JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Coronavirus Pandemic

Epidemiological and clinical characteristics of COVID-19 patients in Nantong, China

Renfei Lu[1]*, Jianru Qin[2,3]*, Yan Wu[1], Jian Wang[1], Shengyong Huang[1], Lijun Tian[1], Tao Zhang[1], Xiuming Wu[3], Songping Huang[1], Xia Jin[4], Chiyu Zhang[3]

[1] Nantong Third Hospital Affiliated to Nantong University, Nantong, China
[2] College of Life Sciences, Henan Normal University, Xinxiang, China
[3] Pathogen Discovery and Evolution Unit, Institut Pasteur of Shanghai, Chinese Academy of Sciences, Shanghai, China
[4] Shanghai Public Health Clinical Center, Fudan University, Shanghai, China

* Authors contributed equally to this work

Abstract

Introduction: COVID-19 is a newly emerging life-threatening respiratory disease caused by a newly identified coronavirus SARS-CoV-2.
Methodology: We included 28 COVID-19 patients admitted to Nantong Third Hospital from January 23 to February 26, 2020. SARS-CoV-2 infection was confirmed using real-time RT-PCR. The demographic, epidemiological, clinical, laboratory parameters were obtained from each patient.
Results: The vast majority (71.4%) of confirmed COVID-19 patients were brought in from outside of the city, and all others had contact history with these confirmed cases. The median age of patients was 50 years old and half had underlying diseases. The most common symptoms at the onset of illness were fever (96.4%), cough (67.9%), and chilly (28.6%), and 75.0% patients had two or more symptoms. Increased erythrocyte sedimentation rate, serum ferritin and C-reactive protein levels, and reduced absolute counts of total lymphocytes and T lymphocyte subsets were observed among the patients. The vast majority (85.7%) of patients showed bilateral or unilateral pneumonia, and three symptomatic patients and one asymptomatic case did not show abnormalities in their CT image. Among the 28 admitted patients, 24 were discharged as of February 26, 2020, with an average hospital stay of 14.96 (±4.27) days, which was not significantly associated with the interval between the onset of symptoms and admission.
Conclusions: In the absence of specific antiviral drugs or a vaccine, quarantine or isolation is the most effective intervention strategy for preventing the spread of the virus. Adequate supportive medical care is crucial for good prognosis of COVID-19 patients.

Key words: COVID-19; SARS-CoV-2; epidemiology; clinical characteristics; pneumonia; Nantong.

J Infect Dev Ctries 2020; 14(5):440-446. doi:10.3855/jidc.12678

(Received 17 March 2020 – Accepted 29 April 2020)

Introduction

Since December 2019, an emerging infectious disease caused by a novel coronavirus SARS-CoV-2 occurred in Wuhan, China [1-4]. The origin of SARS-CoV-2 was believed to be linked to a local seafood market where the virus spilled over from its animal reservoir to human through zoonotic transmission [2, 5, 6]. SARS-CoV-2 infection leads to severe and lethal pneumonia [5,7,8]. The disease caused by SARS-CoV-2 infection is called coronavirus disease 2019 (COVID-19) by WHO, and the COVID-19 pandemic was declared as a public health emergency of international concern in January 30, 2020. SARS-CoV-2 is spreading rapidly all over the world. As of May 21, 2020, it has resulted in 84,516 (including 4,645 deaths) and 5,033,215 (including 325,737 deaths) laboratory-confirmed cases in China and abroad, respectively. Currently, the continuing COVID-19 epidemic is the greatest threat to global health [9].

As the source of the outbreak and the worst-hit regions by COVID-19 in China, Wuhan and other cities of Hubei province account for over 60.8% and 22.6% of all confirmed cases, respectively. It is believed that the vast majority of COVID-19 patients in other regions of China had an exposure history linked to Wuhan (stayed in or traveled through Wuhan). Therefore, a lock-down measure was implemented in Wuhan and other cities of Hubei province since January 23, 2020. However, the influence of lock-down measure on the outbreak in other regions has not been examined directly. In this study, we performed a detailed epidemiological investigation on COVID-19 patients in

Nantong city, Jiangsu province, which is approximately 480 miles northeast of Wuhan, and described the clinical presentation, treatment, and outcomes of these patients.

