
New measures for COVID-19 response: a lesson from the Wenzhou experience

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ABSTRACT

As the outbreak of COVID-19 has spread globally, determining how to prevent the spread is of paramount importance. We reported the effectiveness of different responses of four affected cities in preventing the COVID-19 spread. We expect Wenzhou anti-COVID-19 measures may provide experience for cities around the world that are experiencing this epidemic.

Key words: COVID19, measures, treatment, outbreak, epidemic

An outbreak of coronavirus disease 2019 (COVID-19) caused by a novel coronavirus (SARS-CoV-2) that emerged in Wuhan, China in December 2019¹⁻² was declared by the World Health Organization as "a Public Health Emergency of International Concern" on January 30, 2020. To date (March 27, 2020), COVID-19 has spread globally including China and 200 other countries and territories, with a total of 509,164 laboratory-confirmed COVID-19 cases³. As COVID-19 thus poses a great threat to global public health, determining how to prevent the spread is of paramount importance.

Wenzhou, a coastal city in southern China with a resident population of 9.25 million, was the most heavily affected with respect to COVID-19 infections outside of Hubei Province. This is the result of the more than 90,000 people who return to Wenzhou from Wuhan during this Lunar New Year (around January 25). Here, we compared the effectiveness of the different responses of four affected cities in preventing a COVID-19 epidemic.

The epidemic data (confirmed and new cases) from January 17 to March 13, 2020 were obtained from the database of China CDC and Wenzhou municipal CDCs. The cities examined in this study—Wenzhou in Zhejiang Province and Jingzhou, Xiaogan and Huanggang (neighboring cities of Wuhan) in Hubei Province—are similar in size and population as well as in their number of confirmed and new cases of COVID-19.

On January 17 when the first case of COVID-19 was confirmed, the Wenzhou New Coronavirus Pneumonia Prevention and Control Committee launched emergency epidemic prevention and control measures, which in general consisted of two phases.

Wenzhou's first-phase prevention and control measures (first-phase measures) were moderate preventive measures undertaken from January 17 to January 30, 2020. The main measures included (1) centralizing the confirmed and suspected patients in designated hospitals for treatment, (2) identifying and investigating all returnees from Wuhan using a big data network and persuading them to undergo 14-day home quarantine, and (3) centralizing

and medically observing individuals who had been exposed to a confirmed COVID-19 patient.

Wenzhou's second-phase prevention and control measures (second-phase measures, also called "Wenzhou anti-COVID-19 measures") consisted of the most aggressive social distancing and quarantining measures and were carried out from January 31 to February 20, 2020. The measures were referred to as "25 emergency measures for Wenzhou epidemic prevention and control" and mainly focused on pinpointing the infection source and completely cutting off any transmission routes. The measures are summarized as follows:

- 1) Shutdown of city. All traffic in and around Wenzhou, including airports, high-speed rail stations and bus stations, was cut off. Only five access points to the expressway were open for transportation of prevention and control materials and necessities, and these were under strict monitoring.

- 2) Lockdown of communities. All places of public gatherings were shut down, including malls, public entertainment facilities, group meetings, restaurants and hotels. The committee enforced crowd-grid management using communities and villages as individual units; se Inspection stations were set up in major locations, and all entrants were interviewed and registered, with body temperature monitoring. In addition, all individuals were required to stay at home, and daily necessities were delivered in real time.

- 3) Tracking and inspection. A combination of mobile big data, network searches, screening at city entrances, etc. was used to track and investigate individuals at risk of infection in a timely manner. All COVID-19 contacts and suspected patients were isolated for quarantining. The confirmed cases were rapidly transferred to designated hospitals for treatment.

- 4) Intensive care. All critically severe COVID-19 patients were transferred the First Affiliated Hospital of Wenzhou Medical University for intensive care, whereas the mild cases and suspected patients were treated at designated medical centers in the city. The intensive care of COVID-19 patients was conducted under the guidance of a team of medical experts, which included an epidemiologist. All of the close contacts of each confirmed patient were

isolated and undergo medical observation. Meanwhile, a rapid nucleic acid detection kit for COVID-19 was used as soon as possible for the diagnosis and to make quarantine and treatment decisions.

The epidemic growth rate was estimated by analyzing number of the confirmed cases from January 21 to March 3, 2020. The COVID-19 transmission model in Wenzhou was established using the data-driven network modeling analysis methods⁴. Statistical analyses were performed using Matlab version R2018a software (The MathWorks, Inc).

As of February 17 (when the last case was confirmed), 2020, 504 COVID-19 cases had been reported in Wenzhou. Of these patients, 208 (41.3%) were originally infected outside of the city (imported cases from other cities) and 296 (58.7%) had been infected locally (local cases).

Moderate measures (first phase measures) were executed from January 17 to January 30 in Wenzhou. However, as of January 31, 2020, 246 cases had been reported, of which 180 (73.2%) were imported and 66 (26.8%) were local. The epidemic pattern in Wenzhou showed that COVID-19 mainly spread in the city (social outbreaks). Therefore, the second-phase measures were implemented on January 31, 2020. A total of 258 cases have been reported from February 1 to March 3, of which 37 (14.3%) were imported and 221 (85.7%) were local. The new cases were predominantly reported in five counties (Yueqing, Ruian, Yongjia, Wencheng, and Taishun) in Wenzhou area. Importantly, two-thirds of these cases were family-type onset. Therefore, the Wenzhou Anti-COVID19 Measures made the epidemic changed from social outbreaks to family-type onset.

