COVID – 19 PANDEMIC: A DENTAL PERSPECTIVE OF INFECTION PREVENTION PROTOCOLS AND QUESTIONNAIRE ASSESSMENT OF PATIENTS.

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Abstract

The COVID 19 disease caused by SARS-CoV-2 virus has become a subject of international concern due to its contagious nature and mortality rate. The lack of any definitive treatment also contributes to the severity of the disease. Identification of susceptible dental patient is the first and most important step of all preventive protocols. Categorization of the patients through a questionnaire will help the dentist to follow and modify preventive protocols accordingly. The various comorbidities which make an individual more susceptible to COVID 19 infection were identified through a thorough systematic review of literature. The questionnaire is derived from the studied literature and assigned a score. The generated aggregate of the score is used to categorize dental patient into low, medium and high risk groups. The reviewed literatures were collected from reputed online open access journals and subscribed journals. Dentists being the most vulnerable professionals during this COVID 19 pandemic should practice different preventive protocols. This is also required to limit nosocomial spread of infection through dental setup. Characteristics of the virus and the subsequent infection have also been discussed in brief in this systematic review for better understanding of the various protective protocols.

Keywords: COVID 19; Questionnaire; Susceptibility; Scoring; Dental patient; Prevention.

1. Introduction

In the late December of 2019 a cluster of patients with a respiratory disease mainly characterized by pneumonia and associated symptoms were reported in the Wuhan province of China [1]. Initially the causative pathogen did not correspond to any known strain of virus and on 8th January of 2020, the Chinese Center for Disease Control and Prevention declared it, as a new type of corona virus through genome analysis [2]. Initially it was termed as 2019-nCoV and later the International Committee on Taxonomy of Viruses (ICTV) named it SARS-CoV-2 [3]. The resultant infection was termed as COVID 19 (Corona Virus Disease 2019) by WHO on 11th February [4]. The highly infectious nature of the viral pathogen affected number of people worldwide since December 2019 [5] and WHO declared the outbreak as a Public Health Emergency of International Concern (PHEIC) on 30th January 2020 [6]. The Director General of WHO declared it as a Pandemic on 11th of March 2020 [7]. Identification of most susceptible individual is very essential due to the rapid rise of affected

individuals in international and national arena. Observation in China reveals that the mortality rate is highly concentrated at older age and is the highest for 80+ years [8]. Currently the Case Fatality Rate (CFR) has been calculated as 0.4% for individuals aged between 40 years to 49 years but sharply increases to 14.8% for individuals aged above 80 [9]. The demographics are alarming but it is highly variable and depends on various intrinsic and extrinsic influencing factors [10]. Few professions due to the nature of work are always at a high risk of contracting infections during times of pandemic [11]. Dentists are the most susceptible group of individuals and have the highest chance of developing COVID 19 infection [12] due to the nature of most of the dental treatment procedures [11]. The production of aerosol while performing maximum dental procedure is the major cause of worry as it may contain viable viral particles [13]. Other than this, constant exposure to saliva, blood, crevicular fluid and sharp instruments may also be considered a serious problem [14]. The incubation period of the SARS-CoV-2 virus is about 5 – 6 days for most individuals but it may get

extended for 14 days [15]. Study has shown that asymptomatic individual within the incubation period have the potentiality to transmit the disease to other healthy individuals [15]. It is almost impossible to distinguish an individual in his/her incubation phase from a healthy individual unless test is carried out. Every patient visiting a dental clinic/hospital must be treated as an individual in his/her incubation stage and utmost preventive measures should be practiced. Prevention of the spread of the disease from the dental facility always starts with the identification of susceptible group of people. This article proposes a systematic integrated questionnaire for the dental patients to categories them into three groups. Each parameter of the questionnaire and the preventive protocol are derived from relevant articles through a systematic review. It also discusses the patho-physiology, mode of transmission and virology to better understand the guidelines and protocols to prevent nosocomial spread of infection in a dental setup.

2. Characteristics of SARS-CoV-2 virus & COVID 19 Infection

The SARS-CoV-2 virus belong to the family of *Coronaviridae* of the order of *Nidovirales*, it contains a single large positive-stranded RNA and is one of the largest RNA viruses [16,17]. The outer membrane of the virus contains numerous club shaped spikes resembling solar corona when observed under electron microscope [18]. β -CoV category of coronaviruses affects humans and the novel SARS-CoV-2 virus is the seventh identified in this category [19]. Genetic analysis of Bat-CoV RaTG13 virus from a *Rhinolophus affinis* (Intermediate Horseshoe Bat) bat from Yunnan province of china expressed 96.2% similarity with the novel virus. Subsequent research revealed 99% similarity between pangolin β -CoV viral strain with the novel viral strain indicating pangolins as the intermediate host [20]. SARS-COV 2 virus has the membrane envelope which possesses various poly-proteins, nucleoproteins, membrane proteins such as RNA polymerase, 3-chymotrypsin, papain, helicase, glycoprotein, and accessory proteins [21]. The surface protein (S Protein) of the virus allows attachment to the receptor cells and facilitates the viral entry into the host cell [22]. Studies have identified a difference of four amino acid among the S Protein of SARS-CoV and SARS-CoV-2 but the novel virus is also able to bind to the human angiotensin converting enzyme 2 (ACE2) [23]. As reported by Becker *et al* and Li *et al* in 2020. The incubation period is generally five to six days but in some cases the incubation period has been observed to be fourteen days. Currently the most accepted protocol for medical observation is quarantine for fourteen days based on this data [24,25]. COVID 19 is characterized by the onset of mild fever followed by dry cough and then

