International Journal of Research in Health and Allied Sciences
Journal home page: www.ijrhas.com
Official Publication of "Society for Scientific Research and Studies" [Regd.]
ISSN: 2455-7803

REVIEW ARTICLE

Coronavirus – The Menace: A Dentist's Perspective

Sukhmanpreet Kaur[1], Amarpreet Singh Sandhu[2]

[1]B.D.S., Dental surgeon, Dhaliwal superspeciality hospital , Amritsar
[2]Lecturer, Department of Oral & Maxillofacial Surgery, Sri Guru Ram Das Institute of Dental sciences & Research, Amritsar, GT Road Punjab, India

***ABSTRACT*:**
Various infectious agents are known to be transmitted naturally via respiratory aerosols produced by infected patients. Such aerosols may be produced during normal activities by breathing, talking, coughing and sneezing. One of the most important concerns presently in public, declared by WHO (World Health Organisation) on Feb 11, is now known as COVID -19 presented in Wuhan, China. The participants in dental practice are exposed to tremendous risk of 2019-nCoV infection due to face to face communication and exposure to saliva, blood, and other body fluids and handling of sharp instruments. Dental professionals play great roles in preventing the transmission of 2019-nCoV. Through this article we emphasize on the global epidemic cause by the menace known as coronavirus from a dentist perspectives and the infection control measures during dental practice to block the person to person transmission in dental clinics and hospitals.
Key words: Coronavirus, Dental, Infection, Dentist, 2019-nCoV

Received: 20 March, 2020 Accepted: 26 March, 2020

Corresponding author: Dr. Amarpreet Singh Sandhu, Lecturer, Department of Oral & Maxillofacial Surgery, Sri Guru Ram Das Institute of Dental sciences & Research, Amritsar, GT Road Punjab, India

This article may be cited as: Kaur S, Sandhu AS. Coronavirus – The Menace: A Dentist's Perspective. Int J Res Health Allied Sci 2020; 6(2):1-7

INTRODUCTION:
Coronaviruses belong to the family of *Corona viridae*, of the order *Nidovirales*, comprising large, single, plus-stranded RNA as their genome.[1]Currently, there are four genera of coronaviruses: α-CoV, β-CoV, γ-CoV, and δ-CoV.[2.] The α-CoV and β-CoV mainly infect the respiratory, gastrointestinal, and central nervous system of humans and mammals, while γ-CoV and δ-CoV mainly infect the birds.[3,4,5]
The emergence of two human β-CoV includes:
(i)MERS (Middle east respiratory syndrome),
(ii)SARS (Severe acute respiratory syndrome), is thought to be driven by the spillover of bat adapted CoVs into an intermediate host.
(iii)COVID-19 (Corona virus disease2019) recently explored in WUHAN 2019; also belongs to β-CoV, according to phylogenetic analysis based on viral genome.[1,6]

HISTORY
Coronavirus was first identified in the 1960s, and it got its name from their crown like shape.[7] In 2002, SARS emerged in Guangdong province of southern China and was spreading in 2003 around the world resulting in 8000 cases with a fatality rate of about 10%(WHO,2016), and known to originate from Bats and Civets, with the incubation period of 4 days (range 1to 13 days), symptoms including fever, headache and discomfort. As of 2015, there were no further reports of cases of SARS.[6,8]
Ten years later, MERS emerged in Saudi Arabia and spread to different countries with a fatality rate of about 35%(WHO,2016). In April 2014, the first American was hospitalized for MERS in Indiana, and another case was reported in Florida. Both had just returned from Saudi arabia.[7] The incubation period was 5 days (range 2to 15 days) with, the main symptoms of MERS are fever, chills, generalized myalgia, cough, shortness of breath, nausea, vomiting and diarrhoea.[6] In May2015, there was an outbreak ofMERS in Korea, which was the largest outbreak outside of the Arabian Peninsula.[7] Dromedary camels are the major reservoir host of MERS[8]. Nevertheless,

both viruses are known to transmit from human to human.

