100 Days of COVID-19 Prevention and Control in China

Lei Zhou, M.D., Zunyou Wu, Ph.D., Zhongjie Li, M.D., Yanping Zhang, M.D., Jennifer M. McGoogan, Ph.D., Qun Li, M.D., Xiaoping Dong, Ph.D., Ruiqi Ren, M.D., Luzhao Feng, Xiaopeng Qi, Jingjing Xi, Ying Cui, M.D., Wenjie Tan, Ph.D., Guoqing Shi, M.D., Guizhen Wu, M.D., Wenbo Xu, M.D., Xiaoqi Wang, M.S., Jiaqi Ma, Ph.D., Xuemei Su, M.S., Zijian Feng, M.D., George F. Gao, D.Phil., and China COVID-19 Task Force

Chinese Center for Disease Control and Prevention, Beijing, China.

Corresponding Author

George F. Gao, Chinese Center for Disease Control and Prevention, 155 Changbai Road, Changping District, Beijing 102206, China. Telephone: +86-10-58900303, Email: gaofu@chinacdc.cn

Key Point: The first 100 days of China's response to COVID-19 with specific, simple, and pragmatic strategies used for risk assessment, prioritization, and deployment of resources are critical for its rapid control the epidemic and re-start social life and economic activity.

Abstract

The epidemic of novel coronavirus diseases was first reported in China in late December 2019 and has been brought under control after some two months in China. However, it has become a global pandemic and the number of cases and deaths continues to increase outside of China. We describe the emergence of the pandemic, detail the first 100 days of China's response as a Phase 1 Containment followed by Phase 2 Containment strategy, and briefly highlight areas of focus for the future. Specific, simple, and pragmatic strategies used in China for risk assessment, prioritization, and deployment of resources are described. Details of implementation, at different risk levels, of the traditional public health interventions are shared. Involvement of society in mounting a whole country response and challenges experienced with logistics and supply chains are described. Finally, the methods China is employing to cautiously re-start social life and economic activity are outlined.

INTRODUCTION

A cluster of cases of pneumonia of unknown etiology raised concerns in Wuhan, China in late December 2019 [1], and on March 11, 2020, what is now known as coronavirus disease 2019 (COVID-19) was declared a global pandemic by the World Health Organization (WHO) [2,3]. Worldwide, >5.7 million cases and >357 thousand deaths have been reported [4], far-reaching economic impacts are being felt, and geopolitical repercussions loom [5]. In this article, we describe the emergence of the pandemic, detail the first 100 days of China's response as a Phase 1 Containment followed by Phase 2 Containment strategy, and briefly highlight some areas of focus for the future.

THE COVID-19 PANDEMIC

Discovery to Diagnostics

The Hubei health authority reported a cluster of pneumonia to Chinese Center for Disease Control and Prevention (China CDC) on December 30, 2019 [1], which triggered the dispatch of a rapid response team from Beijing. Initial clinical investigation ruled out major known pathogens including influenza, avian influenza, adenovirus, severe acute respiratory syndrome coronavirus (SARS-CoV), and Middle East respiratory coronavirus (MERS-CoV) while early epidemiological investigation pointed to an unknown animal source at Huanan Seafood Wholesale Market. On January 1, 2020, the market was closed, and scientists raced to discover the pathogen [6-8]. A task force for virus identification was established across several institutes in China. In early January, Chinese scientists identified a novel virus, specifically a β-coronavirus related to known bat coronaviruses and to SARS-CoV and MERS-CoV [9-12]. The identity of the novel coronavirus was announced on January 7, with a clear virus morphology under electron microscopy, and whole gene sequences were shared on January 10 [8], kicking off two parallel workstreams—characterization of the virus and development of diagnostics.