shortness of breath (Cardinal Symptoms). Atypical symptoms include fatigue, muscle pain, confusion, headache, sore throat, diarrhea and vomiting [26,27]. Among all the affected individual around 14% developed severe symptoms and 5% developed fatal respiratory conditions [28,29]. About one-third to one-fourth of the total hospitalized individuals developed fatal conditions other than respiratory problems such as cardiac arrhythmia and shock [30,31]. Upon performance of Chest Computed Tomography (Chest CT) bilateral pneumonia, with ground-glass opacity and bilateral patchy shadows were observed and the findings were consistent for most of the patients [32].

3. Diagnosis and Treatment

The only definitive diagnostic test for COVID 19 infection is the identification of the viral genome in a given sample through reverse transcriptase polymerase chain reaction (RT-PCR) [33]. The preferred sample for the diagnosis is naso-pharyngeal and oro-pharyngeal swab [34], subsequent studies have also proved the diagnostic efficiency of RT-PCR from saliva samples thus it can be another source of sample collection [35]. Other methods of diagnosis include CT scan, enzyme-linked immunosorbent assay (ELISA) and blood culture immune identification technology of IgM/IgG [36]. In community level, screening and gathering epidemiological information is of utmost importance. Till now there has been no published modality for anti COVID 19 treatment. Supportive and symptomatic care is the preferred line of treatment till now. The present approach to control the outbreak is to manage the source of infectious and practice thorough infection prevention measures [37]. Simultaneously randomized trials with promising drugs such as "remdesivir" are being conducted in hope of finding a definitive treatment [38].

4. Transmission SARS-CoV-2 Viral Pathogen

The major route of transmission includes direct transmission (Inhalation of droplets generated by coughing and sneezing) or contact transmission (contact with mucous membrane) [39]. In a dental setup most of the dental treatments require the use of instruments which produces copious amount of aerosol. The use of three way syringes and ultrasonic scaler also produces aerosol which may contain viable viral pathogen [40]. Thus in a dental setup nosocomial spread of infection occurs through 1) Airborne transmission, 2) Contact transmission or 3) Fomite transmission [Figure 1].

Figure 1: Various Modes of Pathogen Transmission

4.1 Airborne transmission

Production of aerosol in dental treatment is inevitable and it may cause the viral pathogen to become airborne but other simple actions such as coughing, sneezing, laughing and talking also has the potential to generate droplets of varied size [41]. Larger droplets ($>5 \mu\text{m}$ diameter) are less contagious as gravity causes them to settle to the ground. Smaller droplets ($\leq 5 \mu\text{m}$ diameter) have the potential to travel larger distances and pathogen can stay viable longer in the air. Studies with SARS-CoV have demonstrated viability of viral pathogen for up to six feet in air [42].

4.2 Contact transmission

The nature of dental procedure is bound to expose the dentist and the auxiliary staff to fluids contaminants such as blood, saliva and sputum. Continuous contact with sharp instruments which might carry the viral pathogen should also be considered a significant source of cross contamination [43]. A dentist working inside the oral cavity is in constant contact with the oral mucous membrane which again contributes to the risk of cross contamination.

4.3 Fomite transmission

Dentistry is a technique sensitive and skillful profession requiring the use of various instruments made up of steel, glass and plastic. It has been observed that the viral pathogen can remain viable for few hours to few days on these various surfaces [44]. Not only dental instruments but commonly touched articles such as the door knob, control panel of the dental chair, magazines in the waiting room can also sustain viable virus.

5. Preventive Measures to be taken in a Dental Setup

A dentist is responsible for the prevention of transmission of disease by all means in their dental setup. Accurate patient screening, good disinfection protocol and good

hygiene practices must be executed continuously. The various methods through which nosocomial spread of the novel infection via any dental setup can be prevented are discussed in this section.

5.1 Patient Waiting Area Design

The waiting area of the dental operatory should be designed in a way that it promotes a social distancing with seating arrangements one meter apart [45]. There should be one separate cubicle to perform thermal screening, oxygen saturation test and the questionnaire assessment. The waiting room should be well ventilated, best if kept in negative air pressure so that air flow occurs from outside to inside (60L/Sec) [46]. There should be no consumables or reading materials in the waiting area as these items or surfaces may promote nosocomial spread of infection if contaminated. Sanitizing tunnels should be placed in the entrance and exit of the waiting room to decontaminate the individual as a whole. It will be ideal if the seating arrangements are made out of non-absorbent and scratch proof materials to ease the cleaning and regular decontamination procedures.