Methodology

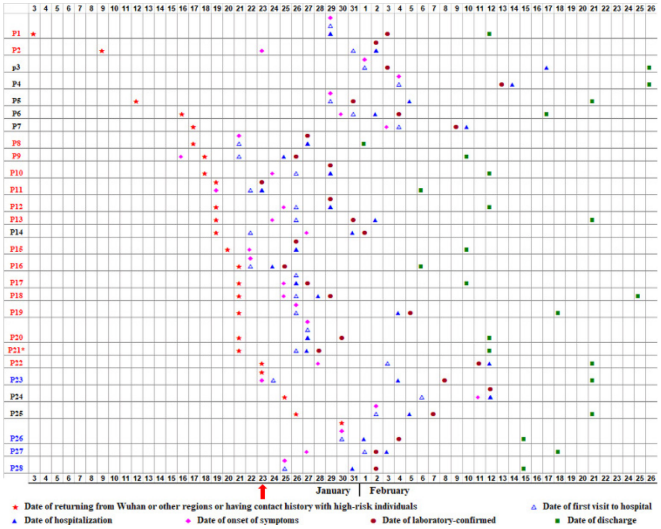
Patients

We recruited 28 COVID-19 patients who were admitted to Nantong Third Hospital Affiliated to Nantong University from January 23 to February 26, 2020. Nantong Third Hospital is a specialized infectious diseases hospital, which is designated to admit and manage most COVID-19 patients in Nantong city during this outbreak. The epidemiological and demographic data were obtained from patients or their family. Throat swabs were collected and maintained in viral-transport medium. Chest CT scans were performed for all patients on admission or during hospitalization. The study was approved by Nantong Third Hospital Ethics Committee (E2020003). Written informed consents were obtained from each of the involved patients.

Diagnosis of COVID-19

COVID-19 patients were diagnosed according to National Guidelines for Diagnosis and Treatment of COVID-19. RNA was extracted from throat swabs and subjected to the detection of SARS-CoV-2 using a 2019-nCoV real-time RT-PCR kit according to the manufacturer's instruction (Liferiver, Shanghai). Only the samples with positive for two or more different SARS-CoV-2 genes were defined as SARS-CoV-2 RNA positive. Positive samples were further sent to Nantong Center for Disease Control and Prevention for confirmation using real-time RT-PCR assay. The patients with SARS-CoV-2 RNA positive were hospitalized.

Figure 1. Timeline of laboratory-confirmed COVID-19 cases in Nantong city, China (n = 28).



Red and blue indicate the patients returning from Wuhan and other regions, respectively. P3 and p4 are the wife and son of P2 (the severe case in ICU), respectively. P26 took the same flight with individuals from Wuhan before returning back to Nantong. The dates of potential exposure were not available for P27 and P28. The red arrow indicates the date of implementation of lock-down measure in Wuhan. * Asymptomatic case.

Data collection and Statistical analysis

The clinical data of all laboratory-confirmed patients were retrieved from their electronic medical records, including their symptoms, clinical parameters, CT images, and treatment and outcomes.

Statistical analysis

The variables were expressed as mean (±SD) or median (with IQR). Categorical variables were expressed as numbers (%). The statistical analysis was performed using T-test.

Results

By February 26, 2020, 28 patients admitted in Nantong Third Hospital were confirmed to be infection with SARS-CoV-2. The median age of the patients was 50.0 years (26-73 years) (Table 1). The majority (60.7%) were male. Half (50.0%) were older than 50 years old, and half (50.0%) had underlying diseases, including cardiovascular and cerebrovascular diseases (32.1%) (Table 1). The median time from onset of symptoms to first hospital admission was 5.0 days (IQR: 3.0-9.0). One SARS-CoV-2-positive individual did not develop any clinical symptoms and signs of COVID-19. One patient was admitted to ICU because of hypoxaemia and hypoxia, and had spread the virus to his wife and son (Figure 1).

