

Case Report

Surgical treatment of thoracolumbar fracture with incomplete lower limb paralysis in a patient with COVID-19

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ABSTRACT

Since December 2019, COVID-19, an acute infectious disease, has gradually become a global threat. We report a case of thoracolumbar fractures (T₁₂ and L₁) and incomplete lower limb paralysis in a patient with COVID-19. After a series of conservative treatment which did not work at all, posterior open reduction and pedicle screw internal fixation of the thoracolumbar fracture were performed in Wuhan Union Hospital. Three weeks later, the patient could stand up and the pneumonia is almost cured. We successfully performed a surgery in a COVID-19 patient, and to our knowledge it is the first operation for a COVID-19 patient ever reported.

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Introduction

On December 31, 2019, China reported a cluster of cases with pneumonia in Wuhan, Hubei Province.¹ The World Health Organization (WHO) has termed this disease as COVID-19 on February 11, 2020. As on May 10, 2020, patients in more than 200 countries around the world have been infected, and nearly 3,917,366 people have been diagnosed,² which has been announced as a pandemic by WHO.³ This article reports the first case of a COVID-19 patient with thoracolumbar fracture who underwent surgical treatment and was discharged during the special outbreak.

Case report

On February 18, 2020, a COVID-19 patient (a 45 years old male) with thoracolumbar fracture and incomplete paralysis was transferred to Wuhan Union Hospital. He initially presented to Wuhan Hanyang District Hospital after a convulsive episode and found himself unable to move the lower limbs after that. The patient

reported that he suddenly developed convulsion with teeth clenching and limb shaking, when resting on a sofa on the day of initial presentation, and symptoms resolved spontaneously after a few seconds. But when he was trying to get up, he noticed a back pain and was unable to move his lower limbs. He sought medical attention at Wuhan Hanyang District Hospital and was hospitalized. Computed tomography (CT) of thoracolumbar spine showed burst fracture of the 12th thoracic vertebra and the compression fracture of 1st lumbar vertebral. Incidentally CT showed bilateral pulmonary exudative changes (Fig. 1), indicating a possible infection of COVID-19.

The day before admission, the patient developed a cough without fever, and throat swab nucleic acid test turned out to be positive. There was also no improvement of the paralysis after conservative treatment in Wuhan Hanyang District Hospital. Subsequently he was transferred to the Wuhan Union Hospital for COVID-19 treatment.

At the time of presentation to Wuhan Union Hospital, the patient had stable vital signs, with body temperature 36.6 °C, blood pressure of 124/86 mmHg, pulse rate 87 beats/min, breathing rate 16 breathes/min, oxygen saturation 98% in ambient air and normal mentation. Upon further inquiry, the patient reported a similar previous convulsive episode in 2008, CT and magnetic resonance imaging of the brain were negative then. Otherwise, he reported no

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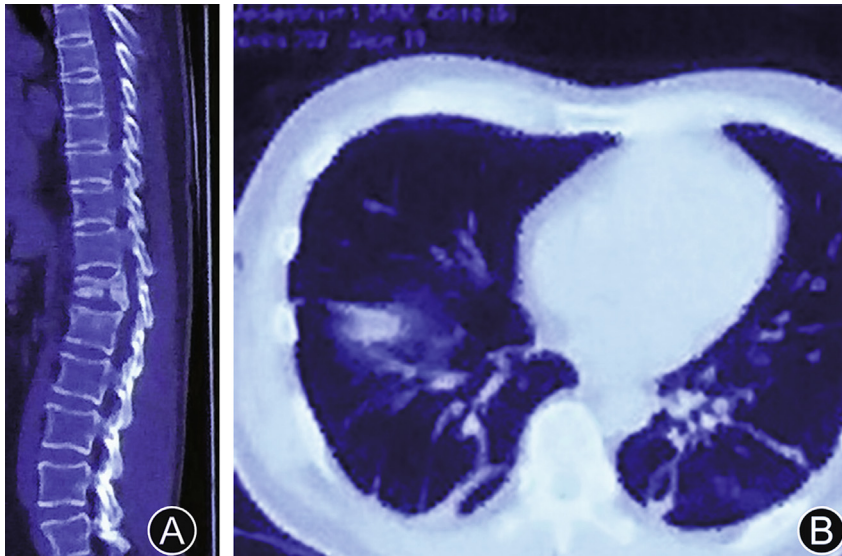


Fig. 1. On 19 February, (A) the thoracolumbar computed tomography (CT) showed thoracic 12 vertebra burst fractures, lumbar 1 vertebral compression fractures; (B) the lung CT showed bilateral pulmonary exudative changes.

other significant past medical history, no family history or drug allergy.