5.2 Dental Patient Screening

The first step of the preventive protocol includes Infra-Red (IR) Thermal screening of each individual to estimate the body temperature. The second step is to estimate blood oxygen saturation [47]. The draw-back of these screening techniques is the lack of accuracy as many individuals may not be symptomatic during the incubation period (5-14 days). Next a systematic and thorough questionnaire containing the above two data should be conducted to categorize patients into three group (Low risk, Moderate risk and High risk). For this given purpose a questionnaire form is prepared which can be used to record the history of the individual for last fourteen days. It uses a scoring system to estimate the risk factor of an individual. The questionnaire is divided into five parts and they are termed as A, B, C, D, and E respectively. After recording the patient's details, the parameters are assigned with a score; the aggregate score differentiates high risk individuals from low risk individuals. Depending on the literature review, parameters were identified which increases the susceptibility of an individual to the novel disease.

In Part A of the questionnaire, increasing score has been assigned with increasing age as elderly patients have increased chances of getting infected and development of fatal symptoms as concluded by Joseph T Wu *et al.* [48]. Study conducted by Chaolin Huang *et al.*, demonstrated male predilection of the disease thus in the proposed form male parameter have been assigned with higher score than that of female parameter [49]. Authors Heshui Shi

and colleagues mentioned the elevated temperature to be 37.3°C in patients confirmed with COVID 19 infection, so diagnosis of a fever while screening will get a high score [50,51]. Blood oxygen saturation below 93% is considered abnormal and is assigned a higher score [47]. Part B of the screening form deals with the epidemiologic information

Form for Evaluation of Risk Factor

Part A – Demographic Information

I. Name: _____ II. Date of Birth: ____/____/____ III. Gender: ____

IV. Address: _____ (Mention town/city/village): V. Temperature: _____

VI. Blood Oxygen Saturation: _____ VII. Total Score for Part A:

Part B – Epidemiologic Information

No.	Question	Answer		Score
		Yes	No	
I.	Have you travelled outside India in the past 14 days?			
II.	Have you travelled inside India in the past 14 days?			
III.	Have you participated in any form of mass gathering in past 14 days?			
IV.	Have you physically interacted with someone of foreign nationality in last 14 days? If yes specify the country:			
V.	Have you physically interacted with someone belonging to pandemic cluster zone in last 14 days? If yes specify the zone and district:			
VI.	Have you contacted anyone with COVID 19 infection in past 14 days?			
VII.	Were you kept in home quarantine for 14 days?			
VIII.	Were you kept in hospital isolation in past 14 days?			

IX. Total Score for Part B:

Part A & B of the Questionnaire

Figure 2: Part A, B & C of the Questionnaire form

Part D of the questionnaire deals with the presence or absence of any chronic illness. Since the beginning of the novel viral disease, many comorbidities such as cardiovascular disease, hypertension, diabetes and malignant neoplasms has been identified to propagate fatal symptoms in infected patients or increase the chance of getting infection [54,55]. These specific conditions are assigned with higher score than the other conditions. Chronic kidney disease, chronic liver disease, chronic pulmonary disease, chronic neurological disorder, asthma,

Part D – Chronic Disease Information

Condition	Answer		Score	Condition	Answer		Score
	Yes	No			Yes	No	
I. Chronic Cardiac Disease (past hypertension)				VIII. Chronic kidney disease			
II. Hypertension				IX. Chronic liver disease			
III. Diabetes Mellitus of any type				X. Chronic neurological disorder			
IV. Malignant neoplasm				XI. Currently smoking			
V. Chronic pulmonary disease				XII. Tuberculosis			
VI. Asthma				XIII. Asplenia			
VII. HIV				XIV. Others (specify)			

X. Total Score for Part D:

Part E – General Health Information of Last 14 Days

Condition	Answer		Score	Condition	Answer		Score
	Yes	No			Yes	No	
I. Fever				XII. Altered consciousness/Confusion			
II. Cough				XIII. Seizures			
III. Shortness of breath				XIV. Abdominal Pain			
IV. Sore throat				XV. Nausea/Vomiting			
V. Runny Nose				XVI. Diarrhea			
VI. Wheezing				XVII. Conjunctivitis			

Part D & E of the Questionnaire

Figure 3: Part D and E of the Questionnaire

of the patients. This section of the form includes questions regarding the patient's social activities and travel history for the past fourteen days. In Part C the patient's occupational background is assessed as many authors have stated a positive correlation among profession and susceptibility to the novel disease [52,53] [Figure 2].

Part C – Occupational Information

No.	Occupation	Answer		Score
		Yes	No	
I.	Medical doctor treating COVID 19 patient?			
II.	Medical nurse attending COVID 19 patient?			
III.	Medical auxiliary attending COVID 19 patient?			
IV.	Dental practitioner treating patients regularly?			
V.	Dental practitioner not treating patients regularly			
VI.	Dental auxiliary attending to patient on a regular/irregular basis?			
VII.	Are you an ambulance driver?			
VIII.	Are you a pathology laboratory technician?			
IX.	Are you a police personnel?			
X.	Are you an administrative officer?			
XI.	Are you a NGO worker or Social volunteer?			
XII.	Are you a municipal cleaning staff?			
XIII.	In your occupation related to transport of goods across state and country?			
XIV.	Other occupation (Specify):			

