


CLINICAL ARTICLE

Safety and Effectiveness of Orthopaedic Medical Staff in Providing Support in Combating the COVID-19 Pandemic: A Retrospective Investigation from Wuhan, China

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Objective: To evaluate whether it is safe and effective for orthopaedic medical staff to provide support to the work against COVID-19.

Methods: One hundred and twenty-two orthopaedic medical staff from the orthopaedic center of Zhongnan Hospital of Wuhan University were included in this retrospective investigation. A total of 43 surgeons and 69 nurses provided medical support in the treatment of COVID-19 patients from 1 January 2020 to 8 April 2020 in four different hospitals in Wuhan. We collected data on the age, gender, and body temperature of orthopaedic medical staff, as well as the results for their chest CT scans, SARS-CoV-2 RNA, SARS-CoV-2 IgM and SARS-CoV-2 IgG tests, and training and examinations on COVID-19 knowledge. We also collected data on the time span of work, the number of infected staff during the support period, the number of COVID-19 patients the surgeons treated and the cure rate, the performance of the surgeons as assessed by the specialists and patients, and the number of infected staff during the pandemic.

Results: Among the 49 surgeons and 73 nurses, 43 surgeons and 69 nurses provided support against COVID-19. A total of 12 surgeons and 11 nurses provided support in the fields of respiration, intensive care, and emergency. A total of 34 surgeons and 58 nurses worked in the designated wards restructured for COVID-19 in the orthopaedic building. The average time span of work for the surgeons and nurses was 14.78 ± 3.64 days and 24.77 ± 7.58 days, respectively. No staff were infected during the support period. Over 1000 patients were received in the fever clinic by orthopaedic surgeons. The overall number of the treated hospitalized patients was 622. Among these patients, 226 cases were mild, 318 were mild to moderate, and 58 were severe or critical. The cure rate was 96.01%, 99.37%, and 52.00% respectively. The performance of the surgeons was scored 87.02 ± 3.17 and 90.69 ± 3.58 by the specialists and the patients, respectively. During the whole pandemic, 3 surgeons and 3 nurses who did not participate in the support work were infected in the early stages. The morbidity of all the orthopaedic staff was 4.92% during the whole pandemic, while no one was infected during the support work.

Conclusion: Our investigation indicated that although they worked outside their specialty, it was safe and effective for the orthopaedic staff to provide medical support in the work against COVID-19 with adequate precautions and proper training.

Key words: COVID-19; Effectiveness; Orthopaedic doctor; Safety; Support work

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Introduction

In late December 2019, a series of pneumonia cases of unknown cause was reported in Wuhan, China, which was soon confirmed as a cluster outbreak of a novel coronavirus disease (COVID-19)¹. COVID-19 proved to be a serious airborne disease, with terrible infectivity and lethality. As COVID-19 spread worldwide, resulting in a global pandemic, clinical work in our hospital was scaled down and all elective surgical procedures were canceled or postponed. With COVID-19 cases increasing, wards of the department of respiratory diseases and the department of infectious disease, the emergency department, and intensive care units (ICU) became fully occupied. Wards in the orthopaedic department and some other specialties were reorganized as quarantine wards for COVID-19 patients following the national guidelines². However, as the pandemic progressed, a shortage of manpower, particularly specialists, became a major problem in the fight against COVID-19.

At the beginning of the outbreak, it seemed to us that COVID-19 and orthopaedic surgery were totally disparate and the impact that the disease would have on orthopaedic surgery, and on surgery for sports medicine in particular, might be merely to scale down the work or even shut down some services. However, as the pandemic progressed, more and more COVID-19 patients appeared, and the shortage of physicians and intensivists had become a major problem that our hospital had to confront. To solve the problem, some of our orthopaedic surgeons were assigned to provide support to the work in the fields of respiration, infectious disease, intensive care, and emergency. Thus, rather than the routine surgical work the orthopaedic surgeons were familiar with and specialized in, they needed to work outside their specialty. In addition, given that the building of the center of orthopaedic surgery was an independent one that was appropriate and convenient for the control and quarantine of the infectious disease, it was restructured and converted to include designated wards for COVID-19 patients. Several surgeons and most of the nurses stayed to work in the building as the basic medical force against COVID-19 under the leadership of the consultants of respiration and infectious disease. Would all this increase the risk of COVID-19 infection for the orthopaedic surgeons and nurses? We were not confident to say no then! What we did learn was that some healthcare workers in our hospital and the other hospitals in Wuhan had been infected with COVID-19. Later, it was reported that as of 11 February 2020, 1716 health professionals had been infected with COVID-19 in China³. As of 22 May 2020, the number of infected Chinese medical professionals had increased to 3607, accounting for 4.27% of the overall infected cases in China, according to a report from the Chinese Red Cross Society⁴.

