Wiener klinische Wochenschrift
The Central European Journal of Medicine

Effect of a bundle of intervention strategies for the control of COVID-19 in Henan, a neighboring province of Wuhan, China

Qi Liu [ID] · Huan Lu · Rongchang Chen

Summary The novel coronavirus disease 2019 (COVID-19) occurred in China (mainly in Wuhan, Hubei Province) at the end of December 2019. Henan province is located in the center of China, borders on Hubei province by land in the south with the nearest distance of 200 kilometers to Wuhan. As the inland provinces in mainland China, frequent communication in transportation and population flow make it difficult to confine the pandemic, which is similar to that in the landlocked countries in Europe. The expected cases in Henan were mainly imported. A bundle of intervention strategies were adopted from 26 January 2020 to cut off the spread between the infected patients and the native residents. The pandemic was controlled 2 month later after the bundle of strategies was adopted although the number of cases continued to increase explosively during the first 10 days. A total of 1273 cases were confirmed, 1251 patients were cured, 22 patients died, and 1 patient was still in hospital until 29 March 2020. The peak of daily increased cases was 109 cases. Our data show that COVID-19 is highly infectious and easy to cause an outbreak, but it can be controlled by early effective interventions. A bundle of strategies according to the specific situation of each country is suggested to be implemented as early as possible.

Keywords Corona virus · Droplet transmission · Mask · Control strategy · Pandemic

The authors Qi Liu and Huan Lu contributed equally as first authors.

Dr. Q. Liu, M.D. (✉) · H. Lu, M.M.
Emergency Intensive Care Ward, the First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan, China
qi.liu@vip.163.com

H. Lu, M.M.
luhuan950317@163.com

R. Chen, M.D.
Shenzhen Institute of Respiratory Diseases, Shenzhen People's Hospital, Shenzhen, Guangdong, China

State Key Laboratory of Respiratory Disease, National Clinical Research Center for Respiratory Disease, Guangzhou Institute of Respiratory Diseases, the First Affiliated Hospital of Guangzhou Medical University, Guangzhou, Guangdong, China
chenrc@vip.163.com

Novel coronavirus (COVID-19) pneumonia occurred in China (mainly in Wuhan, Hubei Province) since the end of December 2019 [1, 2] and the outbreak spread rapidly, surpassing the outbreak of severe acute respiratory syndrome in 2003 and middle east respiratory syndrome coronavirus since September 2012. Up to 29 March 2020 a total of 82,341 cases and 3306 deaths were reported in China [3] although unprecedented control strategies had been implemented from 23 January, 2020. Recently, the epidemic in China has significantly improved with 75,122 cured cases [3]; however, nearly half of the countries over the world are involved in this COVID-19 pandemic, which is especially worrisome in Europe. As is known, most of the European countries are landlocked countries with frequent communication in transportation and population flow, which is similar to the inland provinces in mainland China and make the epidemic difficult to be confined. Henan province with a population of more than 100 million in 2019 is located in the center of China, borders on Hubei province by land in the south with the nearest distance, 200 km to Wuhan, which was the most severe area of this epidemic. The outbreak of COVID-19 coincided with the annual millions of returnees migrating to their hometown for the traditional Spring Festival holidays which was planned to begin on 24 January 2020. The huge population

flow may promote the spread of virus and increase the difficulty of control. A bundle of strategies were implemented to cut off the spread of COVID-19 in Henan province according to the geographical situation. Nowadays, the spread of COVID-19 is under control in Henan province after fighting it for about 2 months. It is necessary to report our strategies and relevant data to provide reference for global prevention and control, especially the landlocked countries.

Since Henan was not the primary place of COVID-19 outbreak, it was expected that the main cases were imported. The core of control strategies was to cut off the spread between the infected patients and the native residents. The bundle of intervention strategies adopted in Henan province included (1) each case was centrally managed to isolate them from the uninfected population. The confirmed cases and suspected cases

