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The Implications of COVID-19 in the Field of Oral and Maxillofacial Surgery: University of Toronto Experience

Introduction

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is the causative pathogen for the coronavirus disease 2019 (COVID-19) worldwide pandemic. First identified in December 2019 following a cluster of patient hospitalizations with pneumonia-like symptomatology of unknown etiology, it was later determined that these patients were epidemiologically linked to a seafood and wet animal wholesale market in Wuhan, China (1). On January 30, 2020, the World Health Organization (WHO) officially declared this outbreak as a “public health emergency of international concern” (2). Since December 2019, countless efforts have been made to further understand the pathogenesis, as well as pathophysiology and transmissibility associated with this novel virus in an attempt to control the progression and develop management strategies for COVID-19. Li et al. conducted a retrospective analysis on the first 425 patients with laboratory-confirmed cases of COVID-19 in Wuhan, China, which showed a median age of 59 years, with an estimated mean incubation period and duration from onset to hospital admission to be 5.2 days and 12.5 days, respectively, likely indicative of the difficulty in early identification and isolation (3). Preliminary analysis from this study estimated a basic reproduction number (R_0) of 2.2, suggesting that each infected patient will go on to spread the infection to 2.2 other people, and postulated a 14-day medical observation period or quarantine for the exposed individual (3). The Chinese Center for Disease Control and Prevention (CCDCP) later released a case series, demonstrating similarities with the severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) in that they, too, were initiated by zoonotic transmission of a novel betacoronavirus and which commonly initially presents with fever

and cough which frequently progresses to lower respiratory tract disease and poor clinical outcomes in the older and medically-complex populations (4). These similarities made sense considering that genetic sequencing of SARS-CoV-2 revealed greater than 80 per cent identity to SARS-CoV-1 (SARS) and 50 per cent to MERS-CoV (MERS) (1). Some evidence demonstrates that of laboratory confirmed cases of COVID-19 ($N = 44672$), the majority were mild (81 per cent) with an overall case-fatality-rate (CFR) of 2.3 per cent; however, a CFR close to 50 per cent was observed among the critical cases (five per cent) (4). Much like SARS and MERS, the CCDCP reported that most cases of secondary transmission of COVID-19 were occurring in the hospital setting with 1716 confirmed cases among health-care workers and five deaths as of February 11, 2020 (4). As of May 09, 2020, there were a total of 3,974,036 confirmed COVID-19 cases and 276,007 deaths globally, affecting 187 countries (5). This rapid incline in confirmed cases is attributable to the transmissibility of SARS-CoV-2 virus. The main modality of transmission remains person-person, which occurs via contact or droplet spread, with the possibility of airborne transmission as well (1,6). Oral and maxillofacial surgeons represent a particularly vulnerable subset of frontline health-care providers to nosocomial COVID-19 infection due to the close exposure to patients’ oropharynx and nasopharynx and the droplets and aerosols generated during routine and emergency clinical practice. Most recently, a final-year oral and maxillofacial surgery resident succumbed to COVID-19 while working at his Detroit area hospital (7). This review aims to provide information and some preliminary guidance relevant to the practice of oral and maxillofacial surgery amidst the COVID-19 pandemic.

