THE ORTHOPAEDIC FORUM

Orthopaedic Guidelines for the COVID-19 Post-Outbreak Period

Experience from Wuhan, People's Republic of China

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Abstract: Currently, the coronavirus disease 2019 (COVID-19) crisis has rapidly spread worldwide. As the earliest outbreak area of the pandemic, Wuhan, People's Republic of China, is gradually recovering to its normal state under the effective control of government authorities. Outpatient services in major hospitals are now being restored. An accumulation of asymptomatic infections is a potential risk for medical personnel, especially when there is crowding in hospitals. As the biggest center for orthopaedic patients in Wuhan, our orthopaedic outpatient department admits >300 patients per day. Optimal guidelines on how to handle this huge number of patients during the post-outbreak stage of the COVID-19 pandemic, particularly with regard to potential asymptomatic infection, are urgently needed for orthopaedic surgeons. We have developed and proposed applicable guidelines to fill this knowledge gap, including the necessary protective strategies for medical personnel in orthopaedic outpatient and inpatient wards as well as during surgery. We also have provided mental health recommendations for health-care workers. To the best of our knowledge, these guidelines are the first of their kind for orthopaedic surgeons who are slowly reestablishing medical activity following the pandemic.

Since the first coronavirus disease 2019 (COVID-19) patients were reported in Wuhan, Hubei Province, People's Republic of China, in December 2019, the virus has spread worldwide and was recognized as a pandemic by the World Health Organization (WHO) on March 11, 2020. As of April 21, 2020, a total of 2,427,657 COVID-19 cases had been confirmed, and a total of 168,120 deaths had been reported[1]. As the first country to be hit by COVID-19, the People's Republic of China led the way to a series of urgent and strict lockdown policies to contain the outbreak. Currently, the outbreak in the People's Republic of China has been effectively controlled, and work and production have resumed. On April 8, 2020, Wuhan lifted the lockdown and the traffic prohibition and people were allowed to return to work[2]. This improvement is not only promising for Wuhan, but also for the entire world. As the biggest center for orthopaedic patients in Wuhan, our orthopaedic outpatient

*Yuan Xiong, MD, and Lang Chen, MD, contributed equally to this work.

Disclosure: This work was supported by the National Science Foundation of China (no. 81772345), National Key Research & Development Program of China (no. 2018YFC2001502 and 2018YFB1105705), National Health Commission of the People's Republic of China (no. ZX-01-018 and ZX-01-C2016153), and the Health Commission of Hubei Province (no. WJ2019Z009). The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/F940).

Fig. 1
Outpatient activity during the COVID-19 post-outbreak period.

department admits >300 patients per day. As frontline orthopaedic surgeons in Wuhan, we are now faced with new concerns.

The issue of asymptomatic COVID-19 patients has been at the center of great debate and concern. An epidemiological study on the prevalence of COVID-19 reported that asymptomatic carriers can transmit the virus to close contacts, resulting in cases of symptomatic COVID-19[3]. It is currently believed that the positive screening accuracy of throat swabs is just 50%[4], which may mean that there are a large number of asymptomatic carriers who have tested negative. Thus, when treating multiple patients in a crowded orthopaedic outpatient department in the unique setting of the post-outbreak period, orthopaedic surgeons have a high risk of infection.

Patient management in the inpatient wards during the post-outbreak period is also noteworthy. During the COVID-19 outbreak, many nonemergency orthopaedic patients were not able to gain hospital admission, which resulted in a surge of admissions after normal medical activity had been resumed. Furthermore, orthopaedic patients often are unable to care for themselves because of functional limitations, such as limb dysfunction, meaning that they frequently require multiple caregivers to support their daily lives. It should be noted that monitoring of the caregivers' health condition may be necessary. A previous study has reported that nosocomial infection during the outbreak of COVID-19 was as high as 41%[5]; therefore, strict and feasible management strategies may be useful to avoid a second surge of nosocomial infection.

Moreover, a large part of new admissions are patients who require surgery, and orthopaedic surgical procedures are particularly prone to aerosol generation, increasing the potential risk of infection for orthopaedic surgeons. Therefore, the safety of surgical procedures is a third factor that should not be neglected. A strict and feasible screening mechanism should be established to reduce the risks for orthopaedic surgeons. It should also be noted that, from our frontline experiences and recent study, some patients who have already recovered may initially continue to test positive with a quantitative real-time polymerase chain reaction (qRT-PCR) test[6]. Thus, repeated nucleic acid testing of surgical patients is necessary to create and maintain a safe environment for surgical procedures.

