseases is important to establish more effective and sophisticated preventive strategies against epidemics.

Until the population develops sufficient immunity through mass vaccination, it is essential to contain the number of patients to a level that the healthcare system can afford to manage. Our investigation showed that the continuous implementation of contact tracing is crucial to reduce the transmission of COVID-19 in communities.

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Competing interests

None declared.

Ethical approval

Not required.

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