

Coronavirus disease 2019 (COVID-19): Experiences and protocols from the Department of Prosthodontics at the Wuhan University

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RESEARCH AND EDUCATION

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ABSTRACT

Statement of problem. The novel Coronavirus Disease 2019 (COVID-19) is a global pandemic,

and many countries and regions are still currently in the midst of the outbreak. This pandemic has caused prosthodontics units to suspend their clinical and educational operations in academia.

Purpose. The purpose of this article was to review the experiences from the Department of Prosthodontics, Wuhan University School and Hospital of Stomatology (DP-WHUSHS) during the COVID-19 outbreak and the protocols DP-WHUSHS utilized to resume clinical activities after the outbreak.

Material and methods. The descriptive approach was used in this article to provide a chronological narrative of the experiences and protocols from the DP-WHUSHS during the COVID-19 outbreak and after the outbreak.

Results. During the COVID-19 outbreak period, clinical care was provided for patients with dental emergencies using enhanced Grade 2 or Grade 3 personal protective equipment (PPE). Teledentistry was used to provide care for patients with non-emergency needs. Online webinars and lectures were provided for the predoctoral students, residents, and dentists to minimize the interruption in their education and engage the dental community amid the pandemic. Various factors were considered before clinical activities resumed after the outbreak subsided. Additional resources were allocated for facility preparation and management and employee training. New infection control and clinical operation protocols were developed to minimize the healthcare-associated infection of airborne transmission diseases. The psychological health and mental wellness of the employees were emphasized. Distance or online education is still under rapid development to provide students and dentists opportunities to advance their knowledge amid the pandemic.

Conclusions. Within the limitation of this descriptive review, the following conclusions were drawn. Patient welfare and emergency needs should be considered amid the pandemic. Enhanced

Grade 2 or Grade 3 PPE should be used during the outbreak. Multifactorial considerations for work resumption after the outbreak included facility preparation and management, training for employees, and clinical operation management. In-person psychological consultation and online mental wellness programs were available to employees to improve their mental wellness. Distance or online education was under rapid development to minimize the interruption in education for the students and to engage the dental community amid a pandemic.

CLINICAL IMPLICATIONS

The described experiences and clinical protocols may provide guiding principles for prosthodontics units in a similar academic environment for their clinical and educational operations during the outbreak and work resumption after the outbreak.

INTRODUCTION

Wuhan City, Hubei Province, China has a population of approximately 11 million, and Wuhan City officials identified an increasing number of a novel acute respiratory disease in late December 2019.^{1,2} On March 11, 2020, the World Health Organization (WHO) officially declared the novel Coronavirus Disease 2019 (COVID-19) outbreak a global pandemic. The COVID-19 is caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and quickly spread throughout China and globally.^{3,4} As of May 14, 2020, more than 4.4 million COVID-19 cases and 300 000 deaths were reported worldwide according to an online COVID-19 dashboard developed and hosted by the Center for Systems Science and Engineering at Johns Hopkins University.⁵

Although the source of origin and transfer to humans is still unclear, current evidence has

confirmed that COVID-19 is highly transmittable and that the predominant route of transmission is human-to-human.^{4,6,7} The human-to-human transmission of COVID-19 typically spreads through respiratory transmission (such as in contact with respiratory droplets from a sneeze or cough) or contact transmission (such as in contact with contaminated surfaces with viral particles emitted from infected individuals).⁸⁻¹¹ The presence of SARS-CoV-2 in the saliva and feces has been identified in infected patients.¹²⁻¹⁴ A recent study confirmed the SARS-CoV-2 could bind to angiotensin-converting enzyme 2 (ACE2) receptors in humans.¹⁵ The ACE2 receptors are highly concentrated in the salivary glands, which explains the presence of SARS-CoV-2 in the saliva.^{8,16} The preliminary evidence has also suggested that airborne transmission is possible for COVID-19. The greatest airborne infection threat in dentistry often comes from aerosols (particles less than 50 μm in diameter).^{10,17-19}