Characterization of the viral genome by Chinese scientists over the ensuing week revealed it encoded 27 proteins and confirmed it is more similar to SARS-like bat coronaviruses than to other human coronaviruses [13,14]. Notably, the most divergent portion of the genome is in an area that interacts with host cell receptors [13]. However, an analysis of >100 sequences indicated that as of mid-February very little mutation of the virus had yet occurred [8]. The first diagnostic test was quickly developed by the Institute of Viral Diseases Control and Prevention at China CDC and in early January, this viral nucleic acid test enabled the first COVID-19 case to be confirmed. Manufacturing

and distribution scaled up and the first test kits arrived in Hubei on January 16, in all other Chinese provinces on January 19, and in Hong Kong and Macao on January 21 [8]. Despite this, diagnostic development continued and by mid-February, Chinese scientists had designed an additional 10 different COVID-19 test kits [8].

Data Collection and Information Dissemination

On January 20, China's National Infectious Diseases Law was revised to include COVID-19 as a Class B notifiable disease and its Frontier Health and Quarantine Law was amended to support the response. These actions coincided with the start of widespread testing and greatly enhanced collection and use of data. COVID-19 data are collected in 4 complementary information systems that were already operational prior to this outbreak and used for routine management of other infectious diseases (**Table 1**) [15-17]. Thus, health and public health personnel immediately began using them to collect data on COVID-19.

*[Insert **Table 1** here.]*

The WHO China Country Team in Beijing was first informed of the outbreak on December 31 [4]. On January 3, top government officials, including the highest-level leaders and epidemiologists within National Health Commission (NHC) and China CDC, began regularly sharing information with WHO leaders and technical staff. At that time, there were 44 known cases [3]. The WHO China Country Team made its first field visit to Wuhan on January 20–21. China also sent delegations to WHO on January 22–23 and 30 to share information and discuss the outbreak and response [18,19]. Then, WHO sent a delegation to China for the China-WHO Joint Mission on COVID-19. The multinational, multidisciplinary Joint Mission team of experts had a series of in-depth meetings and field visits to 5 Chinese cities including Wuhan during February 16–24 [8]. Additionally, through April, Chinese experts have participated in >40 video and teleconferences with WHO, other international agencies, and individual countries. Moreover, Chinese experts have shared knowledge via >50 publications in international peer reviewed scientific and medical journals.

To promote dissemination of information (and limit misinformation and infodemic development [20]) within China, officials focused on being transparent and thorough, targeting messages to intended audiences, and using suitable media channels. Starting on January 21, official epidemic information has been released daily to the public by NHC[21], and starting January 27, the Joint Prevention and Control Mechanism of the State Council (JPCMSC) has held a daily press conference. Early evaluations have suggested that these communications were reaching citizens. For example, a survey of ~7,000 Hubei residents conducted on January 27 to February 1 found 90% had the necessary COVID-19 knowledge [22].

China's COVID-19 Epidemic

The availability of test kits, the rapid scale up of testing and reporting, and the deployment of case finding and contact tracing teams enabled crucial epidemiological advancements, first with small case series [23-26], and then larger ones [1,6,27,28]. Together with studies targeting specific epidemiological questions [28-33], this research yielded several critical findings: 1) despite broad age distribution, elderly people were most vulnerable, 2) while ~80% of cases were mild, higher case fatality rate was associated with underlying health conditions and severe or critical illness, 3) human-to-human transmission was occurring within close contacts causing infection among health workers and in households, 4) mean incubation period was 5 days, infectious period began before symptom onset, and asymptomatic cases existed, and 5) basic reproductive number (R_0) was >2 [1,6,23-33]. Rapid geographic spread was occurring and by January 20, >600 counties in 30 provinces were reporting cases. On February 11, ~1,400 counties in all 31 provinces had cases [1]. However, the epidemiological curve of daily numbers of confirmed cases at the national level indicated that China's epidemic peaked in late January (**Figure 1**) [1,6], and an overall steady decline in domestically acquired cases was observable from January 26 through March 10.