Of the 28 patients, 16 (57.1%) had a direct link to Wuhan (returned back from Wuhan), and five (17.9%) had indirect link to Wuhan by contacting with patients who returned from Wuhan (Table 1 and Figure 1). Four (14.3%) had a recent travel history to other regions, and other three local patients had contact history with those confirmed cases. There were no newly transported cases from Wuhan after January 23 when the lock-down was imposed, and other regions after January 30, 2020 (Figure 1).

Consistent with previous clinical studies [5, 7, 8], the most common symptoms of COVID-19 patients at onset of illness were fever (27/28, 96.4%), cough

Table 1. Demographics, baseline characteristics, treatment and clinical outcomes of 28 laboratory-confirmed patients admitted to Nantong Third Hospital.

Patients (n = 28)	
Age, years (Mean ± SD)	48.3 ± 13.5;
Range of age (years old)	26–73
≤ 29	3 (10.7%)
30-39	5 (17.9%)
40-49	6 (21.4%)
50-59	9 (32.1%）
60-69	4 (14.3%)
≥ 70	1 (3.6%)
Sex	
Male	17 (60.7%)
Female	11 (39.3%)
Exposure history*	
Direct link to Wuhan	16 (57.1%)
Indirect link to Wuhan	5 (17.9%)
Other regions outside of Wuhan	4 (14.3%)
Indirect link to other regions	3 (10.7%)
Chronic medical illness	14 (50.0%)
Cardiovascular and cerebrovascular diseases	9 (32.1%)
Endocrine system disease	2 (7.1%)
Respiratory system disease	2 (7.1%)
Urinary system disease	2 (7.1%)
Digest system disease	2 (7.1%)
Nervous system disease	1 (3.6%)
Tumor	1 (3.6%)
Signs and symptoms	
Fever	27 (96.4%)
Cough	19 (67.9%)
Chilly	8 (28.6%)
Myalgia	5 (17.9%)
Headache	4 (14.3%)
Chest distress or pain	3 (10.7 %)
Sore throat	1 (3.6%)
Diarrhea	1 (3.6%)
Nausea and vomiting	1 (3.6%)
No symptom	1 (3.6%)
Only one symptom	6 (21.4%)
Two symptoms	9 (32.1%)
Three symptoms	5 (17.9%)
More than three symptoms	7 (25.0%)
CT findings	
Unilateral pneumonia	4 (14.3%)
Bilateral pneumonia	20 (71.4%)
Multiple mottling and ground-glass opacity	4 (14.3%)
Normal	4 (14.3%)
Treatment	
Oxygen support	9 (32.1%)
Antiviral therapy	27 (96.4%)
Antibiotic therapy	24 (85.7%)
Antianaphylaxis therapy	7 (25.0%)
Immunological enhancement	7 (25.0%)
Chinese herbal therapy	15 (53.6%)
Clinical outcome*	
Discharged	24 (85.7%)
Remained in hospital	4 (14.3%)
Died	0 (0%)

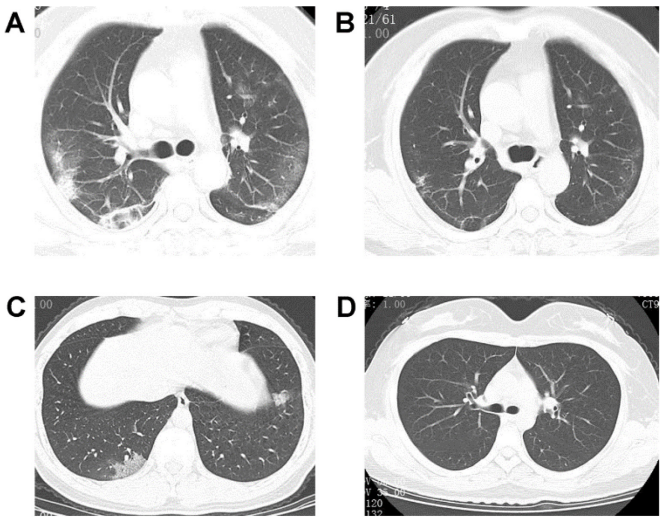
* As of February 26, 2020.