Physical examination revealed bilateral coarse breath sounds with some rales. There was tenderness in the thoracolumbar spine, hyperalgesia below the level of bilateral groin area with left side more severely involved, cremasteric reflex, no saddle anesthesia, and normal anal sphincter tone. As for muscle strength, bilateral flexion hip strength presented level 1/level 5, the left ankle dorsiflexion and toe extensor muscle strength level 2-/level 5, the right ankle dorsiflexion and toe extensor muscle strength level 2+/level 5. The bilateral knee tendon reflexes and achilles tendon reflexes were reduced, and pathological reflexes were not elicited. Both American Spinal Injury Association and Frankel's spinal cord injuries were grade C per guideline. A complication of the left common iliac vein thrombosis was identified by bilateral venous ultrasound of lower limbs, for which an inferior vena cava filter was placed before the orthopedic surgery.

On February 22, 2020, the patient underwent surgery with posterior open reduction and pedicle screw internal fixation of thoracolumbar fracture by medical personnel with a standard level 3 protection. In the morning, the physician wearing level 2 personal protective equipment (PPE) transported the patient from quarantine ward to the entrance of the operating room, then the anesthesiologist and operating room nurse took over. After successful general anesthesia, the surgeon upgraded PPE from level 2 to level 3. The C-arm was used to locate the injured vertebra, followed by incision of the skin and subcutaneous fascia, kyphotic deformity of T12 and L1 was seen. Screws and longitudinal rod were placed from T11 to L2 and retracted, with the kyphosis deformity resolved. The incision was rinsed with saline multiple times, and vancomycin was evenly sprinkled on the incision. After surgery, the patient was transferred to intensive care unit (ICU) for recovery from general anesthesia. The whole operation lasted 2 h and 43 min.

On postoperation day 1, the patient was transferred from ICU back to the general quarantine ward. His vital signs remained stable and afebrile. Anti-inflammatory and analgesic medications were given. The patient's laboratory results were shown in Table 1. There were no signs of infection or abscess formation around the wound. Spinal cord function was evaluated on postoperation day 3. The hyperalgesia of both lower limbs was significantly alleviated and muscle strength gradually improved to level 4/level 5 (Fig. 2).

During the postoperative period, to understand the COVID-19, we checked the patient's lymphocyte subsets, plasma cytokines, and 2019-nCoV antibodies (Table 2).^{4,5} On postoperative days 3, 6, and 14, the 2019-nCoV nucleic acid test was all negative, and the cough subsided, fever maintained, and the oxygen saturation reached 98%. Repeat CT of thoracolumbar spine revealed that the lung exudation was absorbed, and the spinal reduction appeared satisfactory (Fig. 3). The patient could almost stand up with some assistance and was discharged 3 weeks after surgery.

Discussion

COVID-19 is a new type of respiratory infectious disease. Fever, dry cough, and fatigue are common manifestations. Severe cases can develop dyspnea and hypoxemia after 1 week of onset, and may quickly progress to acute respiratory distress syndrome, persistent metabolic acidosis, coagulation dysfunction, and multiple organ failure.^{6,7}

It is the world's first surgery on cases with concomitant COVID-19 and thoracolumbar burst fracture. Moreover, the patient's health condition is optimal with no significant comorbidities. He only carried mild symptoms of COVID-19 with some cough and had mild lung involvement on imaging (Fig. 1).⁸ Lab test is also unremarkable (Table 1). Most important, the patient was young (45 years old), with neurological damage not responsive to 9 days of conservative treatment. Therefore after an extensive multidisciplinary discussion with anesthesiologist and pulmonologist, surgeons decided to perform the surgery as soon as the cough was improved, the inflammation was controlled, and the vital signs were stable.

