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COVID-19: EVALUATION, EARLY DIAGNOSIS AND SAFETY MEASURES IN DENTISTRY

Dental Science

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ABSTRACT

COVID - 19 a recent pandemic disease caused by SARS-CoV2 virus which is associated with human to human transmission. Presence of SARS-CoV-2 in saliva is liable for transmission of COVID-19 via aerosol, fomites, or the fecal-oral route that may contribute to nosocomial spread in the dental office setting. Asymptomatic and pre-symptomatic patients are also contagious in the early stage of disease but difficult to diagnose at this phase as antibodies takes 7-10 to form after infection. The aim of this article is to formulate a protocol using the parameters from differential WBC count in combination with CRP and ESR in order to distinguish the presence or absence of Covid-19 infection in dental practice to prevent the cross infection.. This article also presents clear and easy guidelines to manage dental patients and to make working dentists safe from any risk.

KEYWORDS

Covid-19, SARS-CoV-2, Infection control, lymphopenia.

INTRODUCTION:

COVID-19 is caused by severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) infection. SARS-CoV-2 is an RNA virus, with a typical crown-like appearance under an electron microscope due to the presence of glycoprotein spikes on its envelope. A novel corona virus is associated with human to-human transmission. The virus might pass through the mucous membranes, especially nasal and laryngeal mucosa, then enters the lungs through the respiratory tract.[1]
SARS-CoV-2 can bind to human angiotensin-converting enzyme 2 receptors, which are highly concentrated in salivary glands; this may be a possible explanation for the presence of SARS-CoV-2 in secretory saliva. Therefore, there is a potential for transmission of COVID-19 via droplets, aerosol and fomites, that may contribute to nosocomial spread in the dental office setting.

This review presents the COVID-19 clinical manifestations, diagnosis, case management, emergency response and preparedness.[2]

Sars CoV 2 Transmission:

Contact: The virus can spread directly from person to person when a COVID-19 case coughs or exhales producing droplets that reach the nose, mouth or eyes of another person.[3,4] Alternatively, as the droplets are too heavy to be airborne, they land on objects and surfaces surrounding the person. Other people become infected with COVID-19 by touching these contaminated objects or surfaces, then touching their eyes, nose or mouth.[5]

Respiratory: As mouth is a part of oro-nasal pharynx, it harbors viruses from nose, throat and respiratory tract. During dental treatment, several thousand droplets are aerosolized. The larger droplets (more than 5 microns) travel a short distance (less than 3.3 feet) fall quickly to the floor, onto other surfaces of dental chair and cabinets. The smaller droplets (less than 5 microns) evaporate quickly, leaving dry microscopic droplet nuclei which remain suspended in the air long distance (more than 13.1 feet) and require prolonged hours to settle down. It has been found that the virus remains viable in aerosols upto 3 hours under controlled laboratory conditions.[6] Microorganisms in excess of 5 times that of outdoor air are present in dental surgery units.[7]

Fecal–oral transmission has been reported for 2019-nCoV, which underlines the importance of hand hygiene for dental practice

Clinical manifestations: (picture 1)
After infection, symptoms might not develop for five to six days on average (incubation period) but there is evidence that it could be as long as 14 days.[8] The time between catching the virus and showing symptoms is called the pre-symptomatic phase.(window phase) It has been suggested that people who are pre-symptomatic can definitely transmit the virus, most likely in the one to three days before they start showing symptoms and are most infectious right around the time when symptoms start. For transmission pre-symptomatic is a much more common category than asymptomatic. About 75% of people who test positive without showing symptoms turn out to be pre-symptomatic, displaying coughing, fatigue, fever and other signs of COVID-19 in a later follow-up exam. It has been found that the viral loads were similar between symptomatic and asymptomatic patients. It has been hypothesized that B lymphocyte reduction may occur early in the disease, which may affect antibody production in the patient.[9]

Dawei Wang et al found that the virus begins a second attack, causing ARDS around 7–14 days after onset (acute phase). It has been speculated that lymphocytes in patients with COVID-19 might gradually decrease as the disease progress. If the immune function of patients in the acute phase is effective, the virus can be effectively suppressed (recovery phase)