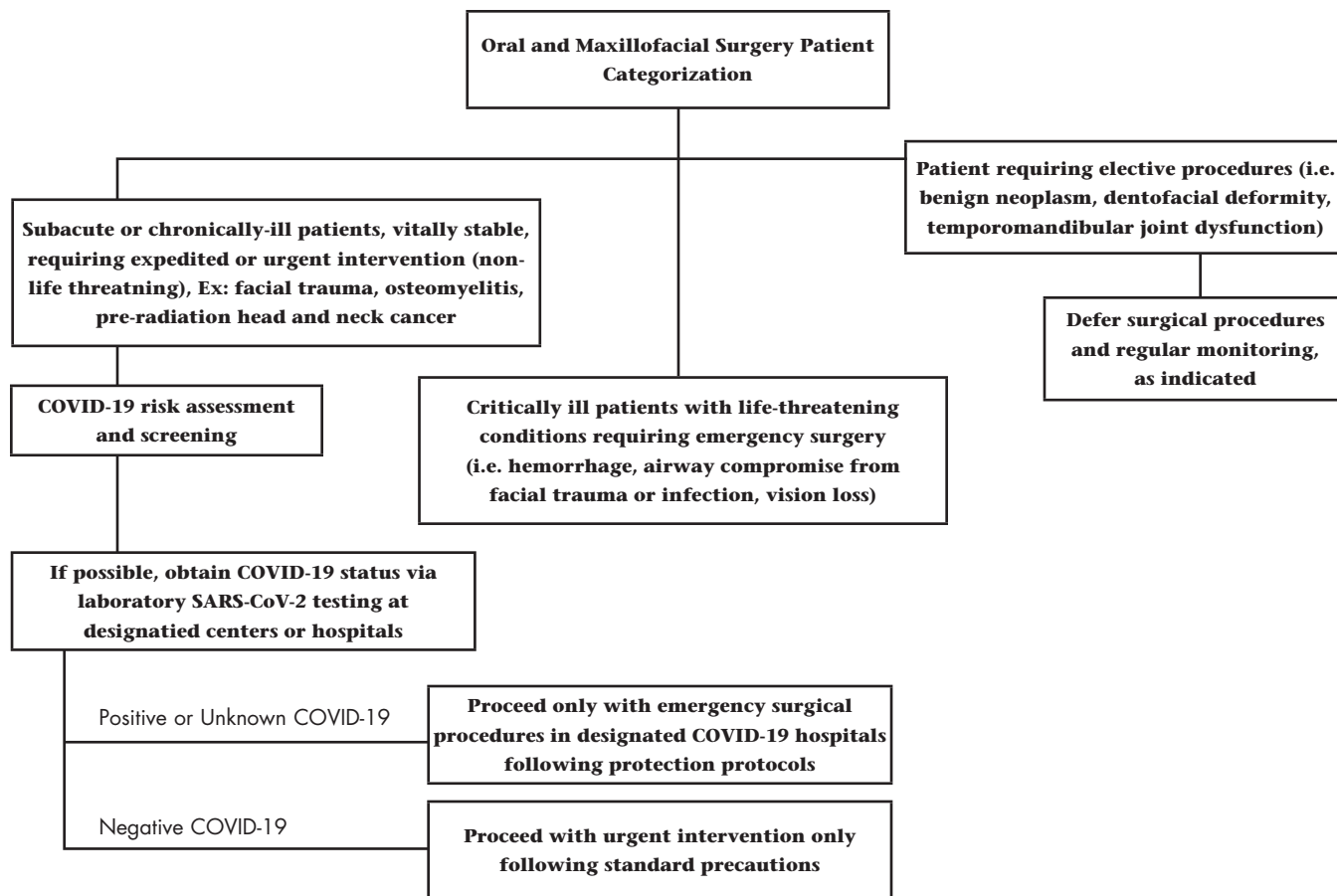


Figure 1. Algorithm for diagnosis and treatment of oral and maxillofacial surgery patients according to disease severity and urgency of intervention required.

Demographics and clinical presentation







Previous reports from retrospective case studies in China have shown that the majority of laboratory-confirmed cases of COVID-19 occurred within the age-category of 30 to 79 years, with the median age of 59 and a slight male predominance (56 per cent) (3,4). While the majority of cases seem to be classified as mild, those deemed critical or present in the elderly (i.e. >80 years of age) or medically complex populations pose a significantly higher mortality threat (4). Symptoms most commonly present at onset include fever and cough, as well as some upper respiratory tract symptoms like sneezing, rhinorrhea and sore throat, while others presented with dyspnea, hemoptysis and lymphocytopenia (1). Severe and critical cases were most related with decreased blood oxygen saturation (≤ 93 per cent), as well as respiratory failure, septic shock and multiple organ dysfunction or failure, respectively (4). Computed tomography of the chest revealing bilateral subpleural ground glass opacities in

the lungs in infected patients has also been recorded (1). Other abnormal findings such as RNAemia, acute respiratory distress syndrome and acute cardiac injury are all associated with critical cases and more likely to be fatal (1). According to Huang et al., myocarditis was diagnosed in 12 per cent of patients in Wuhan, China with significantly elevated levels of hypersensitive troponin I (hs-cTnI) concurrently seen (8). Elevated plasma pro-inflammatory cytokines, such as IL2, IL7, IL10 and TNF α , has been recorded in infected patients admitted to intensive care units and linked to the promotion of disease severity (1). Studies by Liu et al. have shown that SARS-CoV-2 viral proteins interfere with the normal heme anabolic pathway and hemoglobin metabolism; complexes are formed between non-structural proteins (i.e. ORF8, orf1ab, ORF10, and ORF3a and surface glycoproteins) and the heme-containing 1- β chain of hemoglobin to dissociate the iron to form porphyrin (9).