Because of its minimal settling velocity, aerosols can remain airborne for an extended period and travel far before settling on environmental surfaces or entering the respiratory tracts.^{18,19} The aerodynamic nature of SARS-CoV-2 has been studied in the hospital setting. The concentration of SARS-CoV-2 ribonucleic acid (RNA) in aerosols was very low in isolation wards and ventilated patient rooms. However, it was elevated in patient restrooms and crowded public areas. These findings suggested that toilet usage by and crowd gathering with COVID-19 infected patients are non-negligible sources of airborne SARS-CoV-2.²⁰ Previous studies have reported that an aerosol with smaller particles (0.5 to 10 μm) could travel more than 6 feet.²¹ Considering the nature of the profession, dental professionals are at high risk of aerosol exposure. Many dental procedures involving high-speed handpieces, rotary instruments, water spray compressed air, and ultrasonic scalers create aerosols containing biological materials (such as saliva, blood, tooth structure, and dental plaque).^{19,22} These aerosols are expected to float in

the environment and expose dental professionals and their patients to a high risk of airborne disease transmission.^{18,23}

Prosthetic procedures have unique characteristics (rare use of dental dam isolation during tooth preparation, contact with saliva and blood, and frequent aerosol-generating clinical procedures), which require clinicians to take all forms of COVID-19 transmissions into consideration. The Department of Prosthodontics, Wuhan University School and Hospital of Stomatology (DP-WHUSHS) implemented strict and effective protocols to minimize COVID-19 transmissions in the prosthodontics clinical setting at the onset of the outbreak, and no disease transmission through dental practices has been reported to date in the DP-WHUSHS.

Since the DP-WHUSHS is located in one of the epicenters of the COVID-19, it is further ahead of the epidemiological curve than other countries and regions, which are still currently in the midst of the outbreak. The purpose of this article was to review the experiences from the DP-WHUSHS during COVID-19 outbreak and the protocols the DP-WHUSHS utilized to resume clinical activities after the outbreak.

MATERIAL AND METHODS

The descriptive approach was used in this article to provide a chronological narrative of the experiences from the DP-WHUSHS during the COVID-19 outbreak and the protocols the DP-WHUSHS utilized to resume clinical activities after the outbreak. Figure 1 depicts the timeline of events related to COVID-19 from January 2020 to date (May 15, 2020) in Wuhan City and the DP-WHUSHS. The described experiences and clinical protocols aim to provide guiding principles for other prosthodontics units in a similar academic environment for their clinical and education operations during the outbreak and for work resumption after the outbreak.

RESULTS

Clinical care for patients with dental emergencies during the COVID-19 outbreak period

Lockdown orders for the COVID-19 outbreak were issued in Wuhan City on January 23, 2020, the day before the scheduled break for the Chinese New Year and Spring Festival. Although the prosthodontic treatment of some patients had been concluded as scheduled to prepare for the holiday break, many patients were still scheduled to resume treatment after the break. The clinical coordinators contacted the scheduled patients to inform them of COVID-19 lockdown orders and provided patients with suggestions about home care regimens. The patients were informed that only dental emergencies would be evaluated for treatment during the COVID-19 outbreak and lockdown period.

The Department of General and Emergency Dentistry, Wuhan University School and Hospital of Stomatology (DGED-WHUSHS) was responsible for the clinical care of patients with dental emergencies. It was the only operational clinic during the lockdown and outbreak. Experienced dentists, dental assistants, and nurses from the DP-WHUSHS volunteered to care for the patients with prosthodontic and dental implant-related emergencies in the DGED-WHUSHS. Denture-related traumatic ulcers and dislodgement of fixed dental prostheses were 2 typical prosthodontic emergencies.