Data from the American Centers for Disease Control and Prevention (CDC) showed that for a time medical professionals accounted for as high as 19% of the COVID-19 cases in the USA⁵. Given the high infection rate among healthcare workers, the safety of healthcare workers from

specialties other than respiratory and infectious diseases has become a widespread concern. Although surgeons have shared their opinions and experiences in the work to combat the COVID-19 pandemic⁶⁻⁸, based on the outcome of a search in PubMed, up to now no published data is able to provide evidence to illuminate whether or not it is safe for medical staff from other specialties to provide support in the work against the COVID-19 pandemic. In addition, the effectiveness of this kind of support is not yet documented.

The objectives of our study were: (i) to evaluate whether it is safe for orthopaedic medical staff to provide support in the work against COVID-19; (ii) to evaluate if the support work provided by our orthopaedic surgeons and nurses was effective; and (iii) to summarize and share the experiences of our work in directly facing the COVID-19 patients. Thus, we retrospectively investigated the safety of the orthopaedic staff themselves when exposed to the contagious disease when providing support to combat COVID-19 (although with adequate precautions in place and wearing personal protective equipment [PPE]) based on the location of the work, the time span of support work, the number of COVID-19 patients treated by the orthopaedic surgeons and nurses, as well as the number of infected staff during the support period. Meanwhile, the effectiveness of the support by orthopaedic surgeons in the work against COVID-19 was also assessed, based on the cure rate of the patients. A questionnaire was completed by both the specialists from the departments of respiratory diseases and infectious disease, as well as some of the patients who had received treatment from our orthopaedic surgeons. We also reported the details of the orthopaedic staff who were infected with COVID-19 during the whole pandemic. The experiences we gained were also summed up. Thus, our investigation would be the first to provide clinical evidence to demonstrate the safety and effectiveness of medical staff from other specialties providing support in the work against COVID-19, which will be clinically significant for medical practice and helpful to medical administrators in decision-making.

Methods

Study Design and Participants

The purpose of this retrospective investigation is to evaluate the safety and effectiveness of the orthopaedic medical staff from the same orthopaedic unit who provided medical support in the treatment of COVID-19 patients from 1 January 2020 to 8 April 2020 in four hospitals in Wuhan, China. The present study was approved by the Institutional Ethics Board of Zhongnan Hospital of Wuhan University. Informed consent was provided by the participants. The four hospitals included in the investigation were Zhongnan Hospital of Wuhan University (a general hospital designated for COVID-19 patients, which also took over the administration of and provided workforce and technical support for the three following hospitals), the Wuhan 7th Hospital (a designated community hospital for COVID-19 patients),

Dongxihu Cabin Hospital (a simplified temporary hospital for COVID-19 patients with mild disease), and Wuhan Leishenshan Hospital (a designated hospital for COVID-19 patients with severe and critical disease).

The orthopaedic medical staff from Zhongnan Hospital of Wuhan University were included in this study as the participants. Only the staff who fulfilled the following criteria was permitted to participate in the support work against COVID-19: (i) those who were 50 years old or younger without comorbidities such as cardiovascular diseases and diabetes; (ii) non-pregnant women; (iii) those who had completed the training and simulation exercises and passed the exam; (iv) those with normal body temperature, with negative findings on chest CT scans, and without respiratory symptoms; and (v) those who were willing to participate in the work.