1. COVID-19 Patient and staff, physicians and volunteer status (SVP) at all three HRH sites.

Current # of COVID-19 Positive Patients	Patient Deaths (Since Mar14)	# of COVID-19 Positive SPVs Community/Hospital Acquired	Recovered SPVs
56	22	24/6	9
ONTARIO			
# Critical Care Patients		# Confirmed Critical Care Positive COVID-19	# Suspected Critical Care COVID-19
1,362		250	311
HUMBER RIVER HOSPITAL			
# Critical Care Patients		# Confirmed Critical Care Positive COVID-19/ Vented	# Suspected Critical Care COVID-19
42		18/16	5

2. PPE Supply.

*PPE Supply — April 21, 2020			
Supply Legend	Personal Protective Equipment (PPE)		
30 Days' Supply	Gowns		Face Shield 
15-30 Days' Supply	N95s		Gloves 
Under 15 Days' Supply	Procedure Masks		Goggles 
<i>Thank you for continuing to use PPE appropriately.</i>			

*PPE supply is subject to rapid change based on supply and demand. Supply chain is highly variable at this time.

Figure 2.

Example of daily message board delivered to hospital staff with updated COVID patient status and status of PPE.

As such, patients infected with COVID-19 often demonstrate elevated levels of serum ferritin and anemia. This mechanism has multisystemic involvement by interfering with normal gas exchange and compromising respiration, as well as the potential for renal injury associated with the resulting porphyria.

Transmission

Interpersonal transmission of the SARS-CoV-2 appears to occur mainly via contact and respiratory droplets (1). While the possibility of airborne transmission still remains under investigation, the gastrointestinal symptoms observed with COVID-19 suggests the possibility of fecal-oral transmission as well, unlike SARS and MERS (1). The proposed pathogenesis of COVID-19 is founded in the SARS-CoV-2 capacity to infect host cells via binding of angiotensin-converting enzyme 2 (ACE2) receptor expressed on the type I and II alveolar epithelial cells in human lungs, as well as epithelial cells of the oral mucosa, namely the tongue (10,11). This binding is mediated by the membrane-bound viral receptor-binding domain protein, i.e. the spike protein (11). Ocular mucous membranes pose an additional route of transmission as conjunctival samples from confirmed COVID-19 cases have demonstrated a viral presence (6). Higher viral loads have been detected in the nasopharynx, thus the preference for nasal swabs for sample collection (12). Similar viral loads were detected in the asymptomatic and symptomatic COVID-19 patient, suggesting a comparable transmission potential for both states (12). A case series conducted in Wuhan, China showed that 41 per cent of patients admitted with COVID-19 had acquired the disease through nosocomial transmission, 70 per cent of which were designated as health professionals (13). This further emphasizes the importance of proper infection control protocols to be instilled within health-care institutions.

Infection control and personal protective equipment (PPE)

The prevention and mitigation of this disease is rooted in the ability to properly perform infection control, both in the community and health-care setting. This begins with simple and effective measures to be carried out by all community members, which includes proper hand and respiratory hygiene, as well as the use of a medical mask and maintaining a social distance from individuals (\geq one meter), if any respiratory symptoms are present (14).

Transmission of COVID-19 occurs primarily through droplet spread, either airborne or contact with human fluids or mucosa, patient materials, and contaminated instruments or surfaces (6). Though droplets only remain

airborne for short periods of time (seconds) and travel very short distances, studies have shown that SARS-CoV-2 can remain stable on plastic and stainless-steel surfaces for several hours, even detectable on said surfaces after 72 hours (15). Evidence regarding aerosol transmission of COVID-19 is not conclusive but, it is important to recognize that aerosols containing the SARS-CoV-2 virus may remain viable for several hours. Therefore, the need for supplemental precautions are necessary with aerosol generating procedures, such as many procedures in dentistry and, in particular, oral and maxillofacial surgery (15). These findings highlight the importance of proper surface cleaning with approved disinfectants with active ingredients such as sodium hypochlorite, hydrogen peroxide or quaternary ammonium following label directions and allowing required contact time (16). It is imperative to follow the instructions for each individual agent.