The mental health status of the medical staff is the fourth factor that should be considered during the post-outbreak period. When caring for individuals who are severely ill,

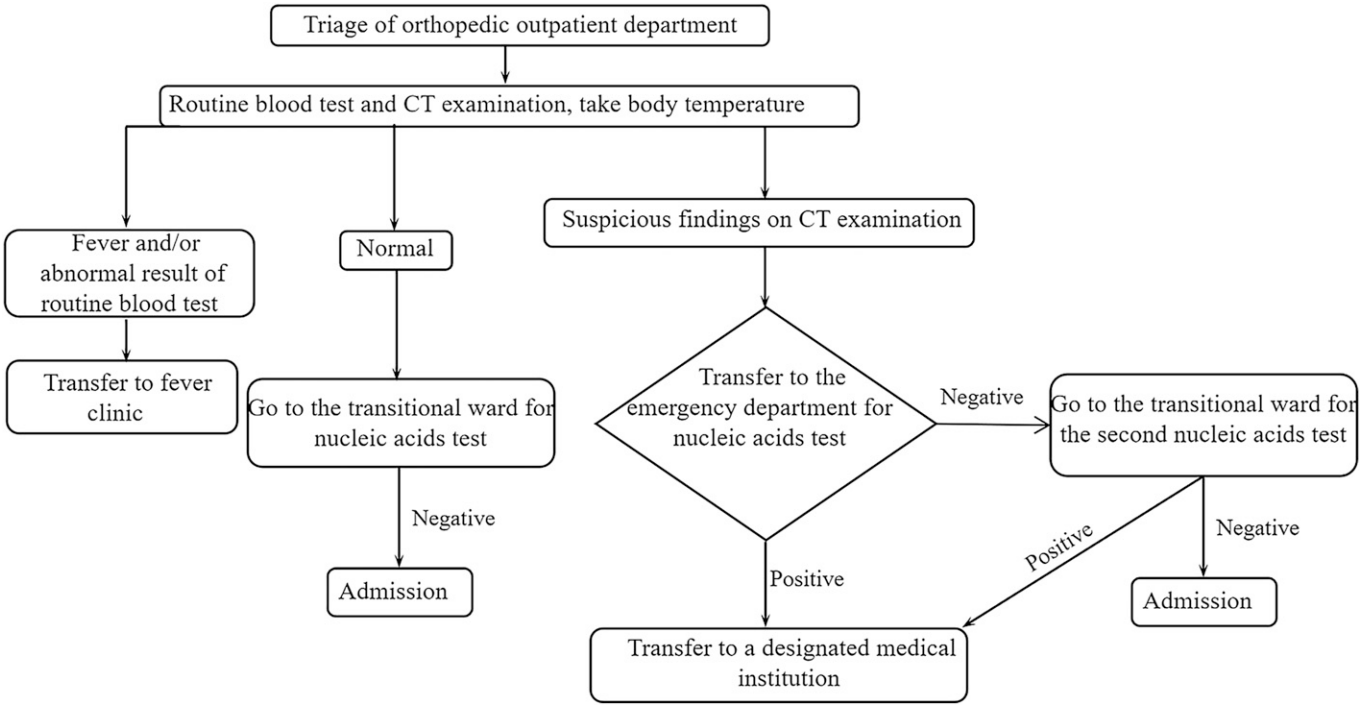

Fig. 2
Flowchart for handling outpatients in the COVID-19 post-outbreak period.

Fig. 3
Medical activity on the patient ward during the COVID-19 post-outbreak period.

frightened, or experiencing bereavement, the medical staff may be overwhelmed with mental stressors. Medical staff are still at high risk of getting infected during the post-outbreak period while simultaneously carrying a large mental burden. The challenges and stresses that they experience can trigger common mental disorders, including anxiety, depressive disorders, and posttraumatic stress disorder (PTSD)[7].