*[Insert **Figure 1** here.]*

The Global Pandemic

The first cases found outside China were reported by Thailand on January 13, Japan on January 15, and the Republic of Korea on January 20 [4]. By January 31, ~9,800 cases had been confirmed, 106 of which were outside of China, mostly in Western Pacific and Southeast Asia region countries. However, 12 cases were found in Europe (including 2 in Italy), and 9 cases were reported in North America (6 in the United States) [4]. Just 1 month later, on February 29, there were ~85,000 cases globally, and although 93% were in China, the rate of new infections had slowed dramatically (**Figure 1**). The remaining 7% of cases were distributed across 53 other nations, and the global death toll had nearly reached 3,000. Outside of China, highest case totals had been reported by Korea (3,150), Italy (888), the Islamic Republic of Iran (388), and the Diamond Princess cruise ship (705) [4]. By March 31, total global cases exceeded 750 thousand (<11% in China) and deaths reached 36,405 (~9% in China). Countries with the largest burdens of cases included the US (140,640), Italy (101,739), and Spain (85,195) [4]. Finally, by April 30, >4.6 million confirmed cases and >315 thousand deaths have been recorded with heaviest burden in North America and Western Europe [4].

CHINA'S RESPONSE: PHASE 1 CONTAINMENT

Mobilization of "Everything"

China met the challenge of COVID-19 by essentially mobilizing "everything." Taking what has been described as a "whole-of-government, whole-of-society approach," the Phase 1 Containment strategy was launched on January 15, 2020. The Central Committee and the State Council triggered a national emergency response posture and established the JPCMSC [33]. The JPCMSC is composed of 9 task forces covering 32 departments and charged with leading inter-agency and cross-sector coordination and communication for the COVID-19 response. On January 21, the JPCMSC was elevated to a national institutional arrangement with NHC as the coordinator of 32 cooperating departments. Top officials lead the task forces with clear duties and divisions of labor. Beginning on January 25, the JPCMSC issued many notices, technical guidelines, and work plans on prevention and control, scientific research, delivery of equipment and supplies, interpretation of policies, and responses to public concerns. A supervisory team was stationed in Wuhan on January 27, and in all provinces on February 3. By January 29, all provinces had declared public health emergencies and launched local Phase 1 Containment strategies [34].

4 Lines, 4 Levels, and 4 Earlies

As the quantity and quality of information improved and as it bettered understanding of the epidemic, Chinese officials were newly able to conduct risk assessments and set priorities, resulting in the so-called "4 Lines" (**Figure 2A**) and "4 Levels" (**Figure 2B**). These simple dictates set out a pragmatic strategy for containment that was easy to understand and easy to communicate. They guided allocation of resources and public health assets to prevent, detect, isolate, treat, and report cases and to trace and quarantine contacts.

*[Insert **Figure 2** here.]*

Without safe and effective treatments or a proven vaccine, China had to rely solely on traditional, non-pharmacological (public health) interventions (NPIs). Controlling sources of infection, blocking transmission, and protecting susceptible populations were crucial. China's public health sector was given a mission summed up by the "4 Earlies" (**Figure 2C**). Like the 4 Lines and the 4 Levels, these simple objectives set out a pragmatic strategy that was easy to disseminate and comprehend, and that could guide personnel and resource allocation. The 4 Earlies (ie, early detection, reporting, isolation/quarantine, and treatment) were implemented quickly and thoroughly with initial focus on Wuhan, that was expanded according to the 4 Lines and 4 Levels. The 4 Earlies generated a lot of information (**Table 1**), which improved the evidence base for strategic decision making and treatment and prevention protocols. Early detection took the form of active testing campaigns, which found

25,645 confirmed cases, 144,992 suspected cases, and 14,870 close contacts in Wuhan, and passive surveillance, which found 913 confirmed cases, 710,000 close contacts, and 658,000 people seeking entry nationwide. Early reporting drove the interval from illness onset to case reporting down to 4 days from 11 in Wuhan and to 4 days from 8 nationwide (January versus February). Early isolation and quarantine drove the interval from illness onset to isolation down to 4 days from 8 in Wuhan and 2 days from 6 nationwide.

National treatment and prevention protocols were developed, and by March 31, they had been revised many times to incorporate new evidence. For example, when many suspected cases in Wuhan and Hubei could not immediately be confirmed because of insufficient testing capacity, diagnostic criteria were changed to create an additional case category and facilitate faster isolation and treatment in hospitals. Once the testing backlog was cleared, case definitions were returned to their original forms. Other examples include broadening travel history criteria, detailing clinical manifestations of mild cases, and integrating serological testing. Also, when asymptomatic and pre-symptomatic cases were discovered [31], new case definitions were added, and when viral shedding was found before symptoms, contact tracing methods were updated.