In December 2019, a novel CoV (2019-nCoV) has emerged from WUHAN in China and spread rapidly from this area to globe.[8] Although its original host remains unknown, all available data point again to a zoonotic, a wild animal source.[8]

GENETIC MAKEUP

Full length genome nucleotide analysis of 2019-n CoVpatient samples revealed a 79.5% and 96% sequence identity to SARS –CoV and a bat SARS r-CoV respectively, however sequences of the seven conserved viral replicase domains, in ORF lab shows 94.6% identity between 2019n CoV and SARS-CoV.[8,9]

Coronavirus (bat CoVRATG13) detected in the bat rhinolophusaffiis from Yunnan province china, and 2019n CoV was 96.2% indicating that the natural host of 2019n CoV may also be the Rhinolophusaffinis bat. However, the differences may also suggest that there is an or more intermediate hosts between the bat and human. A research team from south china agricultural university has invested more than 1000 metagenomic samples from pangolins and found that 70% pangolins contained β-CoV .The virus isolated from the pangolins comprised of a genome that was similar with that from 2019-n CoV and indictaing that pangolin may be the intermediate host of 2019 n CoV.[10] On 11 Feb. 2020, declared a public health emergency of international concern by the WHO (World Health Organisation),[11] On the 31st jan 2020, the US department of health and human services secretary declared it a US public health emergency. The centre for disease control (CDC) and American dental association (ADA) have made public statements regarding precaution that dental practices need to take in order to address this "EMERGENCY OF INTERNATIONAL CONCERN".[12]

MECHANISM OF ACTION

2019-nCoV possessed the typical coronavirus structure with the spike protein (S-protein) in the membrane envelope.[13] The S- protein from coronavirus can bind to the receptor of host to facilitate viral entry into target cells.[14,15] Although there are four amino acid variations of s protein between 2019n-CoV and SARS-CoV, 2019NCoV can bind to human angiotensin converting enzyme 2 (ACE2), the same host receptor for SARS-CoV, as 2019n CoV can bind to the ACE2 receptor from the cells from human, bat, civet cat and pig but it cannot bind to the cells without ACE2.[16,17,18]

A recombinant ACE 2 –lg antibody, a SARS-CoV specific human monoclonal antibody and the serum from a convalescent SARS-Cov infected patient, which can neutralize 2019n CoV confirmed ACE2 as the host receptor for 2019n-CoV[19-24]. The high affinity between ACE2 and 2019n CoV S protein also suggested that the population with higher expression of ACE2 might be more susceptible to 2019n-CoV.[20,21] The cellular seriene protease TMPRSS2 inhibitor might constitute a treatment option.[22] ACE 2 cells were found to be abundantly present thoroughout the respiratory tract as well as the cells morphologically compatible with salivary gland ducts were demonstrated to be a class early targets of SARS- CoV infection and 2019-nCoV is likely to be the same situations.[25-27] Although, no research has been reported so far.

POSSIBLE TRANSMISSION ROUTES OF 2019-nCoV

Based on findings of genetic and epidemiologic research, it appears that the COVID-19outbreak started with a single animal to human transmission and followed by sustained human to human spread.[8] The common transmission routes of novel coronavirus include direct transmission (cough, sneeze and droplet inhalation transmission) and contact transmission (contact with oral , nasal and eye mucous membranes).[28] Although common clinical manifestations of novel coronavirus infection do not include eye symptoms, the analysis of conjunctival samples from confirmed and suspected cases of 2019-nCoV suggests that the transmission of 2019-nCoV is not limited to the respiratory tract.[30] and that eye exposure may provide and effective way for the virus to enter the body.[29] In addition there may be risk of faecal oral transmission as researchers have identified SARS-CoV in the stool of patients from China and United States[8] In addition the asymptomatic incubation period for individual infection with 2019n-CoV have been reported to be 1~14 days and after 24days individuals were reported and it was confirmed that those without symptoms can spread the virus.[30,31,32]