Currently, the growth trajectory of COVID-19 in many countries is on the downturn, signaling that they will be entering the next stage of this pandemic: the post-outbreak period. To ensure safe medical practice after the outbreak of COVID-19, we offer our first-hand experiences as orthopaedic surgeons on the front line of the earliest epicenter of COVID-19 to propose a post-COVID-19 orthopaedic safe-care protocol, including specific guidelines for medical practice in both the outpatient department and the inpatient wards, a management pathway for surgical patients, and monitoring of the mental health of the medical staff throughout the COVID-19 post-outbreak period. We propose our guidelines as an example of how one region is dealing with the post-outbreak period. As more countries enter the post-outbreak period, we hope that orthopaedic departments around the world will find the information in our research to be useful.

Guidelines for Orthopaedic Surgeons in the Outpatient Department

During the post-outbreak period, orthopaedic surgeons should select appropriate personal protective equipment (PPE) based on Level-II protective standards, including a hair net, gloves, an isolation suit, a medical respirator (filtering face piece [FFP]/N, R, or P), eye protection (goggles and/or visor), and shoe covers (Fig. 1).

Any patients who visit the orthopaedic outpatient department should first be asked about the etiology of their fracture and their medical history of infection. All patients should be advised to undergo routine blood testing and pulmonary computed tomography (CT). Three treatment schemes are available according to the test results: (1) patients with fever or abnormal routine blood tests should be transferred to the fever clinic for further examination; (2) patients with normal blood test results,

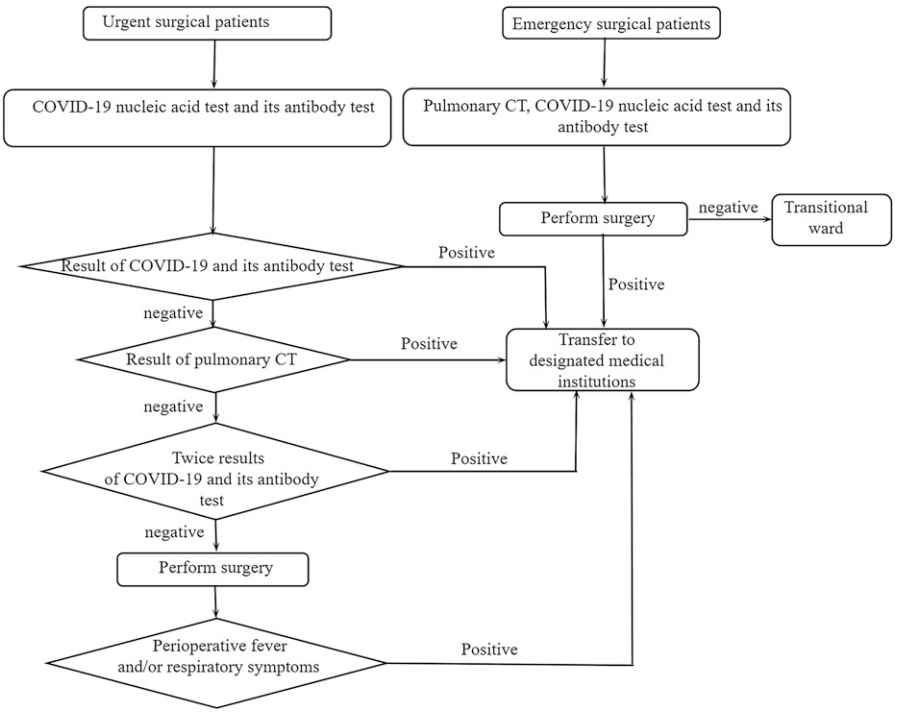

Fig. 4
Flowchart for handling surgical patients in the COVID-19 post-outbreak period.

Fig. 5
Activity in the operating room during the COVID-19 post-outbreak period.

CT examination, and body temperature should go to the transitional ward for nucleic acid testing, after which a patient with a negative test result can be admitted to the orthopaedic inpatient ward; and (3) patients with suspicious findings on CT examination should be transferred to the emergency department for COVID-19 nucleic acid and antibody testing. If the test is positive, patients can be transferred to a designated medical institution for COVID-19 treatment. If the test is negative, they should go to the transitional ward for a second nucleic acid and antibody testing; if the test results remain negative, these patients can be admitted to the orthopaedic inpatient ward (Fig. 2).