Patient triage and screening at emergency intake were mandated during the outbreak. Individuals with a fever (37.3 °C or higher) or acute respiratory symptoms (cough, shortness of breath, or sore throat) were referred to the designated hospitals. Patients and their companions without fevers and respiratory symptoms for at least 14 days were provided with and required to wear surgical masks before entering the dental clinic. Volunteer dentists, dental assistants, and

nurses wore enhanced Grade 2 or Grade 3 personal protective equipment (PPE) while treating patients (Table 1).⁷ Notably, most patients who visited the DGD-SHSWU seeking emergency treatment were conscious of the highly contagious nature of COVID-19. For instance, one patient with a dislodged interim implant-supported fixed dental prosthesis visited the clinic while wearing his N95 mask and a disposable hazmat suit.

All emergency treatments were performed in isolated operatories. Strict protocols were followed during the outbreak period, and no clinical procedures using high-speed dental handpieces were allowed. High-volume suction systems and 4-handed dentistry techniques were used to minimize the risks of exposing dental personnel and patients to droplets or aerosols.^{3,18,19} Between patients, province-sanctioned cleaning and disinfection protocols were used to disinfect the dental operatories.³ Patients and their companions were asked to provide their contact information. They would be contacted at a later date in the event individuals (dental personnel or other patients) with suspected or confirmed COVID-19 had been in close proximity during their dental visits.

Care for the patients with non-emergencies during the COVID-19 outbreak period

Patients with non-emergency needs were asked to stay at home. Teledentistry was implemented to provide patients with necessary advice via telephone and an online platform (WeChat; Tencent Inc). Volunteer prosthodontists from the DP-WHUSHS were on-call to provide timely consultations for the patients. All virtual dental consultations were documented in the patients' electronic health records. In addition, the virtual consultation service was offered to local dental practitioners to maximize patient care in the community. During the outbreak and lockdown period, the DP-WHUSHS provided virtual consultations for general dental questions (53 times), dislodged prostheses (46 times), postoperative evaluations (9 times), and dental implant-specific

questions (18 times). The virtual consultations ended in the third week after work resumption (Fig. 1).

Dental education for the predoctoral students and residents during the COVID-19 outbreak period

Under the government-mandated COVID-19 lockdown orders, no predoctoral students, graduate students, and residents were allowed to return to the Wuhan University School and Hospital of Stomatology until further notifications from the Ministry of Education of China. To minimize the interruption in education, distance education options were provided to the predoctoral students, graduate students, and residents following the preplanned curricula. They were required to report their health condition to their faculty supervisors and program directors daily. On February 3, 2020, immediately after the Chinese New Year and Spring Festival, the DP-WHUSHS started new morning seminars to discuss clinical treatments and review dental literature with the prosthodontics residents and graduate students. On February 17, 2020, faculty in the DP-WHUSHS started online webinars and lectures for the predoctoral students and dentists in the country. The live broadcasting lectures were also recorded, and the recordings allowed the participants to review the presentations at their leisure. An increase in distance education for students and practicing dentists was observed during the COVID-19 outbreak, and one prime example was that one of the most popular online lectures from the DP-WHUSHS reached 30 000 live views and playbacks. Further investigation may be needed to maintain and improve the distance education methods.

Protocols used to resume clinical activities after the outbreak

Following the instructions from the Centers for Disease Control in Hubei Province, the DP-WHUSHS resumed clinical activities on April 20, 2020 (Fig. 1). Separate entrances and routes

within the facility were designated for the employees (dentists, dental assistants, nurses, and facility maintenance personnel) and patients on entering the clinics. The clinics were designated as the contaminated zones. Buffer zones were set up connected to the contaminated zones, and the employees were required to remove PPE in the buffer zones (Fig. 2). A designated individual was assigned to monitor the correct procedures during PPE doffing. Ultraviolet C lights and air purification systems were installed in the clinics to disinfect the operatories. The ventilation systems were adjusted, and the air outflows were increased during the clinical hours. Patients and employees used different restrooms, and the restrooms were disinfected hourly.