In the health-care setting, additional precautions must be considered to prevent the nosocomial spread; appropriate personal protective equipment (PPE) should be utilized when treating patients who are under investigation or are confirmed-positive cases of COVID-19. These include gloves, medical masks, goggles or face shields and gowns, as well as the use of respirators (i.e. N95 or FFP2 standard or equivalent) in high-risk or aerosol generating procedures (14). In the event of PPE shortage, caring for patients with the same diagnosis using the same respirator is permissible as a strategy to optimize the availability of PPE (14). Considerable attention should be employed during the doffing of PPE in an effort to prevent recontamination. Previous studies have shown significant self-contamination during PPE doffing, especially during removal of respirator, shoe covers and hoods, thus posing a risk for self-inoculation or viral spread to patients or other health-care workers (17). As such, institutions may consider appointing a trained observer or assistant for the doffing of PPE to minimize self-contamination after high risk procedures, if possible.

Considerations in oral and maxillofacial surgery

Screening and procedures

In order to prevent and/or minimize health-care provider exposure to COVID-19, it is imperative that patients be properly screened for COVID-19 risk stratification. From there, patients should be categorized based on the severity of the disease or urgency of required intervention (Figure 1) (18). Amidst the current COVID-19 pandemic, our institution has been deferring all elective procedures and consultations. Following a similar model to that



Figure 3.

Humber River Hospital combined medical and surgical outpatient clinics for many surgical subspecialties, including the department of oral and maxillofacial surgery. Bottom right are your authors prior to entering an anteroom and inspected by clinic RNs. The clinic contains many equipped consultation rooms and procedure suites, of which several are negative pressure rooms.

of the Department of Oral and Maxillofacial Surgery of Peking University School and Hospital of Stomatology, patients who require expedited interventions, such as those with osteomyelitis or pre-radiation dental extractions, are subjected to comprehensive risk assessment, involving a detailed history and physical examination (18). Since head and neck examinations include mucous membranes, they should be carried out in separate rooms by the most experienced provider and with only necessary personnel present (19). In subacute patients with stable vital signs and no imminent risk to life, which includes patients with stable facial trauma and odontogenic/orofacial infections, thorough screening for COVID-19 should also be carried out. For facial trauma requiring surgical intervention, COVID-19 status should be obtained before proceeding with definitive treatment, if possible; otherwise, the recommendation is to treat patients of unknown COVID-19 status as COVID-19 positive (19). Current application of the Ontario Telehealth Network has been indispensable to manage routine post-operative follow-up and many non-essential emergencies. This allows providers to maintain relationships and support

assessments without in-person physical examination. Patients who are at risk for significant negative outcomes should present for in-person clinic visits with existing triage and risk assessment protocols for COVID-19. In critically ill patients requiring emergency intervention for life-threatening conditions, such as hemorrhage, airway obstruction from trauma or infection, or potential loss of limb or function, health-care providers involved in the care should practise routine universal precautions and adhere to strict infection control protocol, including donning appropriate PPE according to procedure recommendations utilized by head and neck surgeons and other health-care workers in the U.S., Asia, and Europe (Table 1) (18,19). As part of daily staff communications, hospitals are continuously updating their PPE status, which is available to all staff via message boards (Figure 2).

Peri-, intra- and post-operative considerations

It is recommended to obtain the COVID-19 status of the patient beforehand, if possible. It is also recommended that high-risk procedures or surgery in confirmed

Table 1.
Risk classification and associated protective wear for common procedures in oral and maxillofacial surgery.

Risk	Type of Contact or Exposure	Types of Procedures	Health-Care Provider PPE
Low	Indirect contact	<ul style="list-style-type: none"> History taking 	<ul style="list-style-type: none"> Hand hygiene Scrubs Surgical cap Surgical mask +/- gloves
Moderate	Confirmed COVID-19 <u>negative</u> patients Direct contact Non-aerosol generating encounters	<ul style="list-style-type: none"> Head and neck physical examination Wound dressing Fine needle aspiration 	<ul style="list-style-type: none"> Hand hygiene Scrubs Surgical cap Surgical mask Gloves Face shield or eye goggles
High	Confirmed COVID-19 <u>negative</u> patients Direct contact and exposure body fluids Aerosol-generating procedures	<ul style="list-style-type: none"> Nasopharyngeal and oral airway suctioning Extractions and incision-and drainage Wound irrigation Use of rotary handpiece system Endotracheal intubation Tracheostomy 	<ul style="list-style-type: none"> Hand hygiene Scrubs Surgical cap Respirators (i.e. N95 or FFP2 standard or equivalent) Gloves Face shield or eye goggles Gown
	COVID-19 status unknown or under investigation Aerosol- generating upper respiratory tract procedures		