(19/28, 67.9%), and chilly (8/28, 28.6%) (Table 1). Less common symptoms included myalgia (5/28, 17.9%), headache (4/28, 14.3%), chest distress or pain (3/28, 10.7%), sore throat (1/28, 3.6%), diarrhea (1/28, 3.6%) and Nausea and vomiting (1/28, 3.6%). Twenty one (75%) patients had two or more symptoms.

According to chest CT image, 20 (71.4%) and 4 (14.3%) patients showed bilateral pneumonia and unilateral pneumonia, respectively (Table 1 and Figure 2). Four (14.3%) patients with pneumonia showed multiple mottling and ground-glass opacity (Table 1 and Figure 1C). In particular, there are four SARS-CoV-2 positive patients who did not show abnormalities in chest CT image (Figure 1D).

The COVID-19 patients in Nantong showed similar clinical presentations in blood routine tests, coagulation function, liver function, renal routine, cardiac function, and infection-related biomarkers with the patients in Wuhan and other endemic regions (Table 2) [5, 7, 8]. The most striking clinical features of SARS-CoV-2 infection were that most patients had increased erythrocyte sedimentation rate (89.3%), serum ferritin (82.1%) and C-reactive protein (53.6%) levels. Furthermore, most patients (85.7%) had decreased lymphocyte count (especially T lymphocyte subsets: 57.1%) (Table 2). Exception was that fewer patients in Nantong had decreased albumin (21.4% *vs*. 98%) and lactate dehydrogenase (25.0% *vs*. 76%) levels compared with those in Wuhan [5].

Figure 2. Chest CT images.



A. and B. show the chest CT images of a patient on admission and discharge dates, respectively. C. shows the CT image with bilateral ground-glass opacity. D. shows the CT image of a SARS-CoV-2-positive asymptomatic individual.

Table 2. Laboratory results of the 28 laboratory-confirmed patients admitted to Nantong Third Hospital.

Patients (n = 28)	
Blood routine	
Leucocytes, $*10^9$ per L, normal range 4-10	5.18 ± 1.76
Decreased	9 (32.1%)
Neutrophils, $*10^9$ per L, normal range 2-7.7	3.57 ± 1.60
Decreased	2 (7.1%)
Increased	1 (3.6%)
Percentage of neutrophils (N%), normal range 45-77	67.39 ± 10.02
Increased	4 (14.3%)
Lymphocytes, $*10^9$ per L, normal range 0.8-4.0	1.11 ± 0.53
Decreased	6 (21.4%)
Percentage of lymphocytes (L%), normal range 20-40	67.39 ± 10.02
Decreased	14 (50.0%)
Increased	1 (3.6%)
Platelets, $*10^9$ per L, normal range 100-300	175.89 ± 54.94
Decreased	2 (7.1%)
Increased	1 (4%)
Haemoglobin, g/L, normal range120-160	138.96 ± 14.95
Decreased	1 (3.6%)
Increased	3 (10.7%)
Coagulation function	
Prothrombin time, s, normal range 10-14	13.33 ± 0.75
Increased	4 (14.3%)
Activated partial thromboplastin time, s, normal range23-40	30.74 ± 4.33
Decreased	2 (7.1%)
D-dimer, μg/L, normal range < 0.8	1.30 ± 2.53
Increased	3 (10.7%)
Liver function	
Albumin, g/L, normal range < 37	39.64 ± 3.55
Decreased	6 (21.4%)
Alanine aminotransferase, U/L	33.61 ± 29.62
Increased	6 (21.4%)
Aspartate aminotransferase, U/L	37.18 ± 22.29
Increased	4 (14.3%)
Total protein, g/L, normal range 60-83	67.44 ± 5.57
Decreased	3 (10.7%)
Total bilirubin, μmol/L, normal range 3.42-20.5	12.58 ± 6.15
Decreased	1 (3.6%)
Increased	4 (14.3%)
Renal routine	
Blood urea nitrogen, mmol/L, normal range 2.86-8.20	4.48 ± 1.68
Increased	1 (3.6%)
Serum creatinine, μmol/L, normal range 57-111	77.19 ± 55.69
Increased	1 (3.6%)