Participation of Society

To support the Phase 1 Containment strategy, the Chinese government called upon its 1.4 billion citizens to participate and society helped in the "5 Reliable Forces"—sub-district staff, community grid staff, medical staff, police and other security staff, and staffing a variety of other activities. Citizens assisted with COVID-19 screening, controlling movement of people and goods, supervising critical activities, and helping with education and communication. Society was also mobilized to improve personal hygiene, support environmental disinfection, and comply with new community containment and social distancing rules. All citizens were asked to comply with 3 major personal hygiene and infection protection measures—hand washing, respiratory etiquette, and mask wearing [35]. For persons with occupational exposure risks, such as health, transportation, and food service workers, N95 masks were recommended.

Chinese authorities began to move toward community containment on January 15, when the first cases of COVID-19 were found outside of Wuhan. This included moderate movement restrictions and partial closure of major public venues, restricting travelers with fever leaving from airports and railway stations. Then, on January 23, Wuhan was subjected to a "lockdown" (or *cordon sanitaire*). Fifteen other Hubei cities followed over January 24–26, putting ~60 million citizens into community containment. Movement was strictly controlled into and out of these cities and forbidden within the cities without special permission. This measure was complimented by nationwide social distancing measures. The New Year holiday, planned for January 25–31, was mandatorily extended to February

10 and all public gatherings were cancelled, postponed, or reduced; businesses, schools, entertainment venues, and restaurants were closed; most manufacturing was stopped; and mass transit was curtailed.

Logistics and Supply Chains

Lessons from the SARS outbreak in 2003 [36,37], and the H1N1 pandemic in 2009 38], taught China the value of evaluating response effectiveness, finding problems early, and decisively, rapidly, fully implementing response plans. So, it was immediately apparent that critical bottlenecks and supply challenges needed to be resolved. For example, Wuhan's hospitals were forecasted to run out of beds in early February, just as thousands of patients were being diagnosed each day. So, on February 5, the first 3 "Fangcang" shelter hospitals opened. Over the next few weeks, 13 more of these large temporary field hospitals were built to handle the surge of new patients. This approach facilitated the hospitalization and isolation of all diagnosed COVID-19 patients and avoided problems with home isolation—exposure of family members and lack of monitoring [39]. The surge also quickly depleted equipment and supplies. So, ventilators, oxygen, medicines, and personal protective equipment were shipped in from around the nation and manufacturing was ramped up. Also, >40,000 health workers were brought into Hubei from other provinces. All were provided daily transportation, food, and accommodation. Finally, when concerns emerged about food and supplies for citizens in lockdown, these items along with a monetary allowance, surgical masks, hand sanitizer, and thermometers were provided.

CHINA'S RESPONSE: PHASE 2 CONTAINMENT

A Shift in Strategy

By February 17, China was 23 days beyond the peak of its epidemic curve (**Figure 1**) and numbers of daily new cases had fallen below 800. Yet, the nation was still in danger. Asymptomatic infection was poorly understood, much of the nation remained unexposed and susceptible, and the durability of immunity was unknown. Hence, rather than stop the response, it was revised to better target current conditions and new objectives. This new Phase 2 Containment strategy aimed to avoid a resurgence in local cases (ie, a so-called second wave), prevent importation of cases (which had been increasing since the first imported case was reported on January 30), and facilitate the restart of work and life.

Safely Restarting Economic and Social Activity

Like Phase 1 Containment, the new Phase 2 Containment strategy required strong leadership, coordination, and cooperation. Leading up to this shift in strategy, and throughout this phase of the response many major policies were issued. For example, on February 8, the JPCMSC issued "The Notice on Strengthening Scientific Prevention and Control of the Epidemic and Carefully Resuming Work and Production in Enterprises." In this notice, 8 principles for resumption of routine activities were outlined: 1) resumption of work and production should be immediately promoted and major projects should start as soon as possible, 2) transport should be guaranteed for key groups, 3) capacity for rapid screening should be improved, 4) isolation of key groups and treatment of cases should be strengthened, 5) guidance for enterprises on how to prepare for resumption of work and production should be provided, 6) coordination of the operation of the whole industry supply chain should be provided, 7) work safety should be strengthened, and 8) public service guarantees should be improved.