The orthopaedic staff worked in the fields of respiration, infectious disease, intensive care, and emergency in the hospitals as support staff. During the outbreak of the COVID-19 infection, the number of COVID-19 patients exceeded the capacity of the designated wards in Zhongnan Hospital. Therefore, the wards in the orthopaedic center were restructured and converted into designated wards for COVID-19 patients given that the building of the orthopaedic center was freestanding with two wings, at the opposite ends of the building, which was appropriate and convenient for control of the infection and quarantine. The plan of the restructured orthopaedic center is shown in Fig. S1. Many orthopaedic medical staff stayed and worked as the basic medical force in the building led by the specialists from respiration and infectious disease.

The training, simulation exercises, and exams before the support work included but were not limited to: (i) knowledge of the epidemiology, diagnosis, and treatment of COVID-19; (ii) basics of lung and respiratory diseases; (iii) basic skills of the associated practice, including cardiopulmonary resuscitation, mechanical ventilation and oxygen therapy, and tracheal suction (iv) guidelines for infection control and PPE usage (the PPE applied in different departments are listed in Table S1); and (v) procedures and facilities for nosocomial infection control. All staff were required to self-isolate and undertake 2 weeks of self-isolation after finishing the support work, respectively.

Data Collection

General Information

Demographic information included: age, gender, and chronic medical history (e.g. cardiovascular diseases and diabetes). Work information included: records of training, simulation exercises and an exam before the support work, specialty or unit supported, time span of work, number of patients treated, severity classification, and outcome of the COVID-19 patients treated.

Clinical Data

Clinical data included: body temperature, symptoms (if any), time of onset of the first symptom, and results of chest CT scan, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA test and SARS-CoV-2 specific IgM/IgG test, and other laboratory findings. Only the most typical outcomes of the chest CT scan and the laboratory tests were included, as repeated tests were applied. Criteria for the infection diagnosis were in accordance with the World Health Organization interim guidance⁹. The criteria for discharge of COVID-19 patients were as described in the national guidelines².

Evaluation of the Support Work

The performance of the orthopaedic surgeons was assessed by the specialists (the content of the questionnaire is listed in Table S2, with a score on a scale of 100). Patient satisfaction was evaluated by patients before discharge using the questionnaire adopted routinely in the orthopaedic center for patients (the content of the questionnaire is provided in Table S3, with a score on a scale of 100).

Statistical Analysis

The aim of this study is to investigate the safety and effectiveness of the orthopaedic medical staff who provided support in combating the COVID-19 pandemic. There were no formal hypotheses being implemented to drive the sample size calculation. In our analysis we included the number of orthopaedic surgeons and nurses who provided the support, the time span of their work, the number of infected staff during the support period, the number of COVID-19 patients the surgeons treated and the cure rate, the performance of the surgeons as assessed by the supervising specialists and the patients treated, and the number of infected staff during the whole pandemic. Continuous variables were expressed as means and standard deviations. Categorical variables were summarized as counts and percentages. The infection rate of the medical staff and the cure rate of the COVID-19 patients were calculated. No statistical comparison was conducted or modeling applied.

Results

Overview of the Support Work by the Orthopaedic Staff

There were 49 surgeons and 73 nurses, adding up to 122 medical staff, in our orthopaedic center. A total of 116 staff accepted the training and passed the assessment, of whom 112 participated in the treatment of COVID-19 patients, including 43 surgeons and 69 nurses; 47 were men, with an average age of 37.02 ± 6.79 years, while 65 were women, with an average age of 29.09 ± 6.32 years (Table 1). From 1 January 2020 to 8 April 2020, the medical staff of our orthopaedic center provided support to the fever clinic, the emergency unit, the wards of the cabin hospital, the unit of infectious disease, and ICU, and worked as the basic medical force in the restructured orthopaedic center designated for COVID-19 patients (Table 1; also see Fig. 1 for the timeline). The arrangement of the staff was as