SPREAD BY AEROSOLS

Respiratory virus symptom such as sneezing and coughing result in the generation of virus containing particle in a size continuum from 1 to 500um.[33,34] Coronavirus especially have the ability to survive for long periods in aerosols.[35] The dental papers show that many dental procedure produce aerosols and droplets that are contaminated with virus.[36]Thus, droplets and aerosols transmission 2019-nCoV are the most important concerns in dental clinics and hospitals, because it is hard to avoid the generation of large amount of aerosols and droplet mixed with patients saliva and even blood during dental practice.[37,38] In addition to the infected patients cough and breathing , dental devices such as high speed dental handpiece uses high speed gas to drive, the turbine to rotate at high speed and work with running water.[1]

SPREAD BY CONTAMINATED SURFACE

SARS-CoV, MERS-CoV and influenza virus can survive on dry surfaces for extended periods, particularly when suspended in human secretions,[38] may contaminate hand touch sites in the field.[39] Human coronavirus such as SARS-CoV, middle east respiratory syndrome coronavirus (MERS-CoV) or endemic human coronavirus (HCOV) can persist on surfaces like metal, glass or plastic for upto a couple of days.[40,41] Therefore, contaminated surfaces that are frequently contacted in healthcare settings are a potential source of coronavirus transmission.[1]

SPREAD BY DRY SURFACES

Survival times for SARS CoV, MERS –CoV, and surrogates such as transmissible gastroenteritis virus. (TGEV) are generally measured in day, weeks or months.[42,43] Survival times for influenza virus are generally shorter, often measured in hours rather than days.[43,44] However, some studies have reported considerably longer survival times for influenza virus, measured in days rather than hours.[45,46]

SARS-CoV and MERS-CoV appeared to have and unusual capacity to survive n day surfaces compared with other human coronaviruses.(229E, OC43 and NL63)[47,48,49]

Coronaviruses and influenza both have the capacity to survive on a wide range of porous and non-porous material, including metals, plastic (such as light switches, telephones, Perspex, latex, rubber and polystyrene), woven and non-woven fabrics (including cotton, polyester, handkerchiefs and disposable tissues), paper (including magazine pages, wood, glass, stethoscope, tissue, Formica, bank notes, tiles, eggs, feathers and soft toys.[43,50] The properties of different surfaces are likely to influenza dried on to copper surfaces was considerably shorter than on stainless steel.[51]

SPREAD BY CONTACT

A dental professional frequently direct or indirect contact with human fluids, patient material and contaminated dental instruments or environmental surfaces makes a possible route to the spread of viruses.[37]

SPREAD BY DENTAL

Dental clinics can and do provide needed dental care to many patients. However, because of the types of settings and volume of patients treated, consistently maintaining recommended infection control practices in these clinics can be challenging.[25]The dental office deals with specialized pollution produced by blood spilling procedures on a vast population likely to be affected by numerous diseases.[52]

In addition, dental professionals and other patients have likely contact of conjunctival, nasal or oral mucosa with droplets and aerosols containing microorganisms generated from an infected individuals and propelled a short distance by coughing and talking without a mask. Effective infection control strategies are needed to prevent the spread of 2019-nCoV through these contact routines[1].

When dried devices work in the patients oral cavity, a large amount of aerosol and droplets mixed with the patients saliva or even blood will be generated. Particles of droplets and aerosols are small enough to stay airborne for an extended period before they settle on environmental surfaces or enter the respiratory tract. Thus, the 2019-nCoV has the potential to spread through droplets and aerosols from infected individuals in dental clinics and hospitals.[1]

Dental practices derived droplets and aerosols from infected patients, which likely contaminate the whole surface in dental offices. In addition, it was shown at room temperature that nCoV remains infectious from 2hrupto 9 days and persists better at 50% compared with 30% relative humidity. Thus, keeping a clean and dry environment in the dental office would help decrease the persistence of 2019-nCoV.