The clinical areas in the DP-WHUSHS were composed of 16 clinical bays on 3 different floors. A total of 46 operatories were available in 16 clinical bays. During the first 2 weeks of resumed clinical activities, only 2 operatories in 2 separate clinical bays were used at a time in the DP-WHUSHS, and the principle of one dentist-one dental assistant-one patient-in-one operatory was followed. At this stage, no aerosols-generating procedures were allowed. During the third week of resumed clinical activities, 50% of the operatories were used at a time in the DP-WHUSHS. The clinical operatories were separated into 2 zones to treat patients with different risk levels, including ordinary patients and low-risk level patients. The level classifications were based on the patients' clinical symptoms, contact history, and nucleic acid test results (Table 2). The nucleic acid test was provided through the national health insurance system in China. All citizens and residents in China were encouraged to acquire the COVID-19 nucleic acid tests in the designated hospitals, and the test results could be used as proof of health before dental appointments. At this stage, any aerosols-generating procedures involved with high-speed handpieces, ultrasonic instruments, and air-water syringes were allowed only for low-risk level patients. From the fourth week after resuming clinical activities, all operatories were

operational simultaneously in the DP-WHUSHS, and the same risk level classifications were followed to assign patients to different zones. At this stage, full range of prosthodontics and implant treatment for both low-risk and ordinary patients were resumed. Table 2 depicts the general clinical operation principles after the outbreak.

Before returning to work, all employees were required to attend online training pertinent to COVID-19, infection control guidelines, and clinical operation protocols to minimize the risks of nosocomial infection transmission. Successful post-training assessments and certificates were required before returning to work. COVID-19 nucleic acid tests were administered for all employees to ensure that individuals actively infected with SARS-CoV-2 could anticipate the course of illness and act to prevent disease transmission. In-person psychological consultation and online mental wellness programs organized at multiple universities and hospitals were offered to employees after work resumption. Flyers contained information from the wellness programs were posted in the facility, and individuals could access wellness programs conveniently from their mobile devices by scanning the quick response (QR) codes on program flyers. Various leisure and sports activities were also provided for employees to improve their mental wellness.

Before resumption of clinical activities, the records of 919 patients treated from December 1, 2019 to January 23, 2020 in the DP-WHUSHS were reviewed. Seven hundred and two of them responded. Two patients self-reported a history of recovery from COVID-19. One was instructed to self-quarantine at home during the illness, and another received treatment in a local Fangcang shelter hospital for minor symptoms of COVID-19.

Clinical activities resumed on April 20, 2020 in the DP-WHUSHS. All patients were required to preregister in a new hospital online system for appointments. Precheck triage and

initial screening were performed for all patients before any clinical procedures. The flowchart of patient admission and clinical treatment is shown in Figure 3. A nurse (supervising the overall infection control procedures) and facility maintenance personnel (in charge of disinfection) in the DP-WHUSHS were assigned to assist dentists and dental assistants daily. The clinical treatment team on duty met in morning huddles to discuss the daily schedule and patient care and worked synchronously throughout the day (Fig. 4).

Table 2 depicts general clinical operation principles after the outbreak at the DP-WHUSHS since April 20, 2020. At the different stages of the resumption of clinical activities (Table 2), dentists and dental assistants were required to wear the corresponding PPE following the government and hospital regulations for prevention and control of healthcare-associated infection of airborne transmission diseases (Table 1 and Fig. 5).⁷ Furthermore, all clinical personnel followed appropriate protocol for donning PPE before entering the clinical area (Fig. 6). During the clinical treatment procedures, high-volume suction systems and 4-handed dentistry techniques were used to minimize the risks of exposing dental personnel and patients to droplets or aerosols (Fig. 7).^{3,18,19} Air-water syringes, high-speed handpieces, and rotary instruments were only used after careful evaluation of the patient's risk level and treatment needs (Table 2). After the completion of clinical treatment, the patients and clinical personnel were required to leave the clinics (contaminated zone) via separate routes and exits. All clinical personnel followed the appropriate protocol for PPE doffing in the buffer zone (Fig. 8). Similar clinical operation protocols, infection control guidelines, and PPE donning and doffing procedures were found in multiple prosthodontics departments in China (Fig. 9). The facility modification and management, requirements for COVID-19 nucleic acid tests, and support for psychological wellness varied based on each university's resource allocation and infrastructure.