The start of Phase 2 Containment was marked on February 17 with new guidance issued by the JPCMSC. Based on the 8 principles, it extended the 4 Lines, 4 Levels, and 4 Earlies (**Figure 2**) to ensure continued targeted, tailored, and pragmatic application of NPIs. For example, it indicated that in Wuhan and Hubei (Line 1), COVID-19 spread must be resolutely prevented and the most stringent measures may continue while in Beijing (Line 2), safety must be kept as a high priority and strict measures may be used (**Figure 2A**). In high-risk areas (Level 4), it required strong emphasis on prevention of local and imported cases using strict control measures, recognizing that these areas will only gradually recover. In medium-risk areas (Level 3 or Level 2), prevention of local and imported cases should remain a high priority, but orderly return-to-work activities should begin as soon as possible. Finally, in low-risk areas (Level 1), guidance was for prevention of case importation only. Full resumption of work and production was immediately encouraged (**Figure 2B**). Several additional notices, guidelines, and technical documents have been issued since, all aimed at supporting safe return to work for China's citizens.

To shift out of social distancing and community containment, leaders called for an extremely high degree of public health readiness to handle new cases. Therefore, the 4 Earlies (**Figure 2C**) were strongly emphasized. Testing was dramatically expanded again, this time with serological testing to complement nucleic acid testing. National testing program scale up to drive early detection promoted the second of the 4 Earlies, early reporting. However, reporting in Phase 2 Containment has taken on a larger role—while case reporting is still paramount, reporting negative results has become important too. To facilitate the careful loosening of strict movement controls, all citizens now carry electronic "health codes" on their mobile devices—a red, yellow, green system of QR codes that denotes their personal COVID-19 risk thereby dictating the degree to which they can move about and return to

work. Health code color changes based upon testing frequency and results, proximity to people with different colored health codes, and responses to daily risk surveys. Another way that movement restrictions and return-to-work efforts are facilitated is through a "point-to-point" labor cooperation mechanism. Combining public health protections with employer-provided information, migrant workers are now safely returning to work using a new cross-regional, non-stop chartered car (railway and highway) transport mode. This door-to-door service limits exposures, provides testing, and facilitates rapid tracking and contact tracing should an outbreak occur.

Preventing Importation of Cases

The first imported COVID-19 case was reported on January 30. By mid-February, occasional cases were being detected among travelers entering from abroad (**Figure 1**). The rapidly expanding pandemic put increasing pressure on China's borders and a marked rise in infections detected at entry points has been observed since March 1. Although daily total cases found at border crossings and customs and immigration installations has yet to exceed 75, these figures are worrisome for their potential to spark a new outbreak. All travelers entering China are required to be quarantined under the supervision of security forces at their own expense in designated facilities or immediately deported. Emphasis has been placed on entrants to Beijing (Line 2) and more recently the remote northeast border shared with the Russian Federation. On March 28, China also suspended entry by foreign nationals holding visas or residence permits.

FOCUS ON THE FUTURE

During the first 100 days of COVID-19 in China, the nation experienced a skyrocketing outbreak, but quickly initiated a layered, targeted, tailored, and pragmatic response strategy that has brought the epidemic under control. Much has been learned yet many unknowns make the future uncertain, especially our understanding of the virology of this coronavirus. Prevalence of asymptomatic infection and its contribution to transmission; pathogenesis of disease, optimal supportive care, and means of reducing mortality; and development and durability of immunity all require extensive further study. No therapeutics are yet proven safe and effective, and vaccines are still at least 1 year away. All these areas must be the focus of our future. Furthermore, retrospective analysis of the global response to this pandemic must foster international cooperation in joint pandemic preparedness for the future.

NOTES

Author Contributions

LZ, ZW, and GFG conceptualized the manuscript. LZ, ZW, and JMM drafted the paper. All authors participated in many revisions of the manuscript.