X. Total Score for Part C:

Part C of the Questionnaire

HIV, tuberculosis and asplenia also has some form of effect on the susceptibility and mortality so these condition are also included in this part with a lower score [56-58]. Part E is the final part of the form and records the general symptoms of a patient. The cardinal signs of COVID 19 infection (fever, cough, sore throat and breathing difficulty) are assigned a higher score than other less frequent symptoms (head ache, body ache sputum production, diarrhea, dyspnea, lymphopenia and hemorrhage) [50, 59-61] [Figure 3]

Part E – General Health Information of Last 14 Days

VIII. Chest pain				XVIII. Skin rash			
IX. Muscle ache				XIX. Skin ulcer			
X. Joint pain				XX. Lymphadenopathy			
XI. Fatigue/Malaise				XXI. Headache			
XII. Inability to walk				XXII. Bleeding (Hemorrhage)			

XXIII. Total Score for Part E:

Clinical Notes: -

Aggregate of Scores of all Parts: Risk Category of Patient:

Declaration

A. I hereby declare that the information furnished by me through this "Form for Evaluation of Risk Factor" is true as per my knowledge and I am not hiding any relevant information about any diseases or conditions or details regarding contact with infected individual or travel history. If the data is found to be untrue then the doctor has all the rights to stop the dental procedure irrespective of its stage and has the right to refuse any further therapeutic, diagnostic or prophylactic treatment.

Signature of the patient: _____ Date: ____/____/____

B. According to the doctor and patient confidentiality contract I hereby declare that the information furnished to me by the patient will be kept confidential by me and the data will only be produced to the proper authorities if it is necessary for the betterment of my patient.

Signature of the Doctor: _____ Date: ____/____/____

Continuation of part E of the Questionnaire

Based on the questionnaire system the lowest achievable score is 1 and the highest achievable score is 90, the threshold score was calculated to be 54 as it is the summation of all high score parameters. A total score of 1-27 may be considered as low risk group and dental procedures can be performed with proper precautions, scores between 28-54 may be considered moderate risk group and thorough preventive protocols should be practiced, a score above 54 may be considered as high risk group and dental procedures should be performed with utmost precautions following all the preventive measures. The questionnaire is depicted in the following figures [Figure 4].

Score Chart

Parameter/Question		Answer		Parameter/Question		Answer	
		Yes	No			Yes	No
II	Part A			III			
	Below 30 years	0	X				
	30 years – 50 years		X				
	50 years above		X				
	Male		X				
	Female		X				
	If declared hot spot by Govt.		X				
	If more than 37°C		X				
	If > 93%		X				
III	Part B			IV			
IV	Part C			V			
V	Part D			VI			

Figure 4: Score Chart of the Questionnaire

5.3 Patient Hygiene and Education

Dental patients are advised to practice hand hygiene techniques as mentioned in the online publication by WHO [62]. Once patient is done washing hands he/she should be instructed not to touch anything in the operatory until they reach the operatory. This reduces the chance of fomite transmission of disease. The patient should be provided with mouth mask with instructions of proper use ensuring prevention from airborne transmission or droplet transmission of disease. Shoe covers must also be supplied to prevent carry forward of contamination from the waiting area to the operatory. Also during this time patients has to be educated regarding the importance of maintenance of hygiene protocols and the importance of maintaining social distancing in the confined spaces of a dental operatory.

5.4 Hand Hygiene by the Dentist

Maintenance of hand hygiene is an integral part of dentistry and is practiced before performing any dental procedure. The accurate methods of hand hygiene techniques includes thorough wash of both the hands, washing for atleast 20 seconds and cleaning underneath

the nails [63,64]. During pandemic situation dentists in china practiced two-before and three-after hand hygiene guideline proposed by the infection control department of the West China Hospital of Stomatology, Sichuan University. This guideline suggests washing hands before patient examination, before dental procedures (two-before), after touching the patient, after touching the surroundings & equipment without disinfection, and after touching the oral mucosa, damaged skin or wound, blood, body fluid, secretions (three-after). Dentists should also make a habit not to touch their face, nose, mouth or eye with non-sterile hands while in the dental operatory.

5.5 Use of Personal Protection Equipment (PPE)

PPE kits are mandatory when handling individuals with highly infectious diseases [65]. The disposable design of the PPE kit limits patient-patient or patient-doctor cross-contamination. The kit consists of protective wear designed to cover all the areas of the body from where transmission can occur and it consists of A) Mask – 1 fluid-resistant medical or surgical mask inside, 1fluid-resistant particulate respirator outside; B) Goggles, C) Face shield; D) Gloves – 1 pair surgical gloves inside, 1 pair nitrile

gloves outside; E) Surgical scrubs as inside wear; F) Disposable coverall as outside wear; G) Disposable apron over coverall; H) Head cap – 2 in number; I) Shoe cover.

A) Mask

Two masks are recommended in case of direct contact with COVID 19 patients. One surgical mask should to be worn inside and over that one particulate respirator should be worn. The masks should cover the nose and mouth maintaining good peripheral seal [65]. Under any circumstances the outer aspect of the mask should not be touched. Better peripheral seal may be achieved with absence of facial hair.

