Challenges and Experiences of Dental Medicine in Combating the COVID-19 Pandemic

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The world has been suffering incredible loss due to a pandemic caused by a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; 2019-nCoV). The disease was later named the coronavirus disease-19 (COVID-19). The transmission routes of COVID-19 include respiratory transmission, aerosol transmission, and contact transmission. Many dental diagnosis and treatment procedures generate droplets and aerosols, and thus both dental staff and patients are at a high risk of becoming infected and transmitting COVID-19 to others. Shanghai Ninth People’s Hospital is a comprehensive hospital with 18 craniofacial-/dental-related departments. During the outbreak of COVID-19 and up to the present date, there have been no confirmed cases of COVID-19 in this hospital thanks to strict protocols for infection prevention and control. In this communication, we would like to share with the prosthodontic community our experience in the prevention and control of COVID-19 in our dental departments and hope it will contribute to the worldwide efforts to overcome the global COVID-19 pandemic. Int J Prosthodont 2020;33:599–608. doi: 10.11607/ijp.7139

In December 2019, an epidemic caused by a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; also called 2019 novel coronavirus [2019-nCoV]) broke out. It has since spread globally at a rapid pace, resulting in a pandemic called COVID-19. To date (September 2, 2020), the total number of confirmed COVID-19 patients worldwide was more than 25 million, and the number of deaths more than 850,000. The COVID-19 pandemic is still spiking in many countries around the world, including in developed countries still experiencing the first or second wave of the outbreak with a significant increase in new cases. These outbreaks may indicate suboptimal adherence to COVID-19 prevention and control measures in these countries.

The most common symptoms of COVID-19 are respiratory infection, including sneezing, sore throat, dry cough, fever, and fatigue. It may also cause digestive and urinary system dysfunctions and might affect gustatory and olfactory sensations. The routine diagnosis of COVID-19 infection is based on computed tomography (CT) imaging findings of multifocal patchy opacities in both lungs, along with laboratory testing for 2019-nCoV. These tests are usually carried out in symptomatic patients, since their
performance in asymptomatic individuals who have not been exposed to COVID-19 is still unknown. It is noteworthy that patients may also remain positive after recovery and may continue to shed the virus months after symptomatic recovery from COVID-19.3–5

As an acute respiratory infectious disease, COVID-19 has been included among the Class B infectious diseases specified in the Law of the People’s Republic of China on Infectious Disease Prevention and Cure; however, it has been managed as a Class A infectious disease.5 Consequently, the Shanghai Health Commission activated a first-level emergency response. Class A includes infectious diseases that can cause large and rapid epidemics and require compulsory response measures, such as plague and cholera, while Class B includes infectious diseases with strong infectivity that require strict control and prevention measures, such as AIDS, measles, and malaria.6

On March 23, 2020, the outbreak status in China was changed into a mitigation stage, and a second-level emergency response was activated. This included the opening of China’s borders. Currently, China is experiencing a second wave of infection that is believed to be the result of opening the borders and the subsequent import of COVID-19 cases. By July 21, the total number of imported COVID-19 patients in China was 2,015. Current guidelines dictate that subjects traveling back to China should self-quarantine for 14 days. Thanks to the devoted work of the medical and public health staff and the strict prevention and control measures at China’s ports of entry and designated isolation hotels, it appears as if the second wave of infection has so far been controlled.

On May 9, as the number of imported infected patients decreased to almost 0, the Shanghai Health Commission officially activated a third-level emergency response to the COVID-19 outbreak.

Dentists and dental patients are generally considered to be at high risk of catching infectious diseases (including COVID-19) during treatment. Thus, dentists have always been implementing strict infection control policies, which may explain the apparently small number of reported cases of COVID and other infectious diseases among dentists. However, it is also possible that data are still unavailable. Thus, it is crucial to share with the dental community the successful measures that Shanghai Ninth People’s Hospital has been implementing in preventing the spread of COVID-19 among health care providers and patients. Indeed, according to the May 17 report of the Chinese Stomatological Association,7 since the start of the COVID-19 pandemic outbreak in China, there has been no dental treatment–related COVID-19 infection transmission among dental health care providers or patients in any Chinese stomatology department. To date, the daily life in Shanghai, including the dental and medical services in the hospital, have resumed almost normal activities.