Inpatient Ward Management

Inpatient ward safety should be prioritized. Just as it has become accepted worldwide that every patient should be swabbed for methicillin-resistant *Staphylococcus aureus* (MRSA) on surgical wards, testing for COVID-19 may be considered the first step when admitting a surgical patient. If a confirmed case of COVID-19 is overlooked, the hospital becomes a breeding ground for infection because of its unique environment (i.e., multiple patients in close quarters). The consequences of COVID-19 becoming a nosocomial infection will be grave. For example, in Harbin, People's Republic of China, a 78-year-old male patient was admitted to the hospital without undergoing nucleic acid testing or CT screening. Within 11 days, 35 people who were exposed to him became infected with COVID-19; the number of cases of infection may increase with additional screening[8]. After admission, patients should be kept in an isolation room for medical observation for 3 days. Only patients who have had 3 consecutive days without fever can be transferred to the inpatient ward. A single family member is allowed to enter the ward with the patient. Assistance for the patients and their families is provided by nurses. Accompanying family members also should receive COVID-19 nucleic acid and antibody testing as well as body temperature testing. Additionally, pulmonary CT examination is advised prior to entering a ward, but, understandably, given the radiation considerations, this may not always be possible. Admission to the ward is permitted with negative test results, a normal CT examination, and a normal body temperature.

Similar to the staff in the outpatient department, the medical staff in the inpatient ward should equip themselves with Level-II PPE during this post-outbreak period (Fig. 3). Health-care workers should work <6 hours per day while wearing PPE, and after working for 5 continuous days, they should get at least 5 days of rest.

Guidelines for Surgical Procedures

If a hospitalized patient requires a surgical procedure, a second COVID-19 nucleic acid and antibody test should be performed after the first outpatient screening. Patients who test positive for COVID-19 should be transferred to a designated medical institution for additional treatment prior to surgery. If the results of the COVID-19 tests are negative but the patient has typical pulmonary CT findings for COVID-19, the patient should be admitted to the infectious disease department for isolation. Only when the COVID-19 nucleic acid test is negative on 2 separate occasions and there are no abnormal findings on pulmonary CT should the patient be permitted to undergo surgery for an urgent (i.e., nonemergency and nonelective) procedure (Fig. 4). The operating rooms (ORs) should have either a negative-pressure environment or an independent airflow system. The medical staff should utilize Level-II PPE. When performing tracheal intubation, the anesthesiologist is advised to wear a positive-pressure headset in order to prevent infection from droplets. After surgery, the patient should be admitted to a separate room for medical observation and transitional treatments. Patients with postoperative fever and/or respiratory symptoms should be isolated immediately and investigated with a pulmonary CT scan, a COVID-19 nucleic acid test, and an antibody test.

For emergency orthopaedic surgical patients, we advise that COVID-19 nucleic acid testing, antibody testing, and pulmonary CT examination be performed rapidly prior to preparation for surgery (Fig. 4). If testing is positive for COVID-19, all medical personnel should use Level-III PPE (Fig. 5). All medical supplies should be placed in the designated OR prior to surgery. The number of staff in the operating room is limited to 2 orthopaedic surgeons, an anesthesiologist, an instrument nurse, and a circulating nurse. During surgery, only the circulating nurse is allowed to walk into the OR. After surgery, any confirmed-positive patient should be transferred to a designated institution for further specialized treatment of COVID-19. If testing is negative for COVID-19, surgery can be performed in an ordinary OR with an appropriate airflow system. The anesthesiologist should adopt Level-II protection, but we also advise that the head and face be covered with a visor or a positive-pressure headset in order to prevent droplet infection during tracheal intubation (Fig. 5).

During the post-outbreak period, preventing a second surge of COVID-19 in hospitals is paramount. The OR is a

particularly important location for the prevention of a further COVID-19 outbreak. To ensure the safety of the ORs, hospitals should provide sufficient prior storage and provision of protective supplies. Active cooperation by medical staff should be encouraged, and their health status should be monitored.