TABLE 1 Overview of the support work against COVID-19 of the orthopaedic staff and their safety¹

| Support work by the orthopaedic staff | Support work outside the orthopaedic center | | | | | |
|---------------------------------------|---|---|--|-------------------------|---|--|
| | Support work in the designated wards of the restructured orthopaedic center | Fever clinic (Wuhan 7th Hospital and Zhongnan Hospital of Wuhan University) | Emergency department (Zhongnan Hospital of Wuhan University) | Dongxihu Cabin Hospital | Department of infectious diseases (Zhongnan Hospital of Wuhan University) | Intensive care unit (Zhongnan Hospital of Wuhan University and Wuhan Leishenshan Hospital) |
| Surgeons | | | | | | |
| Number | 34 | 2 | 0 | 3 | 0 | 7 |
| Patients treated | 318 | NA | 0 | 226 | 0 | 58 |
| Time span of support (day/surgeon) | 16.15 ± 2.18 | 12.50 ± 0.71 | 0.00 | 11.00 ± 1.00 | 0.00 | 17.00 ± 7.46 |
| Rate of infection | 0.00% (0/34) | 0.00% (0/2) | - | 0.00% (0/4) | - | 0.00% (0/7) |
| Nurses | | | | | | |
| Number | 58 | 2 | 1 | 0 | 3 | 5 |
| Time span of support (day/nurse) | 24.43 ± 7.29 | 30.50 ± 0.71 | 36.0 | 0.00 | 16.67 ± 12.58 | 29.00 ± 4.36 |
| Rate of infection | 0.00% (0/58) | 0.00% (0/2) | 0.00% (0/1) | - | 0.00% (0/3) | 0.00% (0/5) |

Data from 1 January 2020 to 8 April 2020 was included in the table.; All elective orthopaedic surgeries were canceled or postponed from 22 January 2020 to 20 April 2020, except for trauma and tumor surgeries.; Staff rotated through different positions due to the need for more manpower during the epidemic of COVID-19.

follows: (i) 2 surgeons and 2 nurses worked in a fever clinic for 12.50 ± 0.71 days and 30.50 ± 0.71 days, respectively, 1 nurse worked in the emergency unit for 19.0 days, 3 surgeons worked in the cabin hospital for 11.00 ± 1.00 days, and 7 surgeons and 5 nurses worked in the ICU for 17.00 ± 7.46 days and 29.00 ± 4.36 days, respectively; (ii) another 34 surgeons and 58 nurses, respectively, aged 38.47 ± 6.32 and 29.16 ± 6.42 on average, worked in the designated wards for COVID-19 patients in the orthopaedic center guided and supervised by a consultant of infectious disease and a consultant of respiration (Tables 1 and 2). The time span of work in the designated wards of the restructured orthopaedic center for the orthopaedic surgeons and nurses was 16.15 ± 2.18 days and 24.43 ± 7.29 days, respectively (Table 2).

Safety of the Orthopaedic Medical Staff in the Treatment of COVID-19 Patients

There were 43 orthopaedic surgeons and 69 nurses directly involved in the clinical work for 622 hospitalized COVID-19

patients and over 1000 patients in the fever clinic, with a 14.78 ± 3.64 day and 24.77 ± 7.58 day average time span of work, respectively (Table 1). All staff were supplied with adequate and proper PPE. Because of the surge of patients with fever and the heavy workload, clinical data for the fever clinic were not maintained appropriately and completely; therefore, we could not obtain the exact number of patients. Three orthopaedic operations (two cases of fracture fixation and one case of leg amputation) were performed for patients with COVID-19 during the pandemic. Before they started the support work, the body temperatures of the surgeons and nurses all tested normal and no abnormalities were found on chest CT scan (Table 2 and Table S4). All staff were accommodated in a hotel in single room for the duration of the support work. Each of the staff self-isolated after finishing the support work. Staff stayed in single rooms in the same hotel. Body temperature tests, chest CT scans, throat swabs for SARS-CoV-2 RNA tests, and SARS-CoV-2 IgM/IgG tests were performed for all of the orthopaedic staff