Shanghai Ninth People’s Hospital is a comprehensive hospital with the largest number of craniofacial/dental-related departments (n = 18) and treats the largest number of craniofacial/dental patients in Shanghai. In 2019, there were 1.426 million dental outpatient visits and emergency room visits in the hospital, over 32,000 dental outpatient surgeries, and more than 13,000 dental inpatient surgeries. The number of oral outpatient visits and emergency room visits per dental surgeon per year was over 3,300. There are more than 700 professional dental staff.

At Shanghai Ninth People’s Hospital and the Faculty of Dentistry at the College of Stomatology in Shanghai, strict protocols for infection prevention and control have always been standard operating procedures, and these have been further extended to meet needs during this COVID-19 pandemic. These have indeed proved effective in infection prevention and control since, to date, there have been no confirmed cases of COVID-19 in the dental departments at Shanghai Ninth People’s Hospital or in the Faculty of Dentistry. Since private and hospital dental clinics cancelled all outpatient services at an early stage of the outbreak in China, the private dental surgeons in Shanghai may have also not been infected; however, no public data are available.

Thus, Shanghai Ninth People’s Hospital is in the best position to provide firsthand perspectives of the experiences and challenges in combating the spread and containing the threat of the COVID-19 pandemic while managing dental practices and teaching. It is hoped that the prevention and control measures and the points of consideration taken in Shanghai Ninth People’s Hospital outlined in this paper will help other dental institutions and private practices to fight against COVID-19 and other similar infectious diseases.

THE STATE AT SHANGHAI NINTH PEOPLE’S HOSPITAL

Since dental operations are at high risk of producing droplets and aerosols and thus for virus transmission, during the very early stage of the COVID-19 outbreak (January 29, 2020), the Chinese Stomatological Association, Shanghai Jiao Tong University School of Stomatology, and Shanghai Ninth People’s Hospital have issued new dental work management guidelines.4 The Guidelines of Shanghai Jiao Tong University School of Stomatology on Prevention and Control of New Coronavirus Pneumonia in Oral Outpatient Operation provided detailed guidelines for the management of clinical work. The guidelines consist of four parts, including restriction on the number of outpatients, prevention criteria for pre-examination of patients and triage, prevention criteria...
for dental diagnosis and treatment, and suggestions for
treatment of the environment.8

On the same day, Shanghai Ninth People’s Hospital
issued an outpatient arrangement. In China, general out-
patients usually get service in a walk-in manner and not
by appointment. But on January 29, on-site registration
of nonurgent outpatient services in dental departments was
cancelled. Patients had to postpone their visits unless they
had trauma, infection, acute pain, bleeding, malignant
tumor, or another emergency condition. All emergency
appointments had to be made online or by phone call.
However, in order to meet the daily needs of the general
public for oral diagnosis and treatment, Shanghai Ninth
People’s Hospital also developed telephone and online
consulting systems. Patients can upload their information,
signs, symptoms, and questions online and communicate
with a dental surgeon through texting and pictures.

On February 4, the Shanghai Health Commission of-
 officially mandated each discipline performing operations
in the hospital to assess the level of risk for exposure and
transmission of COVID-19 and to determine the protec-
tive measures required. The disciplines with a high risk of
COVID-19 exposure and spread included the disciplines
of stomatology, ophthalmology, otolaryngology, and re-
spiratory endoscopy operations. Medical staff and stocks
of protective equipment and materials were allocated to
each discipline based on the risk assessment and protec-
tion required.