Disclaimer

The views and opinions expressed herein belong to the authors alone, and do not represent the official policy, or endorsement of their affiliated institutions.

Funding

This work was supported by the National Health Commission (grant number 2018ZX10721102) and National Natural Science Foundation (grant number 71934002), Ministry of Science and Technology (grant number 2020YFC0846300) of the People's Republic of China.

Declaration of Interests

The authors declare no conflicts of interest.

References

1. The 2019-nCoV Outbreak Joint Field Epidemiology Investigation Team, Li Q. Notes from the field: an outbreak of NCIP (2019-nCoV) infection in China – Wuhan, Hubei Province, 2019-2020. China CDC Weekly 2020;2:79-80.

2. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. Lancet 2020;395:470-3.

3. WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020. Geneva: World Health Organization, 2020. https://www.who.int/dg/ speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.

4. Coronavirus disease 2019 (COVID-19) situation reports. Geneva: World Health Organization, 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

5. Scott J. The economic, geopolitical and health consequences of COVID-19. Geneva: World Economic Forum, March 6, 2020. https://www.weforum.org/agenda/2020/03/the-economic-geopolitical-and-health-consequences-of-covid-19/.

6. Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. Vital surveillances: the epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020. China CDC Weekly 2020;2:113-22.

7. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA 2000; Online ahead of print. doi: 10.1001/jama.2020.2648

8. Report of the WHO-China Joint Mission on coronavirus disease 2019 (COVID-19). Geneva: World Health Organization, February 28, 2020. https://www.who.int/publications-detail/report-of-the-who-china-joint-mission-on-coronavirus-disease-2019-(covid-19).

9. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, et al. A new coronavirus associated with human respiratory disease in China. Nature 2020;579:265-9.

10. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 2020;579:270-3.

11. Tan W, Zhao X, Ma X, Wang W, Niu P, Xu W, Gao GF, Wu G. A novel coronavirus genome identified in a cluster of pneumonia cases—Wuhan, China 2019−2020. China CDC Weekly 2020;2:61-6.

12. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020;382:727-33.

13. Chan JF, Kok KH, Zhu Z, Chu H, To KK, Yuan S, et al. Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan. Emerg Microbes Infect 2020;9:221-36.

14. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 2020;395:565-74.

15. Wang L, Wang Y, Jin S, Wu Z, Chin DP, Koplan JP, et al. Emergence and control of infectious diseases in China. Lancet 2008;372:1598-605.

16. Yang W, Li Z, Lan Y, Wang J, Ma J, Jin L, et al. A nationwide web-based automated system for outbreak early detection and rapid response in China. Western Pac Surveill Response J 2011;2:10-5.

17. Liang H, Xue Y. Investigating Public Health Emergency Response Information System initiatives in China. Int J Med Inform 2004;73:675-85.

18. Statement on the meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). Geneva: World Health Organization, January 23, 2020. https://www.who.int/news-room/detail/23-01-2020-statement-on-the-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov).

19. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). Geneva: World Health Organization, January 30, 2020. https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov).

20. Zarocostas J. How to fight an infodemic. Lancet 2020;395:676.

21. Daily briefing on novel coronavirus cases in China. Beijing: National Health Commission, 2020. http://en.nhc.gov.cn/DailyBriefing.html.

22. Zhong BL, Luo W, Li HM, Zhang QQ, Liu XG, Li WT, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. Int J Biol Sci 2020;16:1745-52.

23. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020; Online ahead of print. doi: 10.1001/jama.2020.1585.

24. Wu J, Liu J, Zhao X, Liu C, Wang W, Wang D, et al. Clinical characteristics of imported cases of COVID-19 in Jiangsu Province: a multicenter descriptive study. Clin Infect Dis 2020; Online ahead of print. doi: 10.1093/cid/ciaa199.

25. Xu XW, Wu XX, Jiang XG, Xu KJ, Ying LJ, Ma CL, et al. Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-Cov-2) outside of Wuhan, China: retrospective case series. BMJ 2020;368:m606.

26. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 2020;382:1199-207.

27. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020; Online ahead of print. doi: 10.1056/NEJMoa2002032.