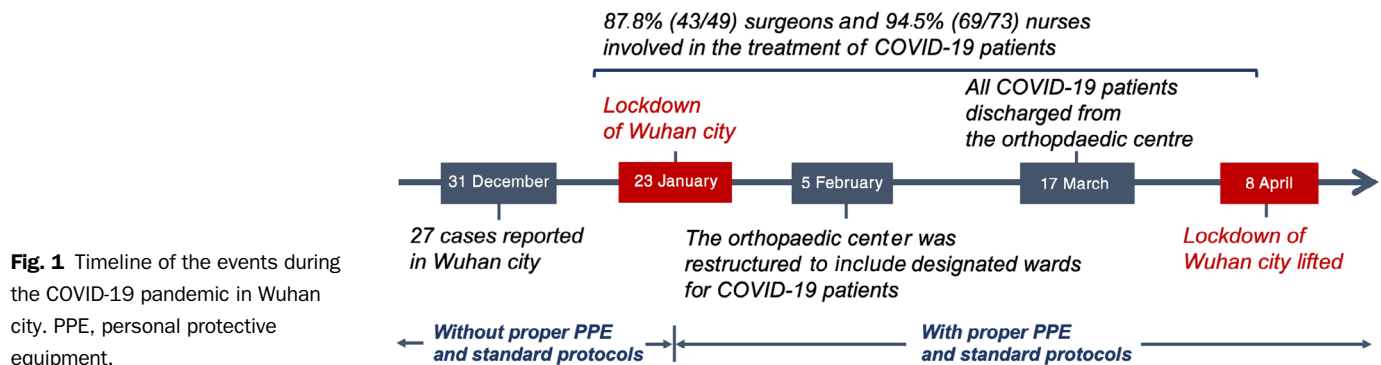


Fig. 1 Timeline of the events during the COVID-19 pandemic in Wuhan city. PPE, personal protective equipment.

TABLE 2 Details of the orthopaedic staff working in the designated wards of the restructured orthopaedic center

| Details of the orthopaedic staff | Surgeons | Nurses |
|---|--------------|----------------|
| Total number | 34 | 58 |
| Gender | All male | 56 women/2 men |
| Average age | 38.47 ± 6.32 | 29.16 ± 6.42 |
| Time span of support (day/surgeon) | 16.15 ± 2.18 | 24.43 ± 7.29 |
| Test before support | | |
| Body temperature (°C) | Normal | Normal |
| Chest CT scan | -(34)/+(0) | -(58)/+(0) |
| Test after support | | |
| Body temperature (°C) | Normal | Normal |
| Chest CT scan | -(34)/+(0) | -(58)/+(0) |
| SARS-CoV-2 RNA | -(34)/+(0) | -(58)/+(0) |
| SARS-CoV-2 IgM | -(34)/+(0) | -(58)/+(0) |
| SARS-CoV-2 IgG | -(34)/+(0) | -(58)/+(0) |
| Self-isolation during/after the support | Yes/Yes | Yes/Yes |

after the support work. Of the 112 staff, none demonstrated abnormal body temperatures. Results for chest CT scans, throat swabs for SARS-CoV-2 RNA tests, and SARS-CoV-2 IgM/IgG tests were negative for all staff (Table 2 and Table S4).

During the whole pandemic, 6 orthopaedic medical staff who did not participate in the support work were confirmed to have been infected with COVID-19, of whom 3 were surgeons and 3 were nurses (Table S5); 5 of them had mild symptoms, while 1 experienced moderate symptoms. Among them, 3 were probably infected by the same patient with COVID-19 in the Division of Orthopaedic Trauma, while the infection source of the other 3 remained unknown (Table S5). The onset of the symptoms was between 1 and 31 January 2020. More detailed information on the 6 infected staff is listed in Table S5 and Fig. S2. In addition, 5 weeks after the lifting of the lockdown in Wuhan city and the withdrawal of all the medical staff from the frontline, throat swabs for SARS-CoV-2 RNA tests were carried out for every Wuhan citizen (organized by the city government for free). The screening showed negative results for the 112 staff who provided the support and the 6 infected staff who finally recovered. The results for the family members of the staff who provided the support were all negative too.