2019-nCoV is mainly transmitted through respiratory droplets and close contact.⁹ There is a possibility of aerosol transmission when exposed to high concentrations of aerosol for a prolonged time, especially in a relatively closed environment. Therefore, medical personnel have a high risk of infection during the operation, especially with tracheal intubation,¹⁰ so extreme precaution needs to be taken for the protection of medical personnel. All medical staffs in the operating room should strictly comply with level 3 PPE, thus all staffs have no signs of infection by March 17.

In intraoperative management, the personnel participating in anesthesia and surgery should avoid entering other operating rooms. Surgery is aimed at saving lives, controlling bleeding, saving

Table 1
Laboratory examinations since admission.

Items	Reference range	Days after hospitalization					
		1	2	6*	7	13	21
White-cell count (g/L)	3.5–9.5	11.89↑	8.55	16.54↑	16.55↑	9.89	8.26
Red-cell count (g/L)	3.8–5.1	5.23↑	5.39↑	4.73	4.17	4.07	4.49
Absolute neutrophil count (g/L)	1.8–6.3	9.35↑	6.37	14.03↑	14.61↑	7.16↑	5.56
Absolute lymphocyte count (g/L)	1.1–3.2	1.69	1.57	1.06↓	1.05↓	2.02	2.03
Platelet count (g/L)	125–350	232	193	242	203	329	336
Hemoglobin (g/L)	130–175	163	165	149	130	125↓	139
Hematocrit (%)	40–50	48.0	49.0	43.8	38.7	38.1	42.2
Sodium (mmol/L)	137–147	137.6	137.5	140.8	137.7	137.9	138.9
Potassium (mmol/L)	3.5–5.3	4.16	3.68	4.32	5.43↑	4.80	4.15
Chloride (mmol/L)	96–108	107.6	104.0	105.0	102.2	97.6	98.8
Calcium (mg/L)	2.0–2.5	2.05	2.09	1.97↓	2.10↓	2.28	2.25
Carbon dioxide (mmol/L)	20–29	25.4	29.6	25.9	25.1	34.2↑	28.1
Anion gap (mmol/L)	8–16	5↓	4↓	10	10	6↓	12
Glucose (mmol/L)	3.9–6.1	5.96	6.66	6.89	7.44	5.77	5.86
Blood urea nitrogen (mg/L)	2.9–8.2	9.18↑	9.21↑	6.65	5.7	4.54	4.59
Creatinine (mg/L)	57–111	71.8	73.1	63.1	67	59.1	67.3
Total protein (g/L)	60–83	68.0	71.6	58.1↓	57.3	63.3	66.9
Albumin (g/L)	33–55	38.6	42.3	33.3	31.0↓	33.4	40.6
total bilirubin (umol/L)	3–20	15.8	15.7	18.8	13.6	8.0	8.6
Procalcitonin (ng/ml)	<0.05	0.04	0.05↑	–	0.25↑	–	–
Alanine aminotransferase (U/L)	5–40	24	62↑	48↑	32	84↑	54↑
Aspartate aminotransferase (U/L)	8–40	17	34	36	26	39	26
Alkaline phosphatase (U/L)	40–150	130	143	172↑	156↑	290↑	313↑
D-dimer (ug/ml)	0–0.5	1.26↑	1.70↑	2.56↑	2.00↑	3.27↑	1.84↑
Fibrinogen (g/l)	2–4	3.37	3.59	5.52↑	7.44↑	6.34↑	4.73↑
Lacate dehydrogenase (U/L)	109–245	186	201	265↑	223	200	157
Prothrombin time (sec)	11.0–16.0	13.1	12.7	13.1	14.3	13.4	13.0
International normal ratio	0.83–1.36	1.01	0.97	1.01	1.14	1.04	1.00
Creatine kinase (U/L)	24–194	227↑	170	–	807↑	85	54
CRP (mg/L)	0–8	0.47	0.10	65.84↑	170.28↑	3.12	1.06

–: not detected, ↑: higher than normal upper limit, ↓: lower than normal lower limit, *: the patient received surgery on this day.
CRP: C-reactive protein.

limbs, and reducing infection. The operation should be simplified and the operation time should be reduced. Comprehensive and orderly exploration should be performed during the operation to avoid misdiagnosis. During the operation, the surgeon and the scrub nurse implemented level 3 protection and the

anesthesiologist can use the level 2 protection, but the head and face should be equipped with a face screen to prevent infection during tracheal intubation. The circulating nurse can use level 2 protection. No personnel outside the room can enter the infection surgery without special circumstances.