The virus can also be asymptomatic, causing no noticeable illness in some people – but these people are still contagious and can spread the virus.[1] Some patients may have sore throat, rhinorrhea, headache and confusion a few days before the onset of fever, indicating that fever is a critical symptom.[5]

The most common symptoms of COVID-19: [1]

- Fever - 99%
- Fatigue - 70%
- loss of smell - 59% -
- Persistent Cough - 59%
- Lack of appetite - 40%
- Body aches - 35%
- Hoarse voice - 32.3%
- Shortness of breath - 31%
- Mucus/phlegm - 27%
- Runny nose - 4%
- Sore throat - 5%

Diagnosis of Covid 19 case:

Diagnosis currently relies on two major methodologies

1. Reverse Transcription Quantitative Polymerase Chain Reaction (RT-qPCR) is a highly sensitive test for SARS-CoV-2 and it requires high-quality nasopharyngeal swabs containing sufficient amounts of viral RNA. Limitations include false negative results and sensitive to spoilage during sample collection, transport, storage and testing.
2. Serological immunoassays (rapid antibody tests) that detect viral-specific antibodies (IgM and IgG) are recommended to be used on patients at least 3 days after onset of symptoms or 7-10 days after infection.[10] Serological tests cannot be used in the early stage of infection as IgM antibodies are formed on the 7 the day and IgG are formed on 14 day after infection respectively.[11] (picture 1)

So a protocol is suggested for early diagnosis based on patient screening, blood examination and serological test.

Suggested protocol for early diagnosis in dental office: (Flowchart1)

Telescreening: [12]

Initial screening is done via telephone using the questionnaire

1) Any symptoms such as fever, cough, runny nose, loss of taste or smell or GIT disturbance during past 14 days. Have you come in contact with any person who has these symptoms?
2) Any exposure to a person with known or suspected Covid 19 or anyone in household infected with Covid 19 (quartined).
3) Any recent travel history to an area with high incidence of Covid 19.
4) Any recent participation in gathering or had close contact with many unacquainted people?

A positive response to any of the above questions, dental treatment should be deferred if negative advice for differential WBC count, ESR and CRP tests.

Decreased lymphocyte count (52.27%) is an important indicator for early diagnosis.[13] It has been suggested that COVID-19 mainly act on T and B lymphocytes, at early stage.[14, 15] According to Zhongping He, there is a reduction in lymphocyte count from the 2nd day after the onset of infection that is before the person becomes contagious.[16]

All patients of Covid-19 presented elevated levels of erythrocyte sedimentation rate (ESR), while 75% for C-reactive protein (CRP).[13] CRP levels begin to rise within 2 hours of an infection, and has a half-life of about 18 hours. In acute bacterial infections CRP level will be raised 150 to 350 mg/L in contrast the viral infections shows lower levels of CRP up to 100mg/L. CRP levels fall more quickly than ESR thus beneficial in monitoring of acute infection and persistent elevated levels suggest continuing inflammation. ESR level rises 24-48 hours after onset of inflammation and remains elevated for days to weeks after resolution of inflammation. Hence ESR is useful in monitoring of chronic inflammatory condition. Both CRP and ESR will be raised in Covid-19 patients and CRP levels can be used to monitor the disease, when CRP levels reduce patients is considered to get better. Both CRP and ESR play an important role in clinical diagnosis of Covd-19. Prescreening with quick read go CRP may be advantageous as result is shown in 2 minutes from finger-prick sample.

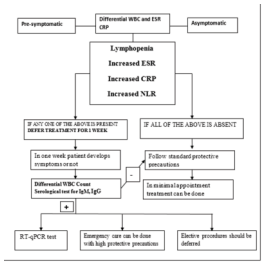
A recent study of COVID-19 showed that severe cases of COVID-19 tended to have higher NLR. (Neutrophil to Lymphocyte ratio) Normal NLR is around 1-3. If the value is little higher indicates subclinical inflammation. This helps for the early diagnosis of the covid-19.[17]

If any of the above is present then treatment should be deferred for one week. Monitor the patient for one week if he develops symptoms or not, afterwards check for differential WBC count. If these are normal treatment can be done using standard protective measures. If any of these not normal ask the patient to undergo serological test for the antibodies against SarsCoV-2. If positive, patient is advised for RT-qPCR test for confirmation of Covid-19.