B) Goggles & C) Face Shields

The goggle and face shield has the same purpose to prevent contact of droplets with the eye. The face shield is not an air tight apparatus and is less recommended when used alone. Goggles are air tight apparatus which covers the whole eye in a comfortable manner and stops absolutely any form of contamination from touching the eye. Use of these two apparatus together provides satisfactory eye and face protection [65].

D) Gloves

Two layers of gloves are recommended while handling individuals. There should be an inner layer of surgical gloves contacting the skin and a pair of nitrile gloves worn outside. Two gloves are recommended because the inner layer will protect the wearer if the outer glove is damaged while handling sharp instruments and corrosive disinfectants. It also protects from needle prick injuries and keeps wearers hand contamination free while removing disposable outer coveralls and aprons [65].

E) Surgical scrubs as inside wear, F) Disposable coverall as outside wears and G) Disposable apron over coverall

The inner surgical scrubs are recommended because they are disposable in nature and they are also moisture resistant. The scrubs are designed in such a way that it do not cause heat related discomfort. The coverall is also made of moisture resistant materials and are worn over the inner wear. They provide the second line of defense and prevent contact of body fluids from affected individuals. The first line of defense against contamination is the apron worn over the coverall which prevents contact from fluid splash. All the three layers of the body wear are disposable and single use is highly recommended [65].

H) Head cap

Head caps provide protection from droplet contamination to the head hair which has the potential to absorb

aerosols. Double layer insures complete protection in case the outside layer is breached due to some reason [65].

I) Shoe cover

Shoe covers are extremely important as in most of the cases the floors of any operatory or hospital is the most contaminated area. Simple act of walking from one room to another room can spread highly virulent infections like the novel disease. Like rest of the kit, shoe covers are also disposable and have to be changed every time when entering into or getting out of a designated contaminated area [65].

5.6 Precautions during Examination of the Oral Cavity

Examination of the oral cavity is the first step of any dental procedure and it includes an array of intra oral procedures. During a pandemic situation it is recommended to use pre-operational antimicrobial mouth rinses to reduce the oral flora during the diagnosis or treatment. Studies have shown that chlorhexidine mouth rinse used before commencement of any dental procedure is not potent enough to degenerate SARS-CoV-2 virus. A solution of oxidative agents such as 1% hydrogen peroxide or 1% povidone is recommended to reduce the salivary load which is a potential carrier of the SARS-CoV-2 pathogen [66]. Cough stimulating intra oral procedures such as taking impressions, IOPA radiographs and the use of the three way syringe [67] should be avoided if possible. An alternative for the IOPA radiographic analysis may be extra oral radiographs such as OPG and CBCT.

5.7 Application of rubber dam

Dental procedures in which generations of aerosol are unavoidable, it is mandatory to use rubber dam. It provides a barrier from the source of viral pathogen (saliva & oral mucosa). If it is placed properly the only source of contamination is the tooth which is undergoing the treatment. Studies have also shown that application of rubber dam decreases the spread of microorganism by 90% [68]. Thus use of rubber dam in procedures generating aerosols must be mandated.

5.8 Use of Disposable Instruments and anti-retraction handpiece

The use of disposable instruments prevents patients-patient cross contamination and promotes hygiene [Figure 5]. The anti-retraction handpiece also plays an important role in prevention of cross contamination as the anti-retraction valve prevents aspiration of the expelled debris and fluid into the water line. This keeps the air ways and the water ways of the dental chair and the handpiece contamination free [69]. The airtorator coolant fluid should

contain effective germicidal dose of disinfectants such as hydrogen peroxide and tosylchloramide sodium [70,71].

Figure 5: Various types of Disposable Instruments

5.9 Removal/Filter of Contaminated Air

Several methods can be incorporated to filter the contaminated air from a dental operatory including the use of 1) high volume evacuator filter (HVE) and 2) high efficiency particulate arrestor filter (HEPA). The HVE filter is portable and is used in close approximation to the source of aerosol production and has a flow rate of 2.83 m³ per minute. Use of HVE system reduces aerosol volume by 90% but one major drawback is that the system requires help of a dental assistant [72]. HEPA filters are more efficient than HVE filters and can remove up to 99.97% of aerosol particles (0.3 µm in diameter) from air. A major drawback of this system is reverse contamination of airways from the dirty filters thus requiring regular cleaning or changing of filter which is cost effective [73]. Electrostatic air purifier may overcome this limitation hence it is recommended [74].

5.10 Disinfection of Dental Setup

The non-disposable dental instruments which are in direct contact with the patient must be disinfected by chemical disinfectant after every patient and subsequently autoclaved. The dental chair must be wiped clean with chemical disinfectant or the disposable cover of the chair must be changed after each patient [75]. Disposable drapes must be used and should be discarded once the procedure is over. After each day of operation fumigation disinfection must be performed in order to disinfect the floors and walls of the dental operatory with chlorine compound, formaldehyde and ethylene oxide [76]. The floor of the operatory should also be wiped clean with phenol and sodium compounds, after attending every patient [76]. Ultra Violet Ray irradiation also has promising disinfection quality and can be used in adjunct with the other techniques [77]. Metal instruments must be

autoclaved should be packed in sterile pouches until further use.