Fine aerosols generated by high speed dental equipment consist of moisture droplets and debris, usually 5 um or less in diameter that can remain suspended in the air, without adequate protection, aerosols may reach the depth of lungs.[53,54] Spatter droplets are much larger than aerosol particles (>50um in diameter) and can act as projectiles. Both aerosols particles and spatter droplets can contain infectious agents as the diameter of a bacterial cell is about 1.0um and that of a virus is much smaller.[55]

A study took place in a university of paedodontic clinic, Tanta University, Egypt consisting of 10 participants.[52]During conservative procedure without rubber dam, the air borne bacterial load increased from 8.8 to 25.1 CFUs. This means that the patients, dentist and assistant and the surfaces and objects in the clinic are at a risk of exposure to airborne contamination 2.5 times greater than the norm.[56]It has been found that the airborne bacteria after the procedure persisted at a higher level than the initial one (8.8 to13.5 CFUs) which is in agreement with Legnani et al.[56]

After many patients have been treated, the microbiological contamination at the end of the day will be worse and many different species of bacteria as well as viruses may be present in a dental office. The contamination may become worse if using a high speed handpiece in infected pulp containing variable species.[52]

During cavity preparation, there were variable distributions of bacterial contaminated aerosols and spatter.Thus, the distributions in variable and may be influenced by many factors, such as the type of procedure, the position of the tooth in the mouth, the position of the operator relative to the patients, the position of the patient in the dental chair, whether high volume evacuation was used and level of microorganisms in the patients mouth.[52]

SPREAD BY SALIVA

The shedding of severe acute respiratory syndrome coronavirus (SARS-CoV) into saliva droplets play a

crucial role in viral transmission. The source of high viral loads in saliva.however, remains elusive.[57]
ACE2+/cytokeratin+ cells loningsalivary gland ducts are early target cells of SARS-CoV and a likely source of the virions found in patients saliva droplets, especially early in infection.[58]
The 2019 novel coronavirus (2019-nCoV) was detected in the self collected saliva of 91.7% of patients (11/12) live virus was detected in saliva by viral culture. The median age was 62.5years, ranging from 37 to 75 years.[59]
The positive viral culture indicated that saliva contain live viruses that may allow transmission. Saliva can be emitted through cough, and respiratory droplets containing influenza virus can be found even during normal breathing.[60]
The result have demonstrated the potential for saliva to be a non invasive specimen type for the diagnosis and viral load monitoring of 2019-nCoV.[59]

PRECAUTIONS/PREVENTION

The dental professional is particularly at risk, if working on an infected patient because of the close contact with and the risk of blood, saliva and droplet exposure. The essential and non essential dental procedures are enlisted in **Table 1**

Table1: Essential and non essential dental procedures

Essential vs. Non-Essential Dental Procedures

This guide is to help dentists identify which dental procedures are considered Essential vs. Non-Essential during a national emergency. Dentists are to use the below as a guide, and encouraged to make professional judgement calls on the urgency of any procedure during emergencies. Please note: All procedures should also consider risk factors associated with demographics more susceptible to COVID-19, such as elderly patients.

Specialty	Procedure Type	Essential	Non-Essential
Restorative	**Fillings/Restorations**		
	Incipient to Mild Decay		x
	Moderate Decay	x	
	Severe Decay	x	
	Fracture tooth repair		
	Pain	x	
	No Pain (if patient feels uncomfortable, consider that patient in pain)		x
	Crown		
	Crowns to be completed to navigate completion of care for moderate - severe decay as well as to complete RCT	x	
	Proactive replacement of restoration without decay		x
	Veneers		x
Cosmetics	**Cosmetic procedures**		x
Endodontics	*Active infection*	x	
	Patient in Pain	x	
	Swelling or cellulitis	x	
Emergency Patients	*Any patient who is contacting the practice with urgent needs should be seen to decrease overflow to Emergency Departments*	x	
Hygiene	*New Patient*		x
	Recall		x
	Continuing Care		x
Oral Surgery	**Extractions**		
	Active Infection	x	
	Patient in Pain	x	
	Swelling or cellulitis	x	
	Third Molar without the above symptoms		x
	Implants		x
Orthodontics	*New Bandings*		x
	Patient complications (wire or bracket fractures)	x	
	Recall		x
	*Debond**		x
	**Doctor to make judgement on if recall has extended time period and warrants a visit.*		
Periodontics	**Initial Therapy SRP or Maintenance**		
	Patient has additional risk factors (Diabetes, Cardiac disease)	x	
	No additional risk factors		x
Prosthodontics	**Bridges**		x
	Dentures and Removables	x	
Pediatrics	*Follow guidelines above for specific procedures.*		