After the implementation of the first-phase measures of Wenzhou, the imported cases from other cities were substantially reduced. However, the outbreak in the city remained, suggesting that the transmission routes were not completely blocked. To prevent further spread, the Wenzhou New Coronavirus Pneumonia Prevention and Control Committee launched “Twenty-Five Emergency Measures” (Wenzhou anti-COVID-19 measures) on January 31. As a result, the number of new cases quickly dropped, and no new and

confirmed cases were reported after February 17. The epidemic was under control in 31 days (from January 17 to February 17).

The implementation of the first-phase measures significantly reduced the incidence of imported cases from other cities, suggesting that these measures were effective for import prevention, but did not block the COVID-19 outbreak in the city. Moderate preventive measures were also implemented in Huanggang, Xiaogan and Jingzhou, cities in the region surrounding Wuhan. The COVID-19 onset time and populations in these three cities were similar to those in Wenzhou, and thus the epidemic was occurring in parallel (Figure 1A). However, after January 31, the incidence curves in the four cities were notably different. Subsequent outbreaks were observed in Huanggang, Xiaogan and Jingzhou but not in Wenzhou. However, the numbers of new cases in these cities were meaningfully reduced after implementation of most aggressive social distancing and quarantining measures, which was similar to Wenzhou second-phase measures on February 10 (Figure 1A). These data suggest that the “Wenzhou Anti-COVID19 Measures” were effective in controlling the spread of COVID-19.

Of the 504 patients in Wenzhou, 434 patients were mild, and 62 were severe and 8 were critically severe, 502 patients had been discharged and 1 patient (0.2% mortality) had died, 1 patient was still in critical condition. 268 (53.2%) were male, and the median patient age was 47 (range, 2-93). The average time to diagnosis for the patients was 5.5 days (range from 1-21 days). The cure rate of COVID-19 (99.6%; 502/504) in Wenzhou was higher than that in nationwide (79.3%; 64111/80813), Wuhan (70.4%; 35197/49991), Huanggang (93.5%; 2720/2907), Jingzhou (92.6%; 1464/1580), and Xiaogan (91.1%; 3204/3518). No health care workers were infected in Wenzhou. As of March 13, 80,270 new cases have been diagnosed in China, with a case fatality rate of 3.9% (3176/80813)⁵. While case fatality rate was 4.5% (3062/67786) in Hubei, 4.9% (2436/49991) in Wuhan, 4.2% (125/2907) in Huanggang, 3.1% (49/1580) in Jingzhou, 3.5% (126/3518) in Xiaogan, and 0.87% (114/13027) in regions out of Hubei province⁵. The case fatality rate in Wenzhou was 0.2%, which was substantially lower than that of Wuhan and other regions in China⁶.

A comparative analysis was conducted in four cities. The incidence curves in these cities were very similar before January 31. Wenzhou's first incidence peak appeared on January 29, and then it declined steadily. No second peak was found thereafter. However, Huanggang, Xiaogan and Jingzhou all had their second and even third incidence peaks after January 31 (Figure 1B). These three cities implemented rigorous measures that were similar to the "Wenzhou Anti-COVID19 measures" on February 10, 14 and 15, respectively. As a result, the outbreak of COVID-19 in these three cities was gradually placed under control.

The basic reproduction number or R_0 (R naught) value was 2.6193 for the COVID-19 outbreak in Wenzhou during the early stage of the epidemic (Figure 1C), meaning that, on average, each patient has spread the infection to 2.6 other people, which is consistent with the reports in the literature. For example, Wu et al⁷ reported an R_0 value of 2.68 (95% CI, 2.47–2.86), Li et al² reported an R_0 value of 2.2 (95% CI, 1.4-3.9) and Read et al⁸ reported an R_0 value of 3.11 (95% CI, 2.39–4.13), suggesting that COVID-19 is very contagious. In general, an epidemic will increase as long as $R_0 > 1$, and control measures aim to reduce the $R_0 < 1$. The R_0 of SARS has been estimated to be ~ 3 ⁹ and SARS outbreaks has been successfully controlled by isolation of patients and careful infection control¹⁰. Therefore, Wenzhou anti-COVID-19 measures were the extremely rapidly response in COVID-19 crisis.

These data suggest that the most aggressive social distancing and quarantining measures (Wenzhou anti-COVID19 measures) in the second phase were effective in controlling the COVID-19 spread. Wenzhou anti-COVID-19 measures may provide valuable experience for other cities around the world that are experiencing this epidemic.

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Figure Legends

Figure 1. The epidemic pattern after implementation of different anti-COVID-19 responses.

(A) Daily distribution of cumulative confirmed cases of COVID-19 in Wenzhou, Zhejiang Province, and Jingzhou, Xiaogan and Huanggang (neighboring cities of Wuhan), Hubei Province after implementation of the 1st (black arrow) and 2nd phase measures (orange line for Wenzhou and blue dotted lines for other three cities).

(B) The effect of different anti-COVID-19 measures on the cumulative number of new cases of COVID-19 in Wenzhou, Jingzhou, Xiaogan and Huanggang.

(C) Comparison of estimated and actual cases of COVID-19 in Wenzhou with and without implementation of anti-COVID measures. Daily numbers of new cases by date of onset of symptoms (blue) after implementation of Wenzhou anti-COVID-19 measures and the number of estimated symptomatic cases (red line) without execution of Wenzhou anti-COVID-measures are plotted. Three basic reproduction numbers (R_0) were estimated with three stages (first stage: January 4-23; second stage: January 23-31; third stage: January 31 to March 3) to evaluate the effect of Wenzhou's 1st and 2nd phase measures on the epidemic.