RESUMPTION OF DENTAL TREATMENTS IN
SHANGHAI

Starting February 14, 2020, Shanghai Ninth People’s
Hospital cancelled all outpatient services, and only the
dental emergency departments were accepting a few
emergency cases.

At this time, only a few of the dental staff returned
to work at the hospital for treating inpatients only. On
March 2, the hospital started seeing outpatients by ap-
pointment only. By the middle of March, about half of
the dental health providers had returned to work. By the
middle of April, almost all dental health providers had re-
turned to work except for international residents or those
residing in areas severely affected by COVID-19. These
health care providers first had to self-quarantine for 14
days. From February to the middle of April, depending on
department needs, each dental health provider worked in
shifts of 2 days per week, then 3 days, and then 4 days.

On April 22, Shanghai Ninth People’s Hospital started
to resume the normal flow of dental treatments with
strict prevention and control measures. To nonlocal pa-
itients, especially those from potential epidemic areas and
abroad, molecular (nucleic acid) testing for SARS-CoV-2
was recommended.

At the end of March, the overall number of dental-
medical outpatient visits and in-hospital services and op-
erations in Shanghai Ninth People’s Hospital had reached
75% of the previous years’ volumes, and no new infec-
tions in dental-medical staff were reported.

In February, each emergency patient was treated in a
separate operating room. Since March 2, the number of
patients and dentists per operating room has gradually
increased, and additional departments in the hospital
have been providing emergency treatments while keep-
ing patient-patient distancing and all infection prevention
and control measures as outlined below. The teaching
clinics for dental students remained closed and then
reopened on May 6, 2020 (see Reopening of Dental
Schools and Student Graduation).

COVID-19 Infection Prevention and Control
Guidelines

The main measures of COVID-19 infection prevention
and control have been directed by the Chinese and Shanghai
Health Commission, and Shanghai Ninth People’s Hospi-
tal has made additional changes and adjustments. Since
the situation of the outbreak has been changing day by
day, the guidelines have also been constantly changing.

Crucial measures for early detection of infected sub-
jects to allow for their early isolation and treatment in-
clude the following:

- Mandatory monitoring of fever (body temperature ≥
37.3°C [99.14°F]) in fever clinic and early warning in
key populations.
- Increased screening efforts in all medical-dental
institutions.
- Symptoms of a cough, runny nose, fatigue, etc.
- History of travel or residency in epidemic areas or
contact with any person with a fever or who had
been to epidemic areas within the past 2 weeks.
- Encouraging enterprises and institutions to test for
COVID-19 nucleic acid in all essential workers who
reside in epidemic areas and who need to return to
work.

In addition, Shanghai Ninth People’s Hospital has
implemented the following measures:

- Safe workflows (Fig 1).
- Social and patient-patient distancing; depending
on the size and layout of each operating room, 1 to
a maximum of 3 patients are admitted into a 1- to
6-chair clinic.
- Hand hygiene protocols.
- Utilization of an effective personal protective
equipment (PPE) program that matches the level
of risk of infection spread (see Personal Protection
Equipment).
- Regular physical examination of staff.
Departments, different expert committees of the Chinese Stomatological Association have put forward differentiated guidelines in accordance with the Diagnosis and Treatment Guidelines of COVID-19 given by the National Health Commission.9–11

### Risk of Infection Spread, Operation Rooms, and Occupational Protection Strategies

Different levels of risk of infection spread for different operations were identified, and different levels of staff protection standards were provided (Fig 3). For example, in the Department of Prosthodontics, frequent use of a high-speed turbine, a slow handpiece for denture repair, and other devices that are likely to generate droplets

- Regular training of staff (Fig 2).
- Careful consideration and limited use of nitrous oxide sedation, as there is insufficient information related to best-practice cleaning, filtering, and potential aerosolization of COVID-19. Best practice is to contact the manufacturer of the nitrous oxide delivery system for specific recommendations for tubing and bag sterilization. If they cannot be sterilized, disposable tubing and bag replacement between patients may be recommended.
- Patient education of infection prevention.