Table 2. (continued).

Cardiac function	
Myoglobin, ng/mL, normal range < 150	80.46 ± 149.10
Increased	3 (10.7%)
Troponin, ng/mL, normal range < 0.1	0.012 ± 0.040
Increased	1 (3.6%)
Creatine kinase, U/L, normal range 5-200	104.61 ± 111.73
Increased	3 (10.7%)
Alanine aminotransferase, U/L	33.61 ± 29.62
Increased	6 (21.4%)
Aspartate aminotransferase, U/L	37.18 ± 22.29
Increased	4 (14.3%)
Total protein, g/L, normal range 60-83	67.44 ± 5.57
Decreased	3 (10.7%)
Total bilirubin, μmol/L, normal range 3.42-20.5	12.58 ± 6.15
Decreased	1 (3.6%)
Increased	4 (14.3%)
Lactate dehydrogenase, U/L, normal range 109-245	300.21 ± 192.61
Increased	7 (25.0%)
Glucose, mmol/L, normal range 3.9-6.1	7.13 ± 3.04
Increased	15 (53.6%)
Infection-related biomarkers	
Procalcitonin, ng/mL, normal range < 0.046	0.13 ± 0.31
Increased	13 (46.4%)
Erythrocyte sedimentation rate, mm/h, normal range < 15	51.79 ± 32.02
Increased	25 (89.3%)
Serum ferritin, ng/mL, normal range < 200	433.16 ± 295.34
Increased	23 (82.1%)
C-reactive protein, mg/L, normal range < 8	19.01 ± 27.73
Increased	15 (53.6%)
Immune function	
Percentage of T lymphocyte (T%), normal range 58-84	68.82 ± 9.33
Decreased	5 (17.9%)
Increased	1 (3.6%)
Percentage of $CD4^+$ T lymphocyte ($CD4^+$%), normal range 25-56	41.13 ± 9.12
Decreased	1 (3.6%)
Increased	1 (3.6%)
Percentage of $CD8^+$ T lymphocyte ($CD8^+$%), normal range 17-44	24.02 ± 6.01
Decreased	3 (10.7%)
Percentage of B lymphocyte (B%), normal range 5-22	14.90 ± 6.27
Decreased	1 (3.6%)
Increased	3 (10.7%)
Percentage of natural killer cell (NK%), normal range 5-15	14.74 ± 4.83
Decreased	1 (3.6%)
Increased	14 (50.0%)

Table 2 (continued). Laboratory results of the 28 laboratory-confirmed patients admitted to Nantong Third Hospital.

Immune Function	
$CD4^+/CD8^+$ ratio, normal range 0.71-2.78	1.85 ± 0.67
Decreased	2 (7.1%)
Increased	1 (3.6%)
Lymphocyte count, per μL, normal range 1530-3700	1116.64 ± 589.60
Decreased	24 (85.7%)
T lymphocyte count, per μL, normal range 723-2737	787.11 ± 439.70
Decreased	16 (57.1%)
$CD4^+$ T lymphocyte count, per μL, normal range 404-1612	461.57 ± 282.53
Decreased	14 (50.0%)
$CD8^+$ T lymphocyte count, per μL, normal range 220-1129	261.46 ± 137.96
Decreased	12 (42.9%)
B lymphocyte count, per μL, normal range 80-616	159.64 ± 92.00
Decreased	4 (14.3%)
Natural killer cell count, per μL, normal range 84-724	165.64 ± 103.14
Decreased	4 (14.3%)