For the protection of surgical supplies, equipment and the environment, the items are clearly marked and fixed in a dedicated operating room. Drugs and disposable items flow in and out in one direction non-disposable devices and items must be processed after use in accordance with the relevant specifications. To prevent pollution caused by the patient's blood and body fluid splashing, the operation should be gentle. To minimize the ground pollution, when there is dirt or blood on the ground or surface, wipe it with 2000 mg/L effective chlorine disinfectant.

After operation, all medical staff involved should complete the process of level 3 protection: take off the protective equipment, wash and sterilize hands according to the specifications. If there is no accidental exposure during the entire process, the operator can apply for exemption from isolation. Otherwise, the medical staff participating in the surgery should conduct medical observation for a period of 14 days. If there is an abnormality during the observation, medical treatment should be produced in time. After the operation, the surgical instrument should be sealed in a double yellow medical waste bag, with the "Novel coronavirus pneumonia" eye-catching logo, and places separately. The staff from disinfection supply room sterilizes these surgical instruments first, then cleans them, and then sterilizes.

Since the new coronavirus mainly affects the respiratory system and the immune system,¹¹ we also checked the lymphocyte population, plasma cytokines, and 2019-nCoV antibodies. Cytokine storms have been reported on cytomegalovirus, hemophilic lymph

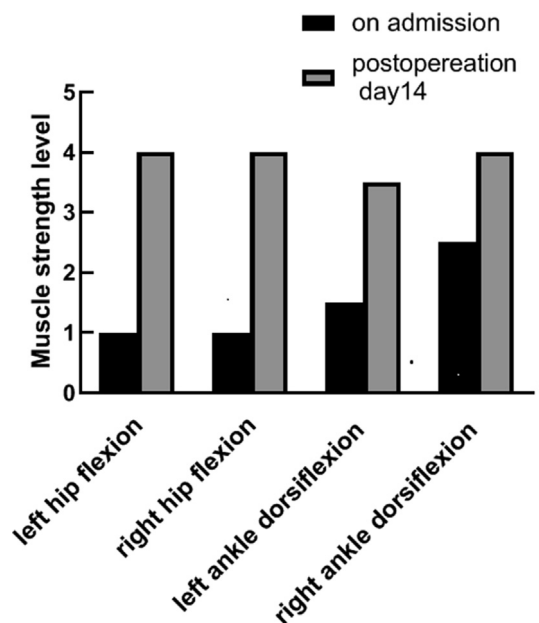


Fig. 2. Changes in muscle strength.

Table 2
Lymphocyte subsets, plasma cytokines, 2019-nCoV antibodies 2019-nCoV nucleic acid.

Items	Feb.17	Feb.25	Feb.28	Mar.1	Mar.4	Mar.7	Mar.9	Mar.10
IL-2 (0.1–4.1pg/mL)						26.22↑		9.18↑
IL-4 (0.1–3.2 pg/mL)						4.97↑		4.96↑
IL-6 (0.1–2.9 pg/mL)				4.72		8.55↑	6.38	9.93↑
IL-10 (0.1–5.0 pg/mL)						4.2		7.45↑
TNF- α (0.1–23 pg/mL)						3.68		5.41
IFN- γ (0.1–18 pg/mL)						8.55		4.56
CD3 ⁺ Lymphocyte (58.17%–84.22%)					76.14	72.38		
CD4 ⁺ Lymphocyte (25.34%–51.37%)					41.4	39.91		
CD8 ⁺ Lymphocyte (14.23%–38.95%)					30.12	30.26		
B Lymphocyte (4.1%–18.31%)					18.97	20.6		
NK Lymphocyte (3.33%–30.47%)					1.81	5.18		
CD4/CD8 (0.41–2.72)					1.36	1.32		
2019-nCov-IgM (<10)				0.26				
2019-nCov-IgG (<10)				0.47				
Nucleic acid of SARS-CoV-2	+	-	-					

+: positive, -: negative, ↑: higher than normal upper limit, ↓: lower than normal lower limit.