At present, depending on the patients’ dental needs and the dental-medical operations in the various departments, different expert committees of the Chinese Stomatological Association have put forward differentiated guidelines in accordance with the Diagnosis and Treatment Guidelines of COVID-19 given by the National Health Commission.9–11

**Fig 1** General workflow of dental diagnosis and treatment. The most important steps in infection prevention and control at this time are patient preexamination and triage. If the patient has neither a fever nor positive epidemiologic history, they are provided with regular treatment in a safe manner. If the patient has a fever or positive epidemiologic history, but the treatment is nonurgent, the patient is advised to go to a designated fever clinic or to self-quarantine. If the treatment is urgent, the patient is treated in an isolated manner and under the inpatient workflow for COVID-19 patients in dental institutions. If both fever and a risky epidemiologic history are identified, whether the treatment is urgent or nonurgent, the patient is first isolated in an isolating room within the clinic until further instruction from COVID-19 testing. Staff who come in contact with these patients must adhere to Grade 3 precautions, and the operating area must be disinfected after the patient leaves the room.
and aerosols are a high-risk source of COVID-19 transmission.\textsuperscript{9,12–14} However, routine oral examination and treatment planning are of low risk, since splattering hardly occurs.

\textbf{Types of splattering treatment considered high risk for infection spread.} According to the guidelines from the Prosthodontics Committee of the Chinese Stomatological Association, splattering treatments include: denture adjustment and modification; crown removal; adhesion of restorations; impression-taking; use of high-speed turbine; use of three-way air syringe; try-in and adjustment of restorations; and chairside repair of restorations. Thus, according to the different operational risks, clinics have been divided into two types of separate rooms: (1) the general operating room, where there is a low risk of infection spread and dental-medical personnel adopt first-level protection (Grade 1 protection); and (2) the splattering operation room, where there is a high risk of infection spread. In splattering operating rooms where operations involve no aerosol generation, personnel have to adopt Grade 2 protection and wear protective N95 masks. In splattering operating rooms where operations do produce aerosols, personnel have to adopt Grade 3 protection and also wear goggles and protective clothing (Fig 3). Implementing and enforcing these operations will ensure the safety of the dental-medical staff and patients and also control the risk of community transmission.

\textbf{Workflow in different oral departments in Shanghai.} In oral and maxillofacial surgery, patients often seek medical treatment due to infection-induced inflammation. Therefore, these patients usually show symptoms of fever and fatigue. This requires a careful investigation of personal and medical histories during patient admission for treatment. In addition, accurate diagnosis of COVID-19 is carried out according to the Diagnosis and Treatment Guidelines given by the National Health Commission (also seen in Fig 1).

The Oral Emergency department has been the busiest department in the hospital with the highest risk of infection spread. Thus, dentists who are in direct contact with patients require high standards of prevention and control protocols (Grade 3). All other emergency department personnel (eg, nurses, triage, and pre-examination staff) must adhere to Grade 2 preventive measures (Fig 3). In addition, the emergency rooms have been equipped with fresh-air ventilation to dilute the concentration of possible airborne infectious particles (all other areas use the central air cleaning system).

\textbf{Typical dental clinic layout.} Operating rooms and hallways in clinics were rearranged in a way that limited the number of patients within the waiting rooms, hallways, and operating rooms and thus minimized infection spread (Fig 4). Any item that could not be cleaned with a disinfectant was removed from the clinic area. Clinics were divided as follows: The “buffer area” is designated for staff donning and doffing of PPE; disinfection; and dental technician work. This area can be accessed directly from the elevator through the restroom/dressing room and office, which are connected to the disinfection rooms. Staff arriving at the buffer area have already changed their clothes and worn medical coveralls at the hospital basement lockers. The “clean” areas are staff resting and preparation areas, and “contaminated” areas are those designated for dental operations, triage, preexamination, and the patients’ waiting area. In addition, there are separated passages for patients and staff (Fig 4). The preexamination and triage areas allow for the direction of patients with fever and positive epidemiologic history to high-risk isolation rooms, while patients with no signs and symptoms are directed to the dental operating rooms.