Predoctoral students, graduate students, and residents are still not allowed to return to the school for in-person education. All of them continue their education online and are working toward the completion of their education degrees. Competency assessments and graduate program oral examinations are all conducted online. The Ministry of Education of China will announce when the students can return to in-person education at a later date.

DISCUSSION

The experiences during the COVID-19 outbreak period and the clinical protocols after work resumption from the DP-WHUSHS have been reviewed in detail. The described experiences and clinical protocols may provide guiding principles for other prosthodontics units in a similar academic environment for their clinical and educational operations during the outbreak and after outbreak work resumption. Proper patient triage and screening, rigorous hand sanitization, strict regimens and reinforcement of donning and doffing of PPE, teledentistry, COVID-19 testing for patients and employees, and resource allocations for facility improvement and management following the progression of a pandemic are recommended to slow healthcare-associated infection. Psychological consultation and leisure and sports activities can be provided for employees to improve their mental wellness after work resumption. Swift development of distance education for students and practicing clinicians can minimize the interruption of students' education and engage the dental community amid the COVID-19 pandemic.

CONCLUSIONS

Based on the findings of this descriptive review, the following conclusions were drawn:

1. Patient welfare and emergency needs should be considered amid the pandemic. Enhanced

Grade 2 or Grade 3 PPE should be used during the outbreak.

2. Multifactorial considerations for work resumption after the outbreak included facility preparation and management, training for employees and clinical operation management.
3. In-person psychological consultation and online mental wellness programs could be offered to employees to improve their mental wellness.
4. Distance or online education should be under rapid development to minimize the interruption of education for students and to engage the dental community amid a pandemic.

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TABLES

Table 1. Personal protective equipment (PPE) grades adapted from regulations for prevention and control of healthcare-associated infection of airborne transmission disease in healthcare facilities in China

Protection grade	Application indications	Personal protective equipment									
		Surgical mask	Medical protective mask (N95)	Face shield /goggles	Hand sanitization	Latex gloves (exam gloves or surgical gloves)	Work clothing (scrubs, reusable coats)	Isolation clothing (disposable gown)	Protective clothing (disposable hazmat suit)	Working cap (disposable hood)	Shoe cover
General	Medical staff in general clinic	+	-	-	+	±	+	-	-	-	-
Grade 1	Medical staff in clinic treating infectious diseases	+	-	-	+	+	+	+	-	+	-
Grade 2	Entering the area where diagnosing and treating suspected or confirmed patients with airborne diseases	-	+	±	+	+	+	±★	±★	+	+
Grade 3	Aerosol-generating procedures for suspected or confirmed patients with airborne diseases	-	+	+	+	+	+	-	+	+	+

+, Needed; -, Not Needed; ±, Depends on work circumstances; ±★, Depends on work circumstances and local healthcare situation.

Table 2. General clinical operation principles after outbreak

Stages	Soft-opening stage	Transition stage	Normal stage
Time period after clinic resumption	First two weeks	Third week	Fourth week and after
Patient classification	No classifications All patients were treated with same clinical protocol	High-risk level patient: Confirmed or suspected COVID-19 symptoms or contact history Ordinary patient: Patients with no suspected COVID-19 symptoms and contact history Low-risk level patient: Patients with no suspected COVID-19 symptoms and contact history and provided the negative nucleic acid test result within last 14 days	Same as Transition stage
Clinical Operation	Two operatories in 2 separate clinical bays with the principle of "one dentist-one dental assistant-one patient-in-one operatory"	50% clinical operatories open Divided clinics into ordinary patient and low-risk level patient bay areas	All clinical operatories were available Divided clinics into ordinary patient and low-risk level patient bay areas
PPE (* Table 1)	Enhanced Grade 2 protection during first week (disposable hazmat suit required) Grade 2 protection can be used during second week	Grade 2 protection	Grade 2 protection
Treatment recommendations	1. Limited patient numbers 2. No aerosols-generating procedures	1. Gradually increased the numbers of patients. 2. Any aerosols-generating procedures involved with high-speed handpieces, ultrasonic instruments, and air-water syringes were allowed only for low-risk level patients. 3. Only emergency treatments were provided to the high-risk level patient in special isolated rooms with Grade 3 protection in a centralized location within the facility.	1. Resumed full clinical capacity. 2. Resumed full range of prosthodontics and implant treatment for both low-risk and ordinary patients. 3. Only emergency treatments were provided to the high-risk level patient in special isolated rooms with Grade 3 protection in a centralized location within the facility.