before being excluded were assigned to the designated hospitals and wards, close contacts and suspicious exposure persons were isolated at designated places, such as homes, hotels; (2) all relevant medical staff were trained and enhanced hospitals' ability of accommodating patients with COVID-19 infection or being suspicious of infection; (3) strictly adhered to the epidemic reporting scheme and made the information open to the public to make the public aware of what was dangerous, the rules of early detection, early reporting, early isolation and early treatment must be strictly implemented, otherwise it would be punished according to relevant laws; (4) everyone was asked to suspend the Spring Festival holiday in advance, live on the spot and reduce the flow of people; prevention and control teams were set up in each community and village; the activity tracks and temperatures
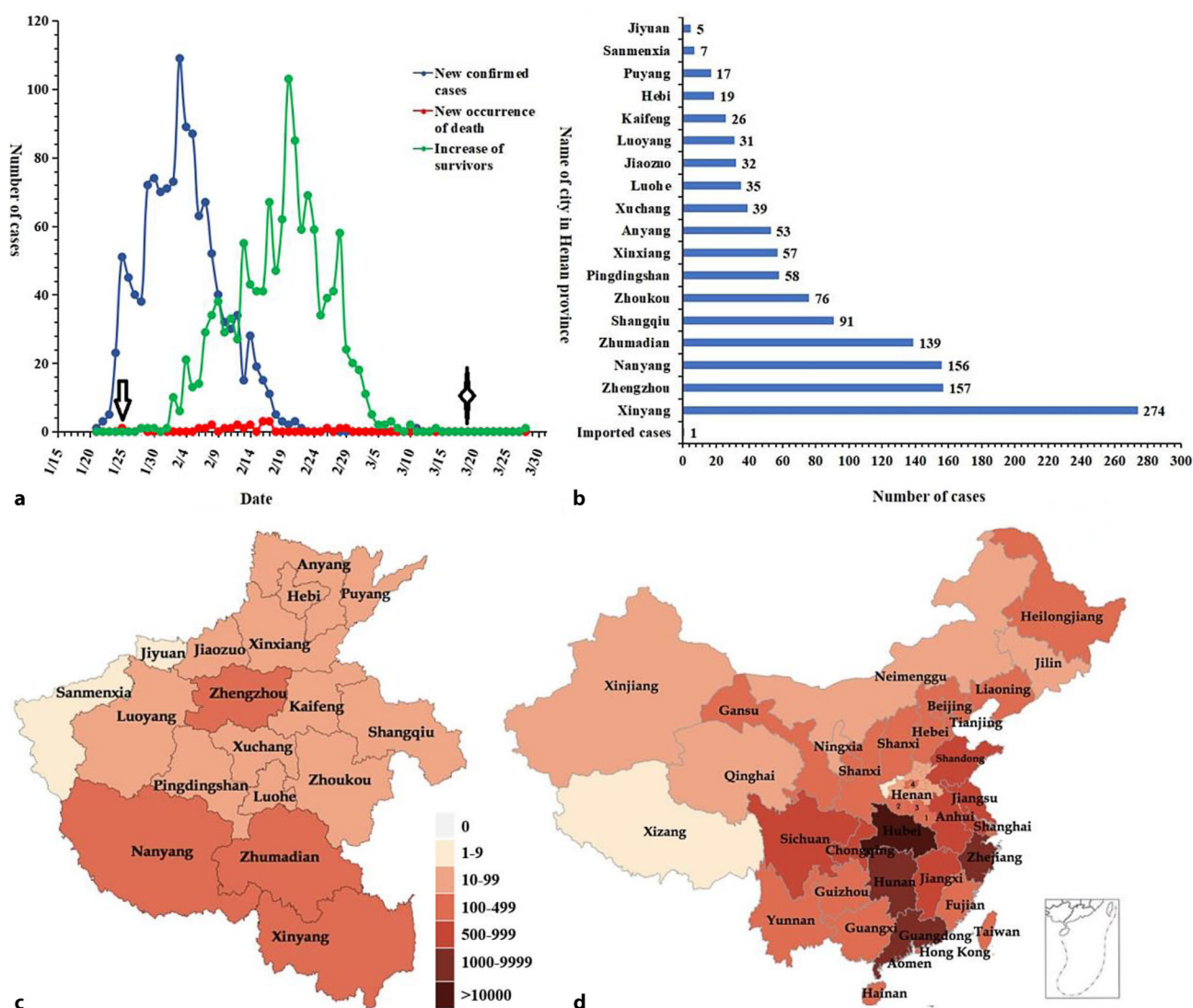

Fig. 1 Time and geographic distributions of COVID-19 cases in Henan province. **a** Distribution of COVID-19 cases with time, the arrow denotes the start time of the bundle of strategies, the star denotes the day on which the preventive level was adjusted lower. **b** Distribution of COVID-19 cases in different cities in Henan. **c** Geographic distribution of COVID-19 in Henan. **d** The neighboring relationship between Henan and Hubei and the epidemic in China. The *numbers 1, 2, 3, 4* represent the cities of Xinyang, Zhumadian, Nanyang and Zhengzhou, respectively

of people were recorded with the two-dimensional codes from the commonly used social software such as WeChat, Alipay, which would send a feedback to the staff with a color of green (healthy), red (suspicious) or gray (needs to be verified) according to the personal travel history from big data processing platform; (5) everyone was persuaded to stop public gathering activities including going to school, wear masks or keep more than 1.5m away from people with unclear contact history; (6) all public transport stations were equipped with temperature detection services, and health registration was carried out. Suspicious cases would be timely reported and shunted to the designated place; (7) publicize epidemiology and personal protection knowledge through internet and the personnel of community prevention teams; (8) sufficient supplies from specialized staff to meet people's living needs and avoid panic [4].