Each of the above areas is occupied by one designated staff member, including one at the entrance to the clinic, one at the triage, one for helping other staff members with gown donning and another for gown doffing, and one member who takes care of receiving all protection and prevention materials and equipment.

\textbf{Disinfection Measures}

Limited data are available on the survival of COVID-19 on different surfaces, including surgical masks. One
adequate ventilation is an effective way to dilute indoor aerosols and improve air quality. This can be achieved by opening windows to allow for fresh air influx directly into the operating room or by electric ventilators. A plasma air purifier system is currently operating only in the fever clinic of Shanghai Ninth People’s Hospital. Dental clinics are considered to be relatively safe areas since, prior to arriving at the dental clinic, patients are preexamined and triaged using epidemiologic contact history, body temperature, respiratory symptoms, and four test results (routine blood test, nucleic acid test, CT, and antibody test within 1 week) to rule out a COVID-19 infection.

For aerosol-generating procedures, there is currently very limited evidence for the benefit of negative pressure rooms. Operating room surfaces, equipment, and lab work. Any item in the consultation and operating rooms

<table>
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<th>Grade 1</th>
<th>Preexamination and triage</th>
<th>Grade 2</th>
<th>Non–aerosol-generating operations</th>
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<th>Aerosol-generating operations</th>
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<td>Medical coveralls</td>
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Fig 3 Occupational protection strategies. (a) Sections in black font are the standard Grade 3 occupational protection strategies for medical personnel in China, while sections in red font are recommendations for personal protective measures during the current COVID-19 crisis. *As needed. (b) Dental workers with Grades 1 (left), 2 (right), and 3 (middle) personal protective measures.

The study by Chin et al showed that COVID-19 is stable at 4°C, and most viruses can survive more than 14 days. At 22°C, viruses can survive for 7 days, but not for 14; and 30 minutes at 56°C and 5 minutes at 70°C can inactivate all viruses. No active virus is detected after 3 hours on paper surfaces. On clothing surfaces, COVID-19 can survive for 2 days, and on stainless steel surfaces, it can survive for 7 days. COVID-19 can survive for more than 7 days on surgical masks. Therefore, operating rooms, surfaces, equipment, and instruments must be disinfected routinely (Fig 5).

Operating room space. Ultraviolet germicidal irradiation. Operating rooms are disinfected with ultraviolet germicidal irradiation (UVGI) for 1 hour in the morning prior to room opening. Consultation rooms are disinfected for 15 minutes between patients.

Room ventilation and air purifiers. Currently, there are no standard guidelines for effective ventilation systems nor air purifiers suitable for dental clinics. Nevertheless, adequate ventilation is an effective way to dilute indoor aerosols and improve air quality. This can be achieved by opening windows to allow for fresh air influx directly into the operating room or by electric ventilators.

A plasma air purifier system is currently operating only in the fever clinic of Shanghai Ninth People’s Hospital. Dental clinics are considered to be relatively safe areas since, prior to arriving at the dental clinic, patients are preexamined and triaged using epidemiologic contact history, body temperature, respiratory symptoms, and four test results (routine blood test, nucleic acid test, CT, and antibody test within 1 week) to rule out a COVID-19 infection.

Negative pressure room. For aerosol-generating procedures, there is currently very limited evidence for the benefit of negative pressure rooms.

Operating room surfaces, equipment, and lab work. Any item in the consultation and operating rooms...
that does not have direct contact with intraoral tissues, such as the floor, surfaces, tables, chairs, and dental equipment, are disinfected frequently with a chemical disinfectant spray or wipes that contain 75% ethanol, 2,000 mg/L chlorine, or hydrogen peroxide ($H_2O_2$). Chlorhexidine has no effect on COVID-19. The necessary cleaning and disinfecting time between patients treated with aerosol-generating procedures is 30 minutes, and between consultations is 15 minutes. Models are disinfected before being sent to the technician.