Recommendation for dental practice[1]

1. Dentists should take strict personnel protection measures and avoid or minimize operations that can produce droplets or aerosols
2. The 4 handed technique is beneficial for controlling infection.
3. The use of saliva ejectors with low or high volume can reduce the production of droplets and aerosols.
4. Evaluation of patients:
   - During the outbreak of the virus, establish pre check triages to measure and record the temperature of every staff and patient as a routine procedure, Take a detailed travel and health history. Do not provide non-emergent or cosmetic treatment to patients within 14 days of travel from other country or exposure to others that have travelled from or via China or presently any part of the world.
   - Reschedule patients with respiratory symptoms to prevent the spread of infection. This includes patients with any flu-like symptoms.
   - Wash hands with soap and water for at least 20 seconds after contact with patients or use an alcohol-based hand sanitizer with at least 60% alcohol if soap and water are not available. Avoid touching the eyes, nose, and mouth with unwashed hands.
   - Stay home when sick; cover coughs and sneezes with a tissue and throw the tissue in the trash; and clean and disinfect frequently touched objects and surfaces.
   - The ADA urges all practicing dentists, dental auxiliaries and dental laboratories to employ appropriate infection control procedures as described in the 2003 CDC Guidelines, and 2016 CDC Summary and to keep up to date as scientific information leads to improvements in infection control, risk assessment, and disease management in oral health care.
5. Oral examination
   - Preoperative antimicrobial mouth rinse could reduce the number of microbes in the oral cavity.
   - o Procedures that are likely to induce coughing should be avoided.
   - Aerosol generating procedure, such as the use of a 3 –way syringe, should be minimized as much as possible.
   - Intraoral x-ray examination can stimulate saliva secretions and coughing. Therefore, extra-oral dental radiographs, such as panoramic radiography and cone beam CT, are appropriate alternative during the outbreak of COVID -19.
6. Treatment of emergency cases:
   - Rubber dams and high volume saliva ejectors can help minimize aerosol
   - Mouthrinses are believed to reduce the number of oral microbes, especially 1% hydrogen peroxide or 0.2 % Povidine.
   - Face shield and goggles are essential with use of high or low speed drilling with water spray.
   - If a carious tooth is diagnosed with symptomatic irreversible pulpitis, pulp exposure could be made with chemo-mechanical caries removal under rubber dam isolation and a high volume saliva ejector after local anaesthesia. Then pulp devitalisation can be performed to reduce the pain. The filling material can be replaced gently without a devitalising agent later.
   - After treatment, environmental cleaning and disinfection procedures were followed. Alternatively, patients could be treated in an isolation and well ventilated room.
   - If a tooth needs to be extracted, absorbable suture is preferred .for patients with facial soft tissue contusion, debridement and suturing should be performed. It is recommended to rinse the wound slowly and use the saliva ejectors to avoid spraying.

INFECTION CONTROL MEASURES

Strict infection control is critical to preventing transmission to healthcare workers, medical, paramedical staff, dental surgeon, patients and their attendants.

(1) Primary protection:- standard protection for staff in clinical settings, wearing disposable working cap, disposable surgical mask, and working clothes(white coat), using protective goggles or face shield, and disposable latex gloves or nitrile gloves if necessary.

(2) Secondary protection:- advanced protection for dental professionals, wearing disposable doctor cap, disposable surgical mask, protective goggles, face shield, and working clothes (white coat) with disposable isolation clothing or surgical clothes outside, and disposable latex gloves.