The treatment of COVID-10 patients included oxygen support, antiviral therapy, antibiotic therapy, antianaphylaxis therapy, and immunological enhancement (Table 1). The antiviral drugs included Aluvia/Kaletra, Arbidol, ribavirin, darunavir, ganciclovir, and/or foscarnet sodium. The antibiotics were moxifloxacin, piperacillin tazobactam, imipenem, fosfomycin, daptomycin, and/or linezolid. The treatment regimens were personalized based on each patient's clinical presentation. As of February 26, 2020, 24 (85.7%) of 28 patients were discharged, four patients were still in hospital, and no one died (Table 1 and Figure 1). Fitness for discharge was based on abatement of fever for at least 3 days, relief of respiratory symptom, improvement of chest radiographic image, and SARS-CoV-2 negative in two consecutive samples collected from upper respiratory tract at an interval of one or more days. The mean duration of hospitalization for 24 discharged patients was 14.96±4.27 days (median 15.0; IQR 14.0-16.0), and there was no significant difference in hospitalization duration between those admitted within 5 days of the onset of symptoms and those admitted after (Table 3).

Discussion

The vast majority of the COVID-19 patients in China are believed to be originated from Wuhan, the epicenter of the pandemics. However, documentation of these cases outside of Wuhan is relatively limited. In this study, we described in details the epidemiological features of 28 laboratory-confirmed COVID-19 patients in Nantong city, Jiangsu province, a place about 480 miles northeast of Wuhan, and presented their clinical characteristics, treatment and outcomes.

Epidemiologically, 20 (71.4%) COVID-19 patients were imported from Wuhan (57.1%) and other regions (14.3%), and 8 (28.6%) other cases all had contact history with infected patients. The same mode of spread may be true for other regions of China. Compared to SARS-CoV and MERS-CoV, the Spike protein of SARS-CoV-2 has higher affinity to human receptor ACE2 [10], which confers stronger capacity for its human-to-human transmission [11, 12]. Therefore, quarantine or isolation of confirmed and suspected COVID-19 case, as well as imported population from high-risk area such as Wuhan, might be the most effective intervention strategy for preventing the spread of the virus [13]. In Nantong, there was no new cases from Wuhan after its lockdown on January 23, 2020. The national data also showed a decrease of new COVID-19 cases in other provinces since February 3, 2020, indicating the effectiveness of lockdown strategy in preventing the spread of the virus. In view of the rapid increase of new COVID-19 cases in other countries all over the world (e.g. the United States, Brazil, Russia, etc.), effective intervention strategies such as quarantine or isolation should also be implemented in spite of potential negative psychological effects caused by long quarantine duration [14].

Clinically, fever and cough were the most common symptoms of COVID-19 patients at the onset of illness [5, 7, 8]. However, a 27-year old woman was confirmed

Table 3. Duration of hospitalization of discharged patients.

Interval between symptom onset and admission (days)	**Number**	**Interval between symptom onset and hospital discharge (days, mean ± SD)**	**Duration of hospitalization (days, mean ± SD)**
0-5	12	18.42 ± 4.11	15.83 ± 3.83
> 5	12	23.75 ± 4.95	14.08 ± 4.50
Total* (5.81 ± 4.11)	24	21.08 ± 5.28	14.96 ± 4.27
P value	-	0.012	0.336

* As of February 26, 2020, 24 of 28 patients were discharged from the hospital, and four were still remained in hospital. One of 24 discharged patients was excluded from the analysis because of no any signs and symptoms of COVID-19.

to be infected with SARS-CoV-2 without any symptoms and signs of COVID-19 (including fever and cough), and had no abnormalities in chest CT image. Abnormalities in chest CT image was also not observed in other three confirmed patients, indicating that SARS-CoV-2 infection does not necessarily cause pneumonia. The proportion of patients who has no radiographic or CT abnormality in Nantong was 14.3%, close to the national level (15.4%) [7]. The presence of asymptomatic infection with SARS-CoV-2 increases the risk of virus transmission [7, 15].