**Dental devices and instruments.** Any instrument or device that comes in direct contact with the patients’ mouth, blood, injured soft tissue, etc (such as dental handpieces, burs, root canal files, forceps, and surgical equipment) must meet the requirements of: one person, one use, one disinfection or sterilization.

**Patient management measures.** When entering the waiting room and then when entering the operating room, patients must wear masks, keep social distancing, and clean their hands with alcohol-based hand sanitizer containing at least 60% alcohol. In the operating room, patients are advised to also wear gloves and shoe covers. Patients must avoid moving around and talking to others in the clinic. Mouthwash with anti-viral disinfectant (1% povidone-iodine or 0.5% $H_2O_2$) must be used prior to any intraoral intervention, a rubber dam must be used for effective isolation (Fig 6), and strong suction must be used for reducing pollutant spread.

Patient education of infection spread prevention includes:
- Regular hand washing with soap and warm water for 20 seconds
- Cough etiquette before consultation

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**Fig 4** Typical layout of a dental clinic after the COVID-19 outbreak.

**Fig 5** Routine disinfection measures in operating rooms.
Hydrogen peroxide sterilization has received FDA emergency use authorization for decontamination of N95 masks and reuse by front-line health care personnel.\(^\text{17}\) The process involves low-temperature sterilization with \(\text{H}_2\text{O}_2\) vapors. Each sterilization cycle of 28 minutes can sterilize 10 respirators, each of which can be processed up to 10 times for single-user reuse.

Heating (≤ 85°C) under humidity (≤ 100% RH) preserves the filtration properties of N95 respirators.\(^\text{18}\) Heating can be applied up to 50 cycles (85°C, 30% RH) without degradation in filtration performance.

UVGI uses short-wavelength ultraviolet light (UVC, \(\sim 3.6 \text{ J/cm}^2\) fluence). This light can destroy the nucleic acids of microorganisms and disrupt their DNA, thereby impairing vital cellular functions and resulting in inactivation or death of microorganisms, including COVID-19.

N95 masks can withstand 10 cycles of treatment, with a small degradation of chemical bonds and a small impact on bacterial infiltration efficiency. However, the process may impact the strength and fit of the respirator.\(^\text{14}\)

Hazardous materials suit. Hazardous materials (Hazmat) suits consist of impermeable whole-body clothing worn as protection against hazardous materials, including coronavirus. Hazmat suits and protective shoes are worn during any aerosol-generating operations. These protective materials or other equipment can be used according to the specific conditions of the material(s) provided in each hospital or private dental clinic. Whatever the PPE used, all skin and mucous membrane areas should be protected from contact with aerosol droplets (Figs 2 and 3).

Donning and doffing PPE. Isolation gowns are placed on top of the medical coveralls and are changed every 4 hours. Of note is that staff are prone to fainting due to long-term use of surgical masks and gowns, so
it is advised that there be specific staff to assist others when donning and doffing isolation gowns in case of such a situation.

An example of a step-by-step procedure can be found at: https://www.youtube.com/watch?v=cCzwH7d4Ags.

Other resources for PPE can be found at: https://www.cpd.utoronto.ca/covid-19/clinical-resources/.

**After-work personal hygiene treatment.** Dental staff who lived in severe epidemic areas were advised to live in a designated hotel or another isolated place and not to go back home. In other areas where the outbreak was not very severe, dental staff could return home after each working day. All dental staff are advised to keep social distancing, wear masks, and keep strict hand hygiene.

In addition, when arriving at work, dental staff should change their clothing to PPE. At the end of the working day, before leaving the workplace, dental staff doff the PPE, take a shower (if a bathroom is available), and change back into their clothing. It is recommended to take a hot bath at least a half an hour long when arriving home after each workday.