Effectiveness of the Orthopaedic Surgeons in the Treatment of COVID-19 Patients

Guided and supervised by the specialists, a total of 622 COVID-19 patients were treated by the orthopaedic surgeons. Of the 622 cases, 226 cases with mild disease were in the cabin hospital, among whom 211 (93.36%) were cured and discharged, while 15 (6.64%) patients were transferred to the nearby designated hospital due to aggravation of illness (Table 3). A total of 318 COVID-19 patients with mild to moderate disease were hospitalized in the designated wards of the orthopaedic center (Table 3). Among them,

316 (99.37%) were cured, while 2 patients were transferred to the unit of infectious disease. A total of 58 patients with severe or critical disease were in ICU in Zhongnan Hospital of Wuhan University and Wuhan Leishenshan Hospital, among whom 26 patients (44.83%) were cured, 24 (41.38%) died, and 8 (13.79%) remained in the hospital when the surgeons withdrew from the work (Table 3). Thus, the cure rate of the severe/critical cases was 52.00% (26/50), except for the patients who remained hospitalized in ICU at that time (Table 3). Given that the patients in the fever clinic were not all confirmed as having COVID-19, they were not enrolled in this section for analysis.

Every one of the surgeons was scored according to their performance by the specialists who guided and supervised them. With an 87.02 ± 3.17 overall average score for the 43 surgeons, 3 surgeons working in the cabin hospital scored 89.00 ± 1.00 (88 to 90), 34 surgeons working in the designated wards of the orthopaedic center scored 86.15 ± 2.89 (80 to 93), while 7 surgeons working, respectively, in ICU in Zhongnan Hospital of Wuhan University and Wuhan Leishenshan Hospital scored 90.43 ± 2.37 (86 to 93, Table 3). The surgeons, who had provided support in the designated wards of the restructured orthopaedic center for COVID-19 patients, the cabin hospital, and ICU, scored: 27.12 ± 1.84 , 26.33 ± 0.58 , and 27.71 ± 1.38 for nosocomial infection control and personal protection; 12.76 ± 0.85 , 14.00 ± 1.00 , and 13.57 ± 0.79 for general practice and skills; 16.85 ± 0.82 , 17.33 ± 0.58 , and 17.86 ± 0.90 for knowledge of respiratory diseases and infectious disease; 16.71 ± 1.22 , 18.00 ± 1.00 , and 17.71 ± 0.95 for capability of observation, execution, and professionalism; and 12.71 ± 0.94 , 13.33 ± 0.58 , and 13.57 ± 0.79 for communication and cooperation, respectively (Table 3). Scoring for patient satisfaction could not be carried out outside the designated wards of the orthopaedic center basically due to different working processes and habits. In the designated wards of the orthopaedic center, 125 COVID-19 patients assessed the performance of the surgeons who treated them according to the questionnaire before their discharge. An average score of 90.69 ± 3.58 (83 to 99) was given to the surgeons (Table 3). The surgeons, who worked in the designated wards of the restructured orthopaedic center for COVID-19 patients, received an average score from the patients of 46.06 ± 2.10 for professionalism and availability, 17.18 ± 1.73 for responsibility and professionalism, and 27.45 ± 1.73 for humanism, care, and comfort (Table 3).

Discussion

The COVID-19 pandemic has brought the whole world and the medical profession to an unprecedented situation and has resulted in a global healthcare crisis. As the epicenter of the outbreak, Wuhan experienced a tough period of time. As the crisis progressed, hospitalizations overwhelmed the local healthcare system, and almost depleted the medical resources. There was a surge in demand for medical workers in the fields of respiration, infectious

TABLE 3 Overview of the effectiveness of the support work by the orthopaedic surgeons