Among laboratory tests, increased erythrocyte sedimentation rate, serum ferritin and C-reactive protein levels were the main features of COVID-19 patient, although these parameters are non-specific and often associated with other diseases [16-18]. Importantly, absolute counts of lymphocytes and T lymphocyte subsets were reduced in most patients, consistent with the existing knowledge that SARS-CoV-2 infection induces a cytokine storm and suppresses antiviral immune responses [5, 7, 8].

Prognosis varied significantly among different provinces in China. The mortality of COVID-19 in Wuhan was very high initially (about 11-15%) [5, 8], and then gradually decreased to the current level of 4.6% (as of Mar. 3, 2020), which is still much higher than the national average of 0.9% excluding Hubei province, where the health care system was strained by a sudden surge of tens of thousands of patients that required care from specialized medical staffs. The reduction is largely benefited from additional medical supplies and personnel support from all over the country. In Nantong, only one severe case was admitted to ICU, and no patient died. In addition, the discharge rate was high (85.7% as of February 26, 2020). The hospital stay duration had no association with the interval between the onset of symptoms and admission, suggesting patients' defense system is crucial for the recovery of COVID-19 in the absence of effective anti-SARS-CoV-2 drugs.

A major limitation of this study is its relatively small patient number. Although the vast majority of COVID-19 patients in Nantong were admitted in Nantong Third hospital, not all patients in this city were enrolled in this study during the brief enrollment period. More accurate clinical results and epidemiological data would be obtained if more patients were included. In addition, there was only one severe patient, and thus limited our power to perform a comparison between mild and severe patients.

In conclusion, we present detailed epidemiological and clinical characteristics of COVID-19 patients in Nantong. The vast majority of the COVID-19 patients were imported cases from Wuhan, and all others had contact history with infected patients. Therefore, quarantine or isolation is the most effective intervention strategy for preventing the spread of the virus. Like other regions outside of Hubei province, a lower fatality and a higher discharge rate were observed in Nantong, suggesting that good and adequate medical care are crucial for better prognosis in COVID-19 patients.

Acknowledgements

We thank Haiping Xiong, Yihua Sun, Wei Zhang, Xiaolei Ji and Jingsu at Nantong Center for Disease Control and Prevention for their helps in this study.

Funding

This work was supported by the grants from the National Science and Technology Major Project of China (2017ZX10103009-002 and 2019YFC1200603), and Natural Science Research Project of Nantong Science and Technology Bureau (MS12019048).

Author contributions

RL and CZ conceived the idea. RL, YW, JW, SH, LT, TZ and SH collected the data. YW, JW and SH performed the experiments. JQ, CZ and XW analyzed data. CZ, RL and XJ interpreted the results. CZ drafted the manuscript. XJ critically revised the manuscript. All authors have read and approved the manuscript.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P, Zhan F, Ma X, Wang D, Xu W, Wu G, Gao GF, Tan W (2020) A novel coronavirus from patients with pneumonia in China, 2019. New Engl J Med 382: 727-733.
2. Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, Si HR, Zhu Y, Li B, Huang CL, Chen HD, Chen J, Luo Y, Guo H, Jiang RD, Liu MQ, Chen Y, Shen XR, Wang X, Zheng XS, Zhao K, Chen QJ, Deng F, Liu LL, Yan B, Zhan FX, Wang YY, Xiao GF, Shi ZL (2020) A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 579: 270-273.
3. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, Hu Y, Tao ZW, Tian JH, Pei YY, Yuan ML, Zhang YL, Dai FH, Liu Y, Wang QM, Zheng JJ, Xu L, Holmes EC, Zhang YZ (2020) A new coronavirus associated with human respiratory disease in China. Nature 579: 265-269.
4. Coronaviridae Study Group of the International Committee on Taxonomy of Viruses (2020) The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. Nat Microbiol 5: 536-544.
5. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B (2020) Clinical features