Screening for oxygen saturation, respiratory rate and heart rate may be useful in the acute phase of infection that is from 7-14 days. The respiratory rate of more than 30, oxygen saturation of less than 93% and heart rate of more than 120 minute, considered as critical in the diagnosis of Covid-19. These finding are less useful in the diagnosis of asymptomatic or pre-symptomatic patients in the early stage of infection.

In this suggested protocol four parameters are considered along with history of the patient, one can diagnose Covid-19 patient at an early phase of the disease.The accuracy of the protocol has to be tested in actual clinical scenario.

(Flowchart 1)



Measures to be taken by the Dentist:

The outbreak of COVID-19 has clearly placed health professionals at risk. According to an article entitled "TheWorkers Who Face the Greatest Coronavirus Risk" published in the New York Times states that dentists are the workers most exposed to the risk of being affected by COVID-19, much more than nurses and general physicians.[18]

How to keep dental clinic safe: Precautions for dental clinic (table 1)

Clean and disinfect frequently touched surfaces and objects such as doorknobs, cabinet handles and front desk areas with sodium hypochlorite or ethanol.[19] Sodium hypochlorite concentration of 0.1% is effective in 1 minute on corona viruses, so a dilution 1:50 of standard bleach is recommended.[20] A concentration of 70% ethanol is recommended by the WHO for disinfecting small surfaces.[21] Dental offices may cover all the equipments with protective covers, such as thin plastic bags, wraps or aluminium foils, which are replaced after each patient.[22]

The dental clinic should be fumigated with formaldehyde on regular basis. During the restorative procedures and ultrasonic scaling, the highest bacterial count was detected on the subject's chest.[23] So the patient drapes should handled carefully and disinfected. Locally high bacterial densities were also found at the treatment tray; this indicates that disinfection and sanitation after a patient's treatment cannot be ignored.[24] Hand hygiene should be performed before touching a patient to prevent hand to mouth transmission as ACE2 receptors are found in the mouth and tongue.

General consideration:

Most dental procedures that use mechanical instrumentation will produce airborne particles from the site where the instrument is used. Dental hand pieces, ultrasonic scalers, air polishers and air abrasion units produce the most visible aerosols. The dental team should not rely on a single precautionary strategy.[25](Table 2)

The first three layers of defense are found routinely in most dental operatories, are inexpensive and fourth layer of defense should be incorporated to fight against Covid-19.

First layer of defence: Personal Protective Equipment (PPE)

During dental procedure significant aerosol droplets are found on upper surfaces of the operator's arms, lower neck region, and chest and face shield.[23] Therefore, protecting these areas—including arms, is essential, as breaks in the skin (scratches) are often unrecognized.[26] Personal Protective Equipments (PPEs) are protective gears designed to safeguard the health of workers by minimizing the exposure to a biological agent. Components of PPE are goggles, face-shield, mask, gloves, coverall/gowns (with or without aprons), head cover and shoe cover.

A high bacterial density was found in the respiratory area outside the full cover facial shield of the dentist. By contrast, the contamination concentration inside the full cover face shield is obviously lower than outside. This means that the full cover face shield has a relevant protective effect for the dentist.[24] To protect the eyes from aerosols and debris created during dental procedure, protective eyewear should be worn throughout the treatment and disinfected between patients.

Face masks:

A surgical mask cannot filter fine particles of less than 2 microns in diameter and will be loose fitting at the edges from there leakage can happen. As respiratory droplets are the main route of SARS-CoV-2 transmission, particulate respirators (e.g., N-95 masks authenticated by the National Institute for Occupational Safety and Health or FFP2-standard masks set by the European Union) are recommended for routine dental practice.

When performing aerosol generating procedures (using high-speed handpiece, air-water syringe, and ultrasonic scaler), a particulate respirator that is at least as protective as a National Institute for Occupational Safety and Health (NIOSH)-certified N95, European Standard Filtering Face Piece 2 (EU FFP2), or equivalent, was used. N 95 mask filters out particles of 0.3 microns diameter and not totally filetrs SARS-CoV-2 as virus measures 0.125 microns in diameter.