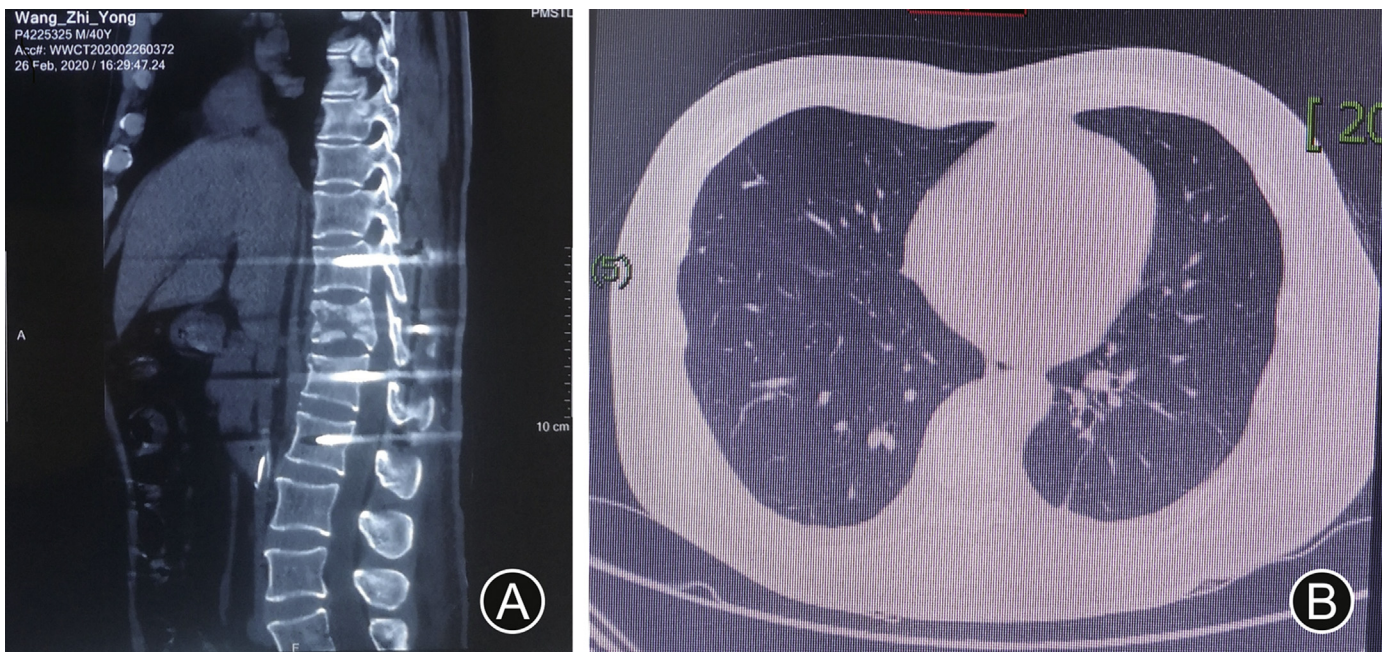


Fig. 3. (A) Re-examination of thoracolumbar and lung computed tomography revealed that the spinal reduction was satisfactory, and (B) the lung infection was absorbed earlier.

histiocytosis, influenza virus, severe acute respiratory syndrome, and 2019-nCoV.¹² Cytokine storm is an important etiology of acute respiratory distress syndrome and multiple organ failure, and its concentration is also related to the severity and the prognosis of the disease.^{5,13} For example, IL-6 can inhibit regulatory T cells, triggering an acute immune pathological response.^{14,15} A surgery can cause inflammatory reactions such as surgical stress and affect the immune system, which may indeed affect the progression of COVID-19. Therefore, we tried very best to avoid any risk after surgery. Regarding the stable signs of the patient, we mainly focused on radiographic and laboratory tests, such as lung CT, white blood cell count, C-reactive protein, erythrocyte sedimentation rate, procalcitonin, etc. Most importantly, plasma cytokines, lymphocyte clustering and antibody detection are routinely examined, which was reported to be important indicators of the prognosis. In this patient, we found IL-2, IL-4, IL-6, and IL-10 levels were elevated after operation and IL-2 level was reduced significantly when checking again, indicating a transient inflammatory response instead of cytokine storm. The patient had a good outcome, who had no cough, fever, pharyngeal swab nucleic acid

rejuvenation or other symptoms after surgery, and lung CT showed lesion absorption. In summary, the surgical treatment did not aggravate the progression of COVID-19.