| Criteria to evaluate the effectiveness | Designated wards of restructured Orthopaedic center for COVID-19 patients | | |
|--|---|---------------------|--|
| | Cabin hospital | Intensive care unit | |
| Training and simulation exercises before support work | Yes | Yes | Yes |
| Test passed before support work or not | Yes | Yes | Yes |
| Patients treated | 318 | 226 | 58 |
| Mild/moderate disease | 318 | 226 | 0 |
| Cure rate | 99.37% (316/318) | 93.36% (211/226) | — |
| Aggravation | 0.63% (2/318) | 6.64% (15/226) | — |
| Mortality | 0.00% (0/318) | 0.00% (0/226) | — |
| Severe/critical disease | 0 | 0 | 58 |
| Hospitalization | — | — | 13.79% (8/58) |
| Cure rate | — | — | 44.83% (26/58); 52.00% (26/50) except those who were still hospitalized |
| Mortality | — | — | 41.38% (24/58) |
| Score of performance of the surgeons assessed by specialists (100') | 86.15 ± 2.89 | 89.00 ± 1.00 | 90.43 ± 2.37 |
| Nosocomial infection control and personal protection (30') | 27.12 ± 1.84 | 26.33 ± 0.58 | 27.71 ± 1.38 |
| General practice and skills (15') | 12.76 ± 0.85 | 14.00 ± 1.00 | 13.57 ± 0.79 |
| Knowledge in respiratory diseases, and infectious diseases (20') | 16.85 ± 0.82 | 17.33 ± 0.58 | 17.86 ± 0.90 |
| Capability of observation, execution, and professionalism (20') | 16.71 ± 1.22 | 18.00 ± 1.00 | 17.71 ± 0.95 |
| Communication and cooperation (15') | 12.71 ± 0.94 | 13.33 ± 0.58 | 13.57 ± 0.79 |
| Score of performance of the surgeons assessed by the patients (100') | 90.69 ± 3.58 | — | — |
| Professionalism and availability (50') | 46.06 ± 2.10 | — | — |
| Responsibility and professionalism (20') | 17.18 ± 1.73 | — | — |
| Humanism, care and comfort (30') | 27.45 ± 1.73 | — | — |

disease, intensive care, and emergency healthcare workers from other specialties, including those from surgery, provided support in the frontline fight against COVID-19. This measure was adopted by many hospitals to cope with the growing number of COVID-19 patients.

It is Safety of Orthopaedic Staff Providing Support Work against COVID-19

The SARS-CoV-2 virus, the pathogen of COVID-19, is a new coronavirus with high contagiousness and strong pathogenicity. A large number of medical professionals were infected by this virus in clinical work or daily life. Data from the US CDC showed that medical professionals accounted for as high as 19% of the COVID-19 cases in the USA⁵. According to a report from the Chinese Red Cross Society, as of 22 May 2020, the number of infected Chinese medical professionals was 3607, accounting for 4.27% of the overall infected cases in China⁴. Given the high infection rate among healthcare workers, the safety of the medical support workers from specialties outside the fields of respiratory and infectious disease has become a widespread concern. In our investigation, 43 orthopaedic surgeons and 69 nurses participated in the clinical work against COVID-19 on the frontline, with a 14.78 ± 3.64 day and 24.77 ± 7.58 day time span of work, respectively. The results showed that none of the orthopaedic surgeons and nurses were infected with COVID-19.

The negative results of the screening for SARS-CoV-2 RNA 5 weeks after their withdrawal further validated that the support work was not only safe for the supporters themselves but also for their family members. Our investigation demonstrates that with adequate precautions, it was safe for the orthopaedic medical staff to participate in the work against COVID-19 after proper training and simulation exercises.

As for the infected colleagues, the onset of the symptoms occurred between 1 and 31 January 2020. Considering the 5.1-day median incubation period and the 11.5-day asymptomatic duration after exposure^{10,11}, the infections actually began earlier than the symptoms indicated, which was in the period before the lockdown of Wuhan city. During that period, the awareness of citizens, even medical personnel, of the infectious characteristics of COVID-19 was minimal and the precautions taken were far from adequate. Some staff did not even wear a surgical mask in hospital public settings, such as elevators. It was not until late January that appropriate precautions were taken. At that stage, wide screening for COVID-19 had not started. Some COVID-19 infections were underlying among the orthopaedic patients. Of the 6 infected colleagues, 1 surgeon and 2 nurses had definite contact histories with an intertrochanteric fracture patient with fever who was later confirmed to be positive for COVID-19. The infection rate of the medical staff of the orthopaedic center was 4.92%, which was more than 10 times

higher than that of the population in Wuhan¹⁰. This indicates that hospitals are high-risk places for COVID-19 infection and that healthcare workers are at higher risk of COVID-19 infection if appropriate precautions are not taken.