5.11 Disposal of Contaminated Medical Waste/PPE Kit

The waste produced including the PPE kit, disposable instruments and disposable drape should be considered as infectious medical waste. Yellow colored double layered medical waste bags should be used along with gooseneck ligation for the disposal of these biohazards. All the waste bags should be marked of its general content and properly disposed [78].

At the end of clinical practice, thorough disinfection through bathing should be performed by the attending physician and dental assistants.

6. Understanding the Risk before Initiation of Dental Practice

Before commencement of any dental procedure, the dentist must understand the associated risks and the possible chance of cross-contamination. The dentist must commit to the disinfection protocols and contamination preventive protocols. The dentist must be thorough with all the major emergency dental procedures so that he/she is able to provide the best care quickly and accurately. The dentists must keep their moral high in this grim situation and online classes, webinar and case presentation may help in this regard [79]. Discussion and sharing of personal experience related dental procedures among dentists will improve the general awareness among the dental community.

7. Conclusion

Thorough practice of disinfection protocol, hand hygiene and proper use of PPE will prevent cross contamination of highly contagious COVID 19 infection. A better understanding regarding the mode of transmission of the disease especially aerosol contamination is mandatory for correction of procedural errors in daily dentistry. Dentists have the highest chance to be infected with the novel disease due to the nature of dental procedure but with proper protocol it can be avoided. The preventive measures explained will not only protect dental professionals and patients but will also help to control the spread of COVID 19 and will positively contribute in the global effort to combat this novel disease.

References

1. 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.
2. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, Wang W, Song H, Huang B, Zhu N, Bi Y. Genomic characterisation and epidemiology of 2019

- novel coronavirus: implications for virus origins and receptor binding. *The Lancet*. 2020 Feb 22;395(10224):565-74.
3. Of the International CS. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. *Nature Microbiology*. 2020 Mar 2:1.
 4. World Health Organization. Naming the coronavirus disease (COVID-19) and the virus that causes it. [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-\(covid-2019\)-and-the-virus-that-causes-it](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it) (accessed 23 April 2020).
 5. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. *The Lancet*. 2020 Feb 15;395(10223):470-3.
 6. World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV). [https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov)) (accessed 23 April 2020).
 7. World Health Organisation. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. <https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020> (accessed 23 April 2020).
 8. Ruan Q, Yang K, Wang W, Jiang L, Song J. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. *Intensive care medicine*. 2020 Mar 3:1-3.
 9. Novel CP. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. *Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi*. 2020 Feb 17;41(2):145.
 10. Istituto Superiore di Sanità, Age specific mortality rates COVID-19. https://www.epicentro.iss.it/coronavirus/bollettino/Bollettino-sorveglianza-integrata-COVID-19_30-marzo-2020.pdf. Accessed 23 April 2020.
 11. Lazaro Gamio. The Workers Who Face the Greatest Coronavirus Risk', *The New York Times*. undefined: 1.
 12. Ge ZY, Yang LM, Xia JJ, Fu XH, Zhang YZ. Possible aerosol transmission of COVID-19 and special precautions in dentistry. *Journal of Zhejiang University-SCIENCE B*. 2020 Mar 16:1-8.
 13. 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 Mar 17.