COVID-19 patients should be performed in designated operating rooms with negative pressure (≤ -5.0 Pa) (18,19). Currently at our teaching hospitals, the turnover time for COVID-19 testing is now under one hour and readily available. Interprofessional coordination for surgery is especially important during the COVID-19 pandemic, including liaison with the anesthesia team to ensure that only essential staff be present in the operating theatre for the intubation and extubation in appropriate PPE. Moreover, protocols and proper lines of communication have been established with the nursing staff, anesthesia team and recovery unit personnel pre- and post-operatively. This is especially critical during patient transfer with unknown COVID-19 status or SARS-CoV-2-positive patients after high-risk procedures. Non-intubated patients should be wearing a surgical mask, and if needed oxygen can be administered by face mask over the surgical mask (19). Intubated patients should be transported with an intensive care unit ventilator and not with a bag-valve mask (19). All health-care workers involved in patient transfer should be wearing appropriate PPE.

Emergency airway procedures

During the COVID-19 pandemic, tracheostomies should be considered in the absence of another viable alternative airway management technique. It is a high-risk and aerosol generating procedure of the upper respiratory

tract that will require a multidisciplinary approach (19). There are many other considerations to protect the patients and health-care workers, these include: proper patient selection; consideration of the surgical anatomy, significant medical comorbidity assessment, and the consideration of modified techniques (i.e. percutaneous dilatation tracheostomy) (19). In COVID-19 positive patients or those with unknown status, delaying the tracheostomy (i.e. 14 days) until the acute phase of the infection passes and viral loads are lowered (19). Intra-operative precautions include complete patient paralysis to avoid coughing, cessation of ventilation prior to entering the airway and minimizing the use of cautery and suction (19). A non-fenestrated and cuffed tracheostomy tube should be used, preferably a smaller size, and the cuff should remain inflated. For tracheostomy care, minimal suctioning using a closed suction system with a viral filter and a heat moisture exchanger device is recommended during the weaning process; the tracheostomy tube should not be changed until viral load is as low as possible (19).

Department response

In accordance with the recommendations made by the provincial regulator and Canadian Association of Oral and Maxillofacial Surgeons, the University of Toronto Department of Oral and Maxillofacial Surgery

has maintained our commitment to providing care to patients with urgent medical conditions, while responsibly minimizing the risk of exposure of other healthcare workers, hospital staff and patients to COVID-19. While navigating the COVID-19 pandemic, our department has implemented the following strategies to mitigate the risk:

- Elective operating room procedures have been delayed until returning strategies are implemented.
- Outpatient clinics have been significantly reduced in capacity and limited to urgent needs exclusively.
- Reduction of the number of residents and staff on-service; only assigned on-call teams will be present and teams will rotate throughout the week; staff and residents are working independently and not in teams.
- Mitigate the educational barriers by providing residents and staff with access to online webinars and online conferences, as well as scheduled lecture sessions via videoconference throughout the week covering various topics within the scope of OMFS.

The Maxillofacial Surgery Department at Humber River Hospital is thankful to all the services and support staff that helped facilitate care throughout the COVID-19 pandemic. The hospital's response to the COVID-19 crisis was swift and seamless, quickly adapting and applying to the everchanging conditions and recommendation. Screening methods and rapid testing for COVID-19 was quickly adopted. All elective surgeries were suspended, and the operating rooms (26 room), as well as recovery rooms (30 beds), same-day discharge unit (30 beds) and the intensive-care unit (30 beds) instantly made themselves available to respond to the surge of patients requiring ventilators. With their help, we were able to service the medical and dental community by seeing, managing and treating patients referred by the emergency department, the local medical and dental practitioners, as well as community oral and maxillofacial surgeons.


The new Humber Hospital on Wilson Avenue in Downsview in North Toronto is the newest and most advanced hospital in Canada. This modern facility houses greater than 550 hospital beds and is fully digitally engaged. The outpatient medical/surgical clinics, located on the fourth floor of the hospital, are a shared, multidisciplinary space for surgical specialities including oral and maxillofacial surgery. This unit is comprised of several consultation rooms and surgical procedure suites, of which several are negative pressure rooms (Figure 3). These rooms are specially designed to ensure that air flows out through a negative pressure system, which requires activation one-hour prior to any patient visit. This is done by converting to a temporary negative-pressure room by physically decreasing the inflow air volume (-4.7 Pa in the

main room and -1.2 Pa in the anteroom). This offset forces air to enter the room under the door and through other leakages and prevents infectious particles from escaping the room envelope, thereby ensuring that aerosols or droplets are not transmitted outside. After the patient is seen, a 20-minute turnover is required in order to completely change the air of the operatory via a HEPA filtration system. With these resources and implemented precautions, emergency examinations and interventions were performed with minimal aerosol generation in a safe environment, for both the patient and provider.