FIGURES

Figure 1. Coronavirus disease 2019 (COVID-19) outbreak timeline. Although State Council of People's Republic of China announced COVID-19 was included in Category B infectious disease, it should be managed as Category A infectious disease because of its epidemic characteristics.

Figure 2. Designated personnel assigned outside buffer zone to monitor proper donning procedures of soiled personal protective equipment (PPE). Three stations allowed 3 individuals in buffer zone at one time.

Figure 3. Flowchart of patient admission and clinical treatment.

Figure 4. Morning huddle of clinical treatment team during first 2 weeks of work resumption.

Figure 5. Example of Grade 2 and enhanced Grade 2 personal protective equipment (PPE) during first 2 weeks of work resumption.

Figure 6. Personal protective equipment (PPE) donning protocol before entering clinical area. Hand sanitizer should be used immediately after touching door handles. Disposable PPE should be exchanged every 4 hours after regular clinical procedures and exchanged immediately after becoming soiled by saliva, blood, high volume of droplets and aerosols, or contact with patients with suspected Coronavirus Disease 2019.

Figure 7. Clinical procedures performed during first 2 weeks of work resumption. A, First week with disposable hazmat suit. B, Second week with disposable gown.

Figure 8. Personal protective equipment (PPE) doffing protocol after leaving clinical area.

Figure 9. Different types of Grade 2 personal protective equipment (PPE) from various oral healthcare facilities in China. A, Department of Prosthodontics, Peking University School and Hospital of Stomatology, China. (photograph provided by Dr. Yunsong Liu). B, Department of

Prosthodontics, Guanghua School of Stomatology, Hospital of Stomatology, Sun Yat-Sen University, China. (photograph provided by Dr. Yan Li).

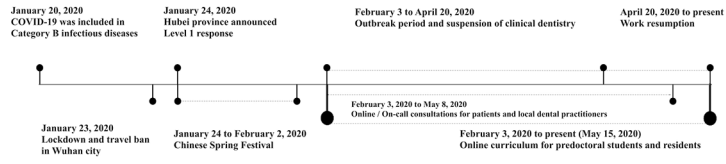
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Grade 2	Entering the area where diagnosing and treating suspected or confirmed patients with airborne diseases	-	+	±	+	+	+	±★	±★	+	+
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Clinical Operation	Two operatories in 2 separate clinical bays with the principle of “one dentist-one dental assistant-one patient-in-one operatory”	50% clinical operatories open Divided clinics into ordinary patient and low-risk level patient bay areas	All clinical operatories were available Divided clinics into ordinary patient and low-risk level patient bay areas
PPE (* Table 1)	Enhanced Grade 2 protection during first week (disposable hazmat suit required) Grade 2 protection can be used during second week	Grade 2 protection	Grade 2 protection
Treatment recommendations	1. Limited patient numbers 2. No aerosols-generating procedures	1. Gradually increased the numbers of patients. 2. Any aerosols-generating procedures involved with high-speed handpieces, ultrasonic instruments, and air-water syringes were allowed only for low-risk level patients. 3. Only emergency treatments were provided to the high-risk level patient in special isolated rooms with Grade 3 protection in a centralized location within the facility.	1. Resumed full clinical capacity. 2. Resumed full range of prosthodontics and implant treatment for both low-risk and ordinary patients. 3. Only emergency treatments were provided to the high-risk level patient in special isolated rooms with Grade 3 protection in a centralized location within the facility.





Patient check-in with the online registration proof at reception