 14. 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.
 15. Backer JA, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. *Eurosurveillance*. 2020 Feb 6;25(5):2000062.
 16. Fehr AR, Perlman S. Coronaviruses: an overview of their replication and pathogenesis. In *Coronaviruses 2015* (pp. 1-23). Humana Press, New York, NY.
 17. Gorbalenya AE, Enjuanes L, Ziebuhr J, Snijder EJ. Nidovirales: evolving the largest RNA virus genome. *Virus research*. 2006 Apr 1;117(1):17-37.
 18. Cavanagh D. The coronavirus surface glycoprotein. In *The coronaviridae 1995* (pp. 73-113). Springer, Boston, MA.
 19. Yin Y, Wunderink RG. MERS, SARS and other coronaviruses as causes of pneumonia. *Respirology*. 2018 Feb;23(2):130-7.
 20. Liu P, Chen W, Chen JP. Viral Metagenomics Revealed Sendai Virus and Coronavirus Infection of Malayan Pangolins (*Manis javanica*). *Viruses*. 2019 Nov;11(11):979.
 21. Li F. Structure, function, and evolution of coronavirus spike proteins. *Annual review of virology*. 2016 Sep 29;3:237-61.
 22. Wong SK, Li W, Moore MJ, Choe H, Farzan M. A 193-amino acid fragment of the SARS coronavirus S protein efficiently binds angiotensin-converting enzyme 2. *Journal of Biological Chemistry*. 2004 Jan 30;279(5):3197-201.
 23. Wan Y, Shang J, Graham R, Baric RS, Li F. Receptor recognition by the novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS coronavirus. *Journal of virology*. 2020 Mar 17;94(7).
 24. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, Azman AS, Reich NG, Lessler J. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. *Annals of internal medicine*. 2020 Mar 10.
 25. Nishiura H, Linton NM, Akhmetzhanov AR. Serial interval of novel coronavirus (COVID-19) infections. *International journal of infectious diseases*. 2020 Mar 4.
 26. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Yu T. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The Lancet*. 2020 Feb 15;395(10223):507-13.
 27. Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, Tan KS, Wang DY, Yan Y. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak—an update on the status. *Military Medical Research*. 2020 Dec;7(1):1-0.
 28. Dehkordi AH, Alizadeh M, Derakhshan P, Babazadeh P, Jahandideh A. Understanding Epidemic Data and Statistics: A case study of COVID-19. *arXiv preprint arXiv:2003.06933*. 2020 Mar 15.
 29. Peeri NC, Shrestha N, Rahman MS, Zaki R, Tan Z, Bibi S, Baghbanzadeh M, Aghamohammadi N, Zhang W, Haque U. The SARS, MERS and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: what lessons have we learned?. *International journal of epidemiology*. 2020 Feb 22.
 30. 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.
 31. Dowd JB, Andriano L, Brazel DM, Rotondi V, Block P, Ding X, Liu Y, Mills MC. Demographic science aids in understanding the spread and fatality rates of COVID-19. *Proceedings of the National Academy of Sciences*. 2020 Apr 16.
 32. Pan F, Ye T, Sun P, Gui S, Liang B, Li L, Zheng D, Wang J, Hesketh RL, Yang L, Zheng C. Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia. *Radiology*. 2020 Feb 13:200370.
 33. Jiang F, Deng L, Zhang L, Cai Y, Cheung CW, Xia Z. Review of the clinical characteristics of coronavirus disease 2019 (COVID-19). *Journal of General Internal Medicine*. 2020 Mar 4:1-5.
 34. Wölfel R, Corman VM, Guggemos W, Seilmaier M, Zange S, Müller MA, Niemeyer D, Jones TC, Vollmar P, Rothe C, Hoelscher M. Virological assessment of hospitalized patients with COVID-2019. *Nature*. 2020 Apr 1:1-0.
 35. Sabino-Silva R, Jardim AC, Siqueira WL. Coronavirus COVID-19 impacts to dentistry and potential salivary diagnosis. *Clinical Oral Investigations*. 2020 Feb 20:1-3.
 36. Li X, Geng M, Peng Y, Meng L, Lu S. Molecular immune pathogenesis and diagnosis of COVID-19. *Journal of Pharmaceutical Analysis*. 2020 Mar 5.
 37. Wilder-Smith A, Freedman DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *Journal of travel medicine*. 2020 Mar;27(2):taaa020.
 38. Al-Tawfiq JA, Al-Homoud AH, Memish ZA. Remdesivir as a possible therapeutic option for the COVID-19. *Travel medicine and infectious disease*. 2020 Mar 5.