Conclusion

The COVID-19 pandemic is a global health and socioeconomic crisis that poses challenges for many. Oral and maxillofacial surgeons and dentists must understand our role as health-care providers amidst the outbreak and the increased risk of exposure of infection in our line of work. We should continue to practise and adhere to evidence-based guidelines and protocols and remain informed about current events in order to ensure the safety of our patients, and colleagues, and broader community.

Acknowledgments

There is no measure of gratitude enough to those who helped us manage these patients in need. The administrative staff, the nurses, the residents, the clerks, maintenance staff and even the security guards who had to do most of the battling are the people who need our support and thanks. 

REFERENCES

1. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. *Journal of Autoimmunity*. 2020 Feb 26:102433.
2. Zhou M, Zhang X, Qu J. Coronavirus disease 2019 (COVID-19): a clinical update. *Frontiers of Medicine*. 2020 Apr 2.
3. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, Ren R, Leung KS, Lau EH, Wong JY, Xing X. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *New England Journal of Medicine*. 2020 Jan 29.
4. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. *JAMA*. 2020 Apr 7;323(13):1239-42.

5. COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU). Available at: <https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6> [Accessed May 09, 2020].
6. Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. *International Journal of Oral Science*. 2020 Mar 3;12(1):1-6.
7. Rahal S, Leblanc B. Help with COVID-19 patients or lose job, Beaumont Health says. *The Detroit News*. April 05, 2020. Available at: <https://www.detroitnews.com/story/business/2020/04/05/help-coronavirus-patients-lose-job-beaumont-tells-workers/2948002001/> [Accessed May 09, 2020].
8. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*. 2020 Feb 15;395(10223):497-506.
9. Liu W, Li H. COVID-19 disease: ORF8 and surface glycoprotein inhibit heme metabolism by binding to Porphyrin. *ChemRxiv*. 2020:1-23. doi:10.26434/CHEMRXIV.11938173.V2.
10. Xu H, Zhong L, Deng J, Peng J, Dan H, Zeng X, Li T, Chen Q. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. *International Journal of Oral Science*. 2020 Feb 24;12(1):1-5.
11. Sun P, Lu X, Xu C, Sun W, Pan B. Understanding of COVID-19 based on current evidence. *Journal of Medical Virology*. 2020;92(6): 548-51.
12. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, Yu J, Kang M, Song Y, Xia J, Guo Q. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. *New England Journal of Medicine*. 2020 Mar 19;382(12):1177-9.
13. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA*. 2020 Mar 17;323(11):1061-9.
14. World Health Organization [WHO]. Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages: interim guidance, 6 April 2020. Geneva: WHO; 2020.
15. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, Tamin A, Harcourt JL, Thornburg NJ, Gerber SI, Lloyd-Smith JO. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New England Journal of Medicine*. 2020 Apr 16;382(16):1564-7.
16. Environmental Protection Agency [EPA]. List N: Disinfectants for Use Against SARS-CoV-2. Washington: EPA; 2020. Available at: <https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2> [Accessed May 9, 2020].
17. Suen LK, Guo YP, Tong DW, Leung PH, Lung D, Ng MS, Lai TK, Lo KY, Au-Yeung CH, Yu W. Self-contamination during doffing of personal protective equipment by healthcare workers to prevent Ebola transmission. *Antimicrobial Resistance & Infection Control*. 2018 Dec 1;7(1):157.
18. Yang Y, Soh HY, Cai ZG, Peng X, Zhang Y, Guo CB. Experience of diagnosing and managing patients in oral maxillofacial surgery during the prevention and control period of the new coronavirus pneumonia. *Chinese Journal of Dental Research*. 2020 Jan 1;23(1):57-62.
19. Givi B, Schiff BA, Chinn SB, Clayburgh D, Iyer NG, Jalisi S, Moore MG, Nathan CA, Orloff LA, O'Neill JP, Parker N. Safety recommendations for evaluation and surgery of the head and neck during the COVID-19 pandemic. *JAMA Otolaryngology-Head & Neck Surgery*. 2020 Mar 31.



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