Provision of Support Work against COVID-19 by Orthopaedic Staff Was Effective

In the working process, the specialists of corresponding specialties developed a therapeutic regimen for every individual patient and then the orthopaedic surgeons implemented the regimen. The orthopaedic surgeons also undertook the daily medical work of running the wards for COVID-19 patients, including: diagnosis and admission, the morning and afternoon ward round, pharmacotherapy and psychotherapy, emergency medical care and referral when patients' condition worsened, daily data collection and reporting to the Chinese Center for Disease Control and Prevention, and compiling progress notes and other paperwork. The nurses provide standard nursing care in the wards. During participation in the work against COVID-19, the orthopaedic surgeons were in charge of and treated 622 hospitalized cases of COVID-19. Among these, 226 were mild cases in the cabin hospital, 318 were mild to moderate cases in the designated wards of the orthopaedic center, and 58 were severe or critical cases in ICU. The cure rate was 96.01%, 99.37%, and 52.00%, respectively. Zhou *et al.* reported that the cure rate for COVID-19 patients with mild and moderate disease was 100%, while that for patients with severe and critical disease was 54.62%¹², which was in accordance with our data. In the fever clinic, more than 1000 patients were diagnosed with fever, segregated, and dealt with accordingly. After finishing the work on the frontline, the performance of the surgeons was scored 87.02 ± 3.17 by the corresponding specialists who guided and supervised them, which indicated a generally good performance. The performance of the surgeons was also evaluated from the point of view of the treated patients. The performance of the surgeons in the designated wards of the orthopaedic center was scored 90.69 ± 3.58 by 125 patients. The results demonstrate that it was effective for the orthopaedic surgeons to work on the frontline against COVID-19 under the guidance and supervision by the specialists, mitigating the shortage of physicians and intensivists during the pandemic. As some researchers have pointed out, orthopaedic surgeons are intelligent, versatile and strong^{13,14}. In times of need, it is that strength and versatility that others could rely on and turn to.

Our Experience in the Support Work against COVID-19

During the period of work against COVID-19, we have gained some experience to share with medical colleagues.

First, as age over 55 years and the comorbidities of cardiovascular diseases and diabetes were major risk factors of COVID-19 infection, only orthopaedic staff under the age of 50 without comorbidities were sent to participate in support work against COVID-19. Pregnant nurses were not permitted to participate. Second, all of the support workers accepted the necessary training and passed the exams before entering the frontline, and every one of them participated in simulation exercises. Third, before participating in the work, every one of the support workers underwent chest CT scans and temperature tests to exclude possible infection. When the nucleic acid test became easily available, the support workers also accepted throat swab tests. Fourth, during the support period, every staff member working on the frontline was accommodated in a hotel in a single room to ensure their safety and that of their family members. Finally, to prevent negative emotions and to cope with stress, emotional support was regularly provided by senior staff who did not participate in the work and by experts if needed.

Limitations of this Study

Our study also has several limitations. First, this is a single center study and the sample size is small, which may result in bias. Second, it is a retrospective study without a control group and statistical comparison; thus, the level of evidence is not sufficiently high. Third, the therapeutic regimens for COVID-19 patients were developed by the specialists and the surgeons implemented them; thus, the value of using the cure rate to assess the effectiveness of the support work is limited or is not sufficiently persuasive. It could only partially reflect the effectiveness of the work by the surgeons. Fourth, different specialists scored the performance of the surgeons. There might exist subjectivity, although the questionnaire itself was objective. Further evidence from other centers, other countries, and other specialties is needed to strengthen our findings.

Conclusion

This study clarifies that after adequate training and with appropriate precautions, it was safe and effective for orthopaedic staff to provide support in the work against COVID-19, although medical staff are at higher risk of COVID-19 infection. This finding is clinically significant for medical practice and provides evidence to medical administrators for decision-making.

Ethical Approval

This study conformed to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the ethics committee of the Zhongnan Hospital of Wuhan University (No. 2020165).

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