39. Rodríguez-Morales AJ, MacGregor K, Kanagarajah S, Patel D, Schlagenhauf P. Going global—Travel and the 2019 novel coronavirus. *Travel medicine and infectious disease*. 2020 Jan;33:101578.
40. Izzetti R, Nisi M, Gabriele M, Graziani F. COVID-19 Transmission in Dental Practice: Brief Review of Preventive Measures in Italy. *Journal of Dental Research*. 2020 Apr 17:0022034520920580.
41. Duguid JP. The numbers and the sites of origin of the droplets expelled during expiratory activities. *Edinburgh Medical Journal*. 1945 Nov;52(11):385.
42. Kutter JS, Spronken MI, Fraaij PL, Fouchier RA, Herfst S. Transmission routes of respiratory viruses among humans. *Current opinion in virology*. 2018 Feb 1;28:142-51.
43. Wei J, Li Y. Airborne spread of infectious agents in the indoor environment. *American Journal of Infection Control*. 2016 Sep 2;44(9):S102-8.
44. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. *Journal of Hospital Infection*. 2020 Feb 6.
45. World Health Organization. Coronavirus disease (COVID-19) advice for the public. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public> (accessed 23 April 2020).
46. Chartier Y, Pessoa-Silva CL. Natural ventilation for infection control in health-care settings. *World Health Organization*; 2009.
47. Liu Y, Yan LM, Wan L, Xiang TX, Le A, Liu JM, Peiris M, Poon LL, Zhang W. Viral dynamics in mild and severe cases of COVID-19. *The Lancet Infectious Diseases*. 2020 Mar 19.
48. Wu JT, Leung K, Bushman M, Kishore N, Niehus R, de Salazar PM, Cowling BJ, Lipsitch M, Leung GM. Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China. *Nature Medicine*. 2020 Mar 19:1-5.
49. 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.
50. Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J, Fan Y, Zheng C. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. *The Lancet Infectious Diseases*. 2020 Feb 24.
51. Chen J, Qi T, Liu L, Ling Y, Qian Z, Li T, Li F, Xu Q, Zhang Y, Xu S, Song Z. Clinical progression of patients with COVID-19 in Shanghai, China. *Journal of Infection*. 2020 Mar 19.
52. Ng K, Poon BH, Puar TH, Quah JL, Loh WJ, Wong YJ, Tan TY, Raghuram J. COVID-19 and the risk to health care workers: a case report. *Annals of internal medicine*. 2020 Mar 16.
53. Guan WJ, Liang WH, Zhao Y, Liang HR, Chen ZS, Li YM, Liu XQ, Chen RC, Tang CL, Wang T, Ou CQ. Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *European Respiratory Journal*. 2020 Jan 1.
54. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, Wang H, Wan J, Wang X, Lu Z. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). *JAMA cardiology*. 2020 Mar 27.
55. Wang H, Zhang L. Risk of COVID-19 for patients with cancer. *The Lancet Oncology*. 2020 Apr 1;21(4):e181.
56. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*. 2020 Mar 11.
57. Cheng Y, Luo R, Wang K, Zhang M, Wang Z, Dong L, Li J, Yao Y, Ge S, Xu G. Kidney disease is associated with in-hospital death of patients with COVID-19. *Kidney international*. 2020 Mar 20.
58. Nowak MA, McMichael AJ. How HIV defeats the immune system. *Scientific American*. 1995 Aug 1;273(2):58-65.
59. Jenks PJ, Jones E. Infections in asplenic patients. *Clinical Microbiology and Infection*. 1996 Jun;1(4):266-72.
60. Ren LL, Wang YM, Wu ZQ, Xiang ZC, Guo L, Xu T, Jiang YZ, Xiong Y, Li YJ, Li XW, Li H. Identification of a novel coronavirus causing severe pneumonia in human: a descriptive study. *Chinese medical journal*. 2020 Feb 11.
61. Wang W, Tang J, Wei F. Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. *Journal of medical virology*. 2020 Apr;92(4):441-7.
62. World Health Organisation. WHO hand hygiene strategy feasible and sustainable for health-care settings around the world. https://www.who.int/mediacentre/news/notes/2013/hand_hygiene_20130823/en/ (accessed 23 April 2020)
63. Pittet D. Improving compliance with hand hygiene in hospitals. *Infection Control & Hospital Epidemiology*. 2000 Jun;21(6):381-6.
64. Kadam A, Karjodkar F, Sansare K, Vinay V. Covid 19—Facts And Its Infection Control Measures For Dentists.
65. World Health Organization. Personal protective equipment for use in a filovirus disease outbreak: rapid advice guideline. *World Health Organization*; 2016.
66. Meenakshi SS, Sankari M. Efficacy of 0.2% chlorhexidine and 1% povidone-iodine as preprocedural mouth rinses in chronic periodontitis patients. *Drug Invention Today*. 2018 Aug 1;10(8).
67. Dickinson CM, Fiske J. A review of gagging problems in dentistry: 2. Clinical assessment and management. *Dental update*. 2005 Mar 2;32(2):74-80.
68. Cochran MA, Miller CH, Sheldrake MA. The efficacy of the rubber dam as a barrier to the spread of microorganisms during dental treatment. *The Journal of the American Dental Association*. 1989 Jul 1;119(1):141-4.
69. Hu T, Li G, Zuo Y, Zhou X. Risk of hepatitis B virus transmission via dental handpieces and evaluation of an antisuction device for prevention of transmission. *Infection Control & Hospital Epidemiology*. 2007 Jan;28(1):80-2.
70. Tuttlebee CM, O'Donnell MJ, Keane CT, Russell RJ, Sullivan DJ, Falkiner F, Coleman DC. Effective control of dental chair unit waterline biofilm and marked reduction of bacterial contamination of output water using two peroxide-based disinfectants. *Journal of Hospital Infection*. 2002 Nov 1;52(3):192-205.
71. Smith AJ, McHugh S, Aitken I, Hood J. Evaluation of the efficacy of Alpron disinfectant for dental unit water lines. *British dental journal*. 2002 Nov;193(10):593-6.
72. Narayana TV, Mohanty L, Sreenath G, Vidhyadhar P. Role of preprocedural rinse and high volume evacuator in reducing bacterial contamination in bioaerosols. *Journal of oral and maxillofacial pathology: JOMFP*. 2016 Jan;20(1):59.
73. Chuaybamroong P, Chotigawin R, Supothina S, Sribenjalux P, Larpkiattaworn S, Wu CY. Efficacy of photocatalytic HEPA filter on microorganism removal. *Indoor Air*. 2010 Jun;20(3):246-54.
74. Kim HJ, Han B, Woo CG, Kim YJ, Lim GT, Shin WG. Air cleaning performance of a novel electrostatic air purifier using an activated carbon fiber filter for passenger cars. *IEEE Transactions on Industry Applications*. 2017 Aug 29;53(6):5867-74.
75. Moorer WR. Antiviral activity of alcohol for surface disinfection. *International journal of dental hygiene*. 2003 Aug;1(3):138-42.
76. Phillips CR, Warshowsky B. Chemical disinfectants. *Annual review of microbiology*. 1958 Oct;12(1):525-50.
77. Kowalski W. UV surface disinfection. In *Ultraviolet germicidal irradiation handbook 2009* (pp. 233-254). Springer, Berlin, Heidelberg.
78. Windfeld ES, Brooks MS. Medical waste management—A review. *Journal of environmental management*. 2015 Nov 1;163:98-108.
79. Meng L, Hua F, Bian Z. Coronavirus disease 2019 (COVID-19): emerging and future challenges for dental and oral medicine. *Journal of Dental Research*. 2020 Mar 12:0022034520914246.