28. Sun P, Qie S, Liu Z, Ren J, Li K, Xi J. Clinical characteristics of 50 466 hospitalized patients with 2019-nCoV infection. J Med Virol 2020; Online ahead of print. doi: 10.1002/jmv.25735.

29. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet 2020;395:514-23.

30. Yu P, Zhu J, Zhang Z, Han Y, Huang L. A familial cluster of infection associated with the 2019 novel coronavirus indicating potential person-to-person transmission during the incubation period. J Infect Dis 2020; Online ahead of print. doi: 10.1093/infdis/jiaa077.

31. Zhou T, Liu Q, Yang Z, Liao J, Yang K, Bai W, et al. Preliminary prediction of the basic reproduction number of the Wuhan novel coronavirus 2019-nCoV. J Evid Based Med 2020;13:3-7.

32. Zhao S, Lin Q, Ran J, Musa SS, Yang G, Wang W, et al. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: a data-driven analysis in the early phase of the outbreak. Int J Infect Dis 2020;92:214-7.

33. Wu Z. Asymptomatic and pre-symptomatic cases of COVID-19 contribution to spreading the epidemic and need for targeted control strategies. Chin J Epidemiol 2020; Online ahead of print. doi: 10.3760/cma.j.cn 112338-20200406-00517

34. The Joint Prevention and Control Mechanism of the State Council (The Fight Against COVID-19). Beijing: Communist Party of China Central Committee and the State Council, 2020. http://www.china.org.cn/english/china_key_words/2020-03/13/content_75810658.htm.

35. Jiang T, Wang H, Gao GF, Jiang X. Wearing face masks-the simple and effective way to block the infection source of COVID-19. China CDC Weekly 2020;2:268-9.

36. Centers for Disease Control and Prevention (CDC). Efficiency of quarantine during an epidemic of severe acute respiratory syndrome—Beijing, China, 2003. MMWR Morb Mortal Wkly Rep 2003;52:1037-40.

37. Ahmad A, Krumkamp R, Reintjes R. Controlling SARS: a review on China's response compared with other SARS-affected countries. Trop Med Int Health 2009;14:36-45.

38. Liang W, Feng L, Xu C, Xiang N, Zhang Y, Shu Y, et al. Response to the first wave of pandemic (H1N1) 2009: experiences and lessons learnt from China. Public Health 2012;126:427-36.

39. Chen S, Zhang Z, Yang J, Wang J, Zhai X, Bärnighausen T, et al. Fangcang shelter hospitals: a novel concept for responding to public health emergencies. Lancet 2020;395:1305-14.

Figure Legends

FIGURE 1. **China's COVID-19 Epidemic Curve and China's COVID-19 Response Strategy.** China's COVID-19 epidemic curve is plotted as daily total confirmed cases over time from December 8, 2019 to April 16, 2020. The 2 insets show zoomed-in views of early (left) and late (right) daily case counts. China began its COVID-19 response on January 1 with Phase 1 Containment. During this phase, primary focus was on stopping the spread of disease. In mid-February, the response strategy was revised, giving rise to Phase 2 Containment, which focused on preventing a second wave of cases and restarting economic and social life.

FIGURE 2. **The 4 Lines, the 4 Levels, and the 4 Earlies.** [A] The 4 Lines were lines of defense drawn around priority geographical areas, with the first line being around Wuhan and Hubei (to prevent export of cases), the second line being around Beijing (to prevent import of cases), the third being around Hubei's neighboring provinces (to prevent and slow spread), and the fourth line around China (to prevent spread). [B] The 4 Levels were risk categories assigned at the county level based on the numbers and types of cases present. Level 1, low-risk counties, had no confirmed cases or no new confirmed cases in for 14 consecutive days. Level 2, mid-low-risk counties, had sporadic cases only. Level 3, mid-high-risk counties, had clusters of cases. Level 4, high-risk counties, had ongoing community transmission. Goals for each of these levels were additive. For example, in Level 3, mid-high risk areas, the goal was not only to stop local transmission, but also to prevent local transmission and strictly prevent importation. [C] The 4 Earlies were public health mission areas—early case detection, early case reporting, early case isolation and contact quarantine, and early supportive care. *Surveillance networks highlighted here are supplements to information systems detailed in Table 1.