In Henan province, a total of 1273 cases were confirmed, 1251 cases were cured, 22 cases died, 1 case was still in hospital until 29 March 2020. As shown in Fig. 1a, the first case was diagnosed on 21 January 2020, about o1ne month later than that in Wuhan, Hubei province, but it spread rapidly and increased to nearly 50 on 25 January. It was painful that the first case of death occurred. On the same day, the emergency response level was adjusted to the highest level one and the bundle of strategies were implemented. Over the next 10 days, the number of cases continued to increase explosively. On 3 February the number of daily increased cases reached the peak, 109 cases, and then it decreased rapidly, and the local newly increased cases disappeared 3 weeks later. On 11 March there was an international imported case who had just returned from a trip to a European country. The curve of daily newly added cured patients was similar to that of daily newly confirmed patients, but it lagged 17 days behind. The number of daily deaths remained at a low level, with a maximum of 3 cases a day, and a total of 22 cases, overall mortality was 1.72%. The effect of the bundle of intervention strategies was reflected by the trend of epidemiological curve. It was well known that the exit from Wuhan was to be closed on 23 January and hundreds of thousands of people flooded into Henan Province before the deadline. The local government searched actively for suspicious patients according to the big data platform, which made the new diagnosis of imported cases increase rapidly during the first 2 weeks and then the epidemic declined sharply, very few native residents were infected because of the strategies.

In terms of geographical distribution (Fig. 1b), the top four cities in the number of cases are Xinyang, Zhengzhou, Nanyang and Zhumadian (Fig. 1c). Zhengzhou is the capital city of Henan Province, with convenient transportation. The other three cities are adjacent to the epidemic area of Hubei Province and hundreds of thousands of people worked in the affected cities in Hubei (Fig. 1d), some of them returned home for the Spring Festival holiday before the national strict restrictive measures. This indicated that traffic and people flow were the main factors influencing the spread of COVID-19. Droplet transmission among the close contacts was the main spreading route of COVID-19 [5]. The core of the bundle was to cut off the transmission of the virus among the population although droplet transmission was not the only way. The public lacks sufficient knowledge of prevention of infectious diseases, but the infected people might be hidden among them. It might be the only way to cut off the spread of virus among general population by reducing the aggregation or maintaining the safe distance (depends on the height difference) between people. For the diagnosed and suspected patients in hospital, the effective isolation and treatment in designated wards could not only prevent cross-infection between patients or medical staff in Wuhan [6], but also enable patients to get effective treatment of a unified plan.

The data show that the epidemic had been constrained and gradually improved after a bundle of strategies were implemented more than 10 days. The rapid control of the epidemic benefited from early and timely intervention than Hubei Province, in which interventions were performed after the huge outbreak. An epidemiological model was set up incorporating the domestic migration data and the COVID-19 epidemiological data in China to predict the epidemic progression [7], it told us the number of infected people would increase more than three times if the intervention was delayed for 5 days. The data and the model indicated proper timely intervention might be the core for prevention and control of COVID-19 pneumonia.

In conclusion, novel coronavirus, COVID-19 is highly infectious and easy to cause outbreak, but it can be controlled by early effective interventions. A bundle of strategies according to the specific situation of each country is suggested to be implemented as soon as possible.

References

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506.

2. Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med. 2020;382(13):1199–207. https://doi.org/10.1056/NEJMoa2001316.

3. CDC of China. Distribution of novel coronavirus pneumonia. 2020. http://2019ncov.chinacdc.cn/2019-nCoV/. Accessed 29 March 2020

4. Henan.gov. Announcement on prevention and control of novel coronavirus pneumonia. 2020. https://www.henan.gov.cn/2020/01-26/1285120.html. Accessed 29 March 2020

5. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. N Engl J Med. 2020;382(16):1564–7.

6. Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA. 2020;323(11):1061–9. https://doi.org/10.1001/jama.2020.1585.

7. Zifeng Yang ZZ, Ke Wang SW, Wenhua Liang MZ, et al. Modified SEIR and AI prediction of the epidemics trend of COVID-19 in China under public health interventions. J Thorac Dis. 2020;12(3):165–74.