Mental Health Recommendations

As nationwide lockdowns begin to be lifted, an increasing number of patients will be arriving at hospitals. Health-care workers are concerned about the occurrence of a second surge of infection. Concern about the existence of asymptomatic carriers has been exacerbated by widespread misinformation, often driven by erroneous news reports, which exacerbate the anxiety of health-care workers. Furthermore, after the immense mental health burden of the COVID-19 pandemic, local medical health-care workers are exhausted, which may contribute to common mental disorders[9].

During the post-outbreak period, psychologists and psychiatrists in our hospital have been sharing useful strategies to deal with common psychological stress, including using the internet and social media (e.g., WeChat and Weibo), which can help in assessing the accuracy of information regarding COVID-19. It is also important to provide multiple hospital services that are aimed at eliminating the mental burden that is associated with the fear of a second surge of infection, provide information about maintaining a normal life under safe conditions, and provide telephone-based and internet-based counseling for health-care workers and their family members. These mental health interventions may empower health-care workers to better cope with non-COVID-19 patients during the post-outbreak period.

Summary

Although the current global outlook may not appear optimistic, with the development of herd immunity, a successful vaccine, and advanced preventative treatments, we hope that COVID-19 will be eradicated and normal order can be restored. With Wuhan—the former epicenter of COVID-19—now on the path of recovery, we, the frontline workers, share our first-hand experiences of performing surgery during the post-outbreak period. We recognize that our response will differ from that of other localities and there will be challenges in translating our guidelines globally. Our intention is not to provide a worldwide solution but to offer one solution that we hope will be of use and inspire others around the world as more and more orthopaedic centers reopen and tailor their responses in the post-outbreak period. ■

NOTE: The authors thank Yingze Zhang, the Chinese Academy of Engineering from Hebei Medical University; Guodong Liu, editorial director of the Chinese Journal of Trauma; Jiacan Su, MD, PhD, from Changhai Hospital, The Second Military Medical University; Zengwu Shao, MD, PhD, Liming Xiong MD, PhD, Tian Xia, MD, PhD, Wu Zhou, MD, PhD, Faqi Cao, MD, PhD, Mengfei Liu, MD, PhD, Jing Liu, MD, Hang Xue, MD, Liangcong Hu, MD, Yiqiang Hu, MD, Chenchen Yan, MD, Xudong Xie, MD, and Ranyang Tao, MD, from the Department of Orthopedics; Yun Sun, MD, PhD, from the Department of Neurosurgery; and Wei Xiong, MD, PhD, from the intensive care unit, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology for their kindly help revising our manuscript.

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References

1. Johns Hopkins University Center for Systems Science and Engineering. COVID-19 dashboard. Accessed 2020 Apr 21. https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6
2. National Health Commission of the People's Republic of China. [Update on epidemic situation of novel coronavirus infected pneumonia in China by April 08]. 2020 Apr 8. Accessed 2020 Apr 8. Chinese. http://www.nhc.gov.cn/xcs/yqtb/202004/6b7e8905b62f4cf89517cb0ebdf24d00.shtml
3. Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, Wang M. Presumed asymptomatic carrier transmission of COVID-19. JAMA. 2020 Feb 21. [Epub ahead of print].
4. Guo WL, Jiang Q, Ye F, Li SQ, Hong C, Chen LY, Li SY. Effect of throat washings on detection of 2019 novel coronavirus. Clin Infect Dis. 2020 Apr 9. [Epub ahead of print].
5. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA. 2020 Feb 7. [Epub ahead of print].
6. Lan L, Xu D, Ye G, Xia C, Wang S, Li Y, Xu H. Positive RT-PCR test results in patients recovered from COVID-19. JAMA. 2020 Feb 27. [Epub ahead of print].
7. Bao Y, Sun Y, Meng S, Shi J, Lu L. 2019-nCoV epidemic: address mental health care to empower society. Lancet. 2020 Feb 22;395(10224):e37-8. Epub 2020 Feb 7.
8. CCTV. [Investigation of COVID-19 infection chain in two hospitals in Harbin]. 2020 Apr 21. Accessed 2020 Apr 30. Chinese. http://news.cctv.com/2020/04/21/ARTIfQNAPeTJnf6d0JVSW9Gm200421.shtml
9. Shultz JM, Baingana F, Neria Y. The 2014 Ebola outbreak and mental health: current status and recommended response. JAMA. 2015 Feb 10;313(6):567-8.