In conclusion, we reported a relatively successful surgery to improve the quality of life in a mild COVID-19 patient, with thoracolumbar fracture and incomplete lower limb paralysis. WHO has announced COVID-19 as a global pandemic, and it would possibly persist for certain duration.² We hope the case could provide some insight for the management of COVID-19 patients who require surgery.

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Nil.

Ethical Statement

Ethics approval (0318–01) was obtained from the ethics committee of Union Hospital, Tongji Medical College, Huazhong University of Science and Technology.

Declaration of Competing Interest

The authors have no conflicts of interest relevant to this article.

References

- Zhu N, Zhang DY, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020;382:727–733. <https://doi.org/10.1056/NEJMoa2001017>.
- World Health Organization. *Coronavirus disease(COVID-19) situation report-111*; 2020. https://www.who.int/docs/default-source/coronavirus/situation-reports/20200510-covid-19-sitrep-111.pdf?sfvrsn=1896976f_4.
- Guo Y, Huang YM, Huang J, et al. COVID-19 Pandemic: global epidemiological trends and China's subsequent preparedness and responses. *Zhonghua Liuxingbingxue Zazhi*. 2020;41:643–648. <https://doi.org/10.3760/cma.j.cn112338-20200301-00222>.
- Li ZT, Yi YX, Luo XM, et al. Development and clinical application of a rapid IgM-IgG combined antibody test for SARS-CoV-2 infection diagnosis. *J Med Virol*. 2020. <https://doi.org/10.1002/jmv.25727>.
- Chen C, Zhang XR, Ju ZY, et al. Advances in the research of cytokine storm mechanism induced by Corona Virus Disease 2019 and the corresponding immunotherapies. *Zhonghua Shaoshang Zazhi*. 2020;36:E005. <https://doi.org/10.3760/cma.j.cn501120-20200224-00088>.
- General Office of National Health Commission of the People's Republic of China. *Office of National Administration of Traditional Chinese Medicine. Notice about issuing the diagnosis and treatment protocols of COVID-19 (Pilot version 6 modified)*; 2020. <http://www.nhc.gov.cn/yzygj/s7653p/202002/8334a8326dd94d329df351d7da8aefc2.shtml>.
- Chen NS, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet*. 2020;395:507–513. [https://doi.org/10.1016/s0140-6736\(20\)30211-7](https://doi.org/10.1016/s0140-6736(20)30211-7).
- Han R, Huang L, Jiang H, et al. Early clinical and ct manifestations of coronavirus disease 2019 (COVID-19) pneumonia. *AJR Am J Roentgenol*. 2020:1–6. <https://doi.org/10.2214/ajr.20.22961>.
- Han Y, Yang H. The transmission and diagnosis of 2019 novel coronavirus infection disease (COVID-19): a Chinese perspective. *J Med Virol*. 2020. <https://doi.org/10.1002/jmv.25749>.
- Zuo MZ, Huang YG, Ma WH, et al. Expert recommendations for tracheal intubation in critically ill patients with novel coronavirus disease 2019. *Chin Med Sci J*. 2020. <https://doi.org/10.24920/003724>.
- Qin C, Zhou L, Hu Z, et al. Dysregulation of immune response in patients with COVID-19 in Wuhan, China. *Clin Infect Dis*. 2020. <https://doi.org/10.1093/cid/ciaa248>.
- Oldstone MBA, Rosen H. Cytokine storm plays a direct role in the morbidity and mortality from influenza virus infection and is chemically treatable with a single sphingosine-1-phosphate agonist molecule. *Curr Top Microbiol Immunol*. 2014;378:129–147. https://doi.org/10.1007/978-3-319-05879-5_6.
- Wang YL, Wang F, Geng J. Cytokine and cytokine storm. *Tianjin Med J*; 2020. <http://kns.cnki.net/kcms/detail/12.1116.R.20200311.1245.002.html>.
- Mahmud-Al-Rafat A, Majumder A, Rahman TKM, et al. Decoding the enigma of antiviral crisis: does one target molecule regulate all? *Cytokine*. 2019;115:13–23. <https://doi.org/10.1016/j.cyto.2018.12.008>.
- Huang CL, Wang YM, Li XW, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020;395:497–506. [https://doi.org/10.1016/s0140-6736\(20\)30183-5](https://doi.org/10.1016/s0140-6736(20)30183-5).