**Use of magnification systems during dental operations with Grade 3 protection equipment.** While a bit complicated, loupes and microscopes can be used to magnify dental tissue during dental operations while wearing Grade 3 precaution gear (Fig 7). Like all other dental equipment, microscopes and magnifying loupes must be disinfected for 30 minutes between patients.

### Reopening of Dental Schools and Student Graduation

The outbreak of COVID-19 happened during the students’ winter vacation. After winter vacation, the COVID-19 situation was still grim; thus, in-class didactic teaching was conducted online and clinical practice suspended. Since it appeared that COVID-19 was under control, on April 20, the Shanghai Municipal Government announced that the universities in Shanghai would reopen in May.

The reopening of Shanghai Jiao Tong University, School of Stomatology, started at the end of April, beginning with didactic teaching of graduate students and then gradually adding graduate clinical teaching. Students were to work half a day and treat only one patient or a maximum of two. Then, didactic undergraduate teaching was to start, but only in the form of lectures, reviews, and case reports. Students would be asked to summarize and report cases they treated prior to faculty closure.

The suggested schedule for students returning to Shanghai Jiao Tong University, School of Stomatology, was as follows:
- April 26 to May 5, 2020: graduates and postgraduates (except first-year postgraduates)
- May 6 to May 10, 2020: first-year postgraduates; clinical teaching reopening on the afternoon of May 6 for graduate students who had become interns
- May 11 to May 17, 2020: other undergraduate classes

This reopening was planned to be gradual while ensuring the safety of students and staff. Guidelines include:
- Registering and recording the health status of students and staff
- Preparing adequate medical protection supplies, such as surgical masks (N95 masks if possible), goggles (such as the 3M GA500 Series), protective clothing, and disinfectants
- Strict disinfection of places including the classrooms, cafeteria, and dormitories
- Keeping social distancing (cafeteria: 1 meter apart, sitting facing one direction; maximum of 20 students per classroom, 9 to 10 students per group in problem-based learning/teaching, etc)
- Measuring body temperature of students and staff before entering the workplace
- Forbidding people who are sick from coming to work

The dissertation defenses were delayed by 1 month, and a combination of online and offline defenses were adopted. As the COVID-19 situation in Shanghai remains stable, graduates are allowed to return to Shanghai earlier than other students if they are healthy and have an absence of abnormal COVID-related signs and symptoms after 14 days of isolation.
POSTPANDEMIC CHALLENGES

On March 18, 2020, for the first time since the outbreak, no new COVID-19 patients were confirmed in China except for cases from overseas. At this time, the epidemic in China has changed into a mitigation stage, and the risk of infection comes mainly from imported cases. Thus, the biggest postpandemic challenge is ensuring that people coming back from abroad are quarantined.

Another challenge is the mental health of doctors, nurses, grieving families, and even people with long-term home lockdown or quarantine. These people are at high risk of suffering from emotional, physical, and mental exhaustion caused by excessive and prolonged stress produced by the COVID-19 crisis. Thus, psychologic counseling is crucial and is carried out both online and offline.

While the challenge of economic recovery is immense, the health and wellbeing of the workforce and the people of China need to remain a priority in order to prevent the return of the epidemic and maintain quality of life. Since there is still no COVID-19 vaccine available and no predictable treatment, since not everyone can be tested, and since there is some margin of error even when people are tested, we have to assume we are not immune to COVID-19. At the same time, we have to act as if we are infected by COVID-19 and take measures to prevent its spread to others. Thus, at this time, the Chinese Center for Disease Control recommends continued use of protective measures by apparently healthy people. This includes wearing face masks when going outside, maintaining social distancing, and adhering to hand hygiene. According to the report from the Chinese Stomatological Association on May 17, there have been no COVID-19 infection cases in dental workers or patients caused by dental treatment in the Chinese stomatology departments during the entire pandemic outbreak.

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REFERENCES