N 95 mask should be discarded after each patient encounter and after aerosol producing procedures. N95 mask can be protected and reused by wearing a surgical mask/face shield over the N 95 mask. And surgical mask can be discarded after each aerosol producing procedure. N 95 can be discarded when damaged, no longer forms an effective seal or if it becomes contaminated aerosol or spatter.

Second layer of defence: Pre-procedural mouth rinses:
Higher bacterial counts in aerosols were observed with the patient, who did not brush or floss for 24 hours, than with the patient, who had brushed and flossed before treatment.[23] As Sars CoV-2 is vulnerable to oxidation, pre-procedural mouth-rinse containing oxidative agents such as 0.5% to 1% hydrogen peroxide or 0.2% to 1% povidone iodine is recommended, for the purpose of reducing the salivary load of oral microbes, including potential 2019-nCoV carriage.[27]

Commonly hydrogen peroxide is supplied in a 3 percent concentration. Stronger 3% solution is likely to cause mucosal irritation. So mix two parts water with one part hydrogen peroxide. Tilt the head back and continue gargling for 30 seconds.[20] Spit the solution out entirely. Children should not gargle with hydrogen peroxide as there is danger of swallowing the solution It has been suggested that the use of a mouth rinses and/or with local nasal applications that contain β-cyclodextrins combined with flavonoids agents, such as Citrox, in decreasing the viral load in saliva and nasopharyngeal microbiota, including potential SARS-CoV-2 carriage. β-cyclodextrins **disturb the lipid membrane of the virus, effectively decreasing its activity and spread**.[28]

Third layer of defence: Rubber dam with HVE:
When rubber dam is applied, high vacuum evacuator(HVE) held approximately 6-15mm away from the handpiece or ultrasonic tip can reduce 90% of aerosol production.[25, 29,] Isolate 3 delivers quick, easy reliable isolation with uninterrupted retraction and continuous evacuation of fluids and oral debris. It is found that the use of a rubber dam with HVE or the Isolite system significantly reduced aerosol production compared with use of HVE alone.[30]

When using rubber dam the primary source of airborne contamination is the water supply from the dental instruments. This can be prevented by using anti-retraction dental handpiece [29] and by flushing the dental unit water line at the start of each clinical day and between patients for 30 seconds to 1 minute or use valve preventing suckback of liquids.[31]

Fourth layer of defence: Air Cleaning System (ACS)
Whyte *et al.* proposed that for an ultraclean operating room the mean bacteria-carrying particles should not exceed more than 10 per m^3.[32]

ACS comprises a 1,500 mm long flexible polypropylene plastic/ metal suction duct (125 mm diameter) that firstly directs air through a combination of High Efficiency Particulate Air (HEPA) pre-filters which retain particles less than 0.3 µm in size. Finally by use of ultraviolet irradiation (wavelength 254nm), the DNA of all bacteria and viruses are ruptured.[7]

ACS can significantly reduce the bioaerosol load during dental procedures. However, on no occasion aerosol level reduced to that encountered at absence of clinical activity.[33] In order have best effect from air cleaner during procedure it should be placed close to the patient mouth at a distance of 1m and afterwards has to moved near the patient's feet.[34]

Patient protection items:
Nose filter is a small device with a special electrostatic nano-fiber material that sits discreetly into the nostrils and passes clean filtered air directly. They provide protection from pollutants, bacteria (90%) and viruses (50%). Cover the patient's nose with mask and eyes with glasses to prevent cross infection.

Table 3 shows the emergency treatments that cannot be postponed has to be carried out even in Covid-19 patients. Table 4 enlists the general safety measures for the dental offices. The non-Aerosol Generating Procedures are
Examinations
Hand scaling with suction
Non-surgical extractions
Removable denture stages

Removal of caries using hand excavation, slow speed hand-piece, vector method, chemo-mechanical method and by hard tissue lasers

CONCLUSION:
Dental health care provider should be familiar with the possible transmission routes of Covid-19, such as the airborne spread, contact spread, and fomites spread. The article also reviewed the early diagnosis of asymptomatic and pre-symptomatic patients based on Telescreening and blood examination. Several safety measures are also reviewed to block virus transmission. The protective strategies of Covid-19 include early diagnosis, use of personnel protective equipments, fit tested N95 respirator, rubber dam with HVE and air cleaning system during dental diagnosis and treatment.

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