TABLE 1. **The 4 Information Systems.** These four online reporting systems were already in operation and were used as a matter of routine to track COVID-19 in China starting on January 20, 2020 when it was first designated a mandatorily reportable Class B infectious disease. All cases identified before January 20, were entered into the systems within 24 hours of the Infectious Diseases Law being amended for COVID-19.

	Notifiable Infectious Disease Reporting System (NIDRS)	Public Health Event Information Management System (PHEIMS)	Epidemiological Investigation Information System (EIIS)	Close Contacts Tracing and Management System (CCTMS)
Purpose	• To collect, store, and manage all cases of all notifiable infectious diseases* • To provide linkage to surveillance systems	• To alert authorities to all clustering of cases among any of the notifiable infectious diseases* • To collect, store, and manage information on epidemiological investigations of clusters	• To collect, store, and manage information on epidemiological investigations of individual cases • To supplement information contained in NIDRS case reports	• To collect, store, and manage information on all traced close contacts of notifiable infectious disease cases
Information Collected	• System-created unique case ID# • Very basic individual case-level data; ie, identification/contact details, demographics, location data, primary diagnosis	• System-created unique event ID# • Event-level data; eg, index case identification, number of related cases, scale of affected population • Each event record contains associated NIDRS case ID#s	• Uses NIDRS case ID#s • Detailed individual case-level data not included in NIDRS case reports; eg, exposures, symptoms, dates and results of clinical exams and tests, and diagnosis and initial treatment	• System-created unique contact ID# • Individual contact-level data; ie, identification/contact details, demographics, exposures, location data, quarantine dates and results • Each contact record contains an associated NIDRS case ID#
Access & Use**	• Attending physicians enter case reports (write-only access)	• Local epidemiologists investigate and enter records (write-only access)	• Local epidemiologists investigate and enter records (write-only access)	• Local epidemiologists investigate and enter records (write-only access)
Epidemic Response Role	• Geo-location of cases (precision is at village and household levels) • Analysis of case characteristics • Highly granular case data can be aggregated to any government level • Near-real-time epidemiological reporting facilitating rapid response	• Rapid awareness of new clusters • Geo-location of clusters (precision is at village and household levels) • Analysis of cluster characteristics • Highly granular case data can be aggregated to any government level	• Analysis of case epidemiological and clinical characteristics (severity, transmission modes, risk factors) • Monitoring of testing, diagnosis, treatment, and hospitalization metrics • Highly granular case data can be aggregated to any government level	• Facilitates rapid contact tracing and quarantine of contacts • Geo-location of contacts (precision is at village and household levels) • Supports risk assessment and evaluation of response effectiveness • Analysis of epidemiologic characteristics • Highly granular case data can be aggregated to any government level

*With the addition of COVID-19, China recognizes a total of 31 designated Class B notifiable infectious diseases.

**Authorized China CDC staff manage, quality check, and secure records (selected full access). China CDC and other government health authorities can view reports (view-only access)

Figure 1

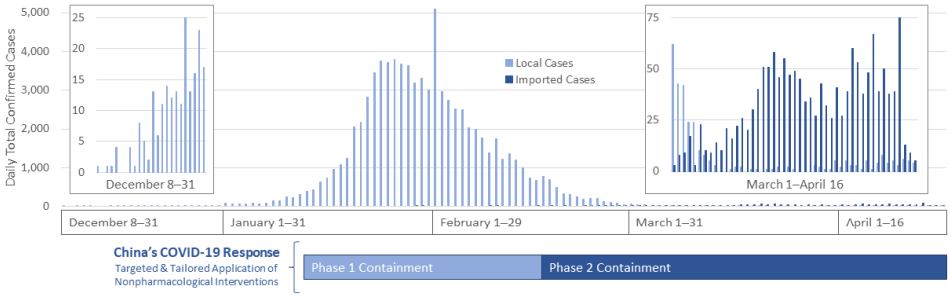

Figure 2