of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395: 497-506.
6. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, Wang W, Song H, Huang B, Zhu N, Bi Y, Ma X, Zhan F, Wang L, Hu T, Zhou H, Hu Z, Zhou W, Zhao L, Chen J, Meng Y, Wang J, Lin Y, Yuan J, Xie Z, Ma J, Liu WJ, Wang D, Xu W, Holmes EC, Gao GF, Wu G, Chen W, Shi W, Tan W (2020) Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. Lancet 395: 565-574.
7. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC, Du B, Li LJ, Zeng G, Yuen KY, Chen RC, Tang CL, Wang T, Chen PY, Xiang J, Li SY, Wang JL, Liang ZJ, Peng YX, Wei L, Liu Y, Hu YH, Peng P, Wang JM, Liu JY, Chen Z, Li G, Zheng ZJ, Qiu SQ, Luo J, Ye CJ, Zhu SY, Zhong NS, China Medical Treatment Expert Group for Covid-19 (2020) Clinical characteristics of coronavirus disease 2019 in China. New Engl J Med 382: 1708-1720.
8. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Xia J, Yu T, Zhang X, Zhang L (2020) Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. Lancet 395: 507-513.
9. Hui DS, E IA, Madani TA, Ntoumi F, Kock R, Dar O, Ippolito G, McHugh TD, Memish ZA, Drosten C, Zumla A, Petersen E (2020) The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China. Int J Infect Dis 91: 264-266.
10. Wrapp D, Wang N, Corbett KS, Goldsmith JA, Hsieh CL, Abiona O, Graham BS, McLellan JS (2020) Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation. Science 367: 1260-1263.
11. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, Ren R, Leung KSM, Lau EHY, Wong JY, Xing X, Xiang N, Wu Y, Li C, Chen Q, Li D, Liu T, Zhao J, Liu M, Tu W, Chen C, Jin L, Yang R, Wang Q, Zhou S, Wang R, Liu H, Luo Y, Liu Y, Shao G, Li H, Tao Z, Yang Y, Deng Z, Liu B, Ma Z, Zhang Y, Shi G, Lam TTY, Wu JT, Gao GF, Cowling BJ, Yang B, Leung GM, Feng Z (2020) Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. New Engl J Med 382: 1199-1207.
12. Wu JT, Leung K, Leung GM (2020) Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. Lancet 395: 689-697.
13. Zhang KK, Xie L, Lawless L, Zhou H, Gao G, Xue C (2020) Characterizing the transmission and identifying the control strategy for COVID-19 through epidemiological modeling. medRxiv: 2020.02.24.20026773.
14. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, Rubin GJ (2020) The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 395: 912-920.
15. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, Zimmer T, Thiel V, Janke C, Guggemos W, Seilmaier M, Drosten C, Vollmar P, Zwirglmaier K, Zange S, Wolfel R, Hoelscher M (2020) Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. New Engl J Med 382: 970-971.
16. Bedell SE, Bush BT (1985) Erythrocyte sedimentation rate. From folklore to facts.Am J Med 78: 1001-1009.
17. Wang W, Knovich MA, Coffman LG, Torti FM, Torti SV (2010) Serum ferritin: Past, present and future. Biochim et biophys acta 1800: 760-769.
18. Pepys MB, Hirschfield GM (2003) C-reactive protein: a critical update. J Clin invest 111: 1805-1812.

Corresponding author
Prof. Chiyu Zhang, PhD
Head of Pathogen Discovery and Evolution Unit, Institut Pasteur of Shanghai, Chinese Academy of Sciences,
320 Yueyang Road
Shanghai, China.
Tel: +86 21 5492 3051
Fax: +86 21 5492 3044
E-mail address: zhangcy1999@ips.ac.cn

Conflict of interests: No conflict of interests is declared.