(3) Tertiary protection:- strengthened protection when in contact with patient suspected or confirmed with 2019-nCoV infection.

The other protective measures taken during treatment of emergency cases are:-mouth rinse of patient before treatment, use of rubber dam isolation, use of anti retraction hand-piece are indicated during the treatment of all coronavirus patients, in the end disinfection of the clinical settings, and management of the medical waste, and such protocols for droplet-spread respiratory viruses are part of hospital infection control practices. Remember it is not possible to carry out complete disinfection, but to minimise the risk.

MEDICAL COUNTERMEASURES

Evidence based studies are need of the hour, to find a rampant and appropriate treatment for this epidemic, as the moment , the therapeutic strategies to deal with the infection are only supportive, and prevention aimed at reducing transmission in the community is our best weapon. No antiviral therapy has been proven to work for COVID-19 in humans. REMDESIVIR, LOPINAVIR, RIBAVIIRIN, (antiviral molecules) are under trial. Other treatment options are ACE inhibitor / angiotensin receptor blockers, chloroquine/ hydrochloroquine, corticosteroids are the other available treatment options.[61]

REFERENCES

1. Xian Peng et al. Transmission routes of 2019-nCoV and controls in dental practice. Int J Oral Science, 2020, 12:9
2. Nakagawa KKG, Makino S. in Advances in Virus Research(ed John Ziebuhr) vol.96,165-192 (Academic press, 2016)
3. Perlman S, Netland, J. Coronavirus post –SARS :update on replication and pathogenesis. Nat. Rev. Microbial. 7 ,439-450 (2009).
4. Weiss S, Leibowitz, J. Coronavirus pathogenesis. Adv. Virus Res. 81, 85-164(2011).
5. Yin, Y. &Wunderink, R. G. MERS, SARS and other coronavirus as causes of pneumonia Respirology. 23, 130-137 (2018).
6. Johns Hopkins centre for Health Security, coronaviruses: SARS, MERS and 2019-nCoV. Jan 21,2020
7. Fan Y, Zhao K, Shi ZL, Zhou P, Bat coronaviruses in china (march 2019) ;11(3) ;210.
8. QiangHuang , Andreas Herrmann. Fast assessment of human receptor – binding capability of 2019 novel coronavirus (2019-nCoV)
9. Liu, P., Chen, W. & Chen, J.-P. Viral metagenomics revealed sendai virus and coronavirus infection of malayan pangolins (Manisjavanica). Viruses 11, 979 (2019).
10. Wahba L. et al. Identification of a pangolin niche for a 2019-nCoV-like coronavirus through an extensive meta-metagenomic search. Preprint at https:// www.biorxiv.org/content/10.1101/2020.02.08.939660v2 (2020).
11. Vlmir, Adobe Stock. The coronavirus threat: how should dental office be prepared?
12. CDC to offer corona virus guidance during webinar jan31 American Dental Assosication 2020 39.
13. Li, F. Structure, function, and evolution of coronavirus spike proteins. Annu. Rev. Virol. 3, 237–261 (2016).
14. Hantak MP, Qing, E., Earnest, J. T. & Gallagher, T. Tetraspanins: architects of viral entry and exit platforms. J. Virol. 93, e01429–e01417 (2019).
15. Belouzard S, Millet JK, Licitra BN, Whittaker GR. Mechanisms of coronavirus cell entry mediated by the viral spike protein. Viruses 4, 1011–1033 (2012).
16. WanY, Shang J, Graham R, Baric RS, Li F. Receptor recognition by novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS. J. Virol. https://doi.org/10.1128/jvi.00127-20 (2020).
17. Chai, X. et al. Specific ACE2 expression in cholangiocytes may cause liver damage after 2019-nCoV infection. Preprint at https://www.biorxiv.org/content/10.1101/ 2020.02.03.931766v1 (2020).
18. Fan, C., Li, K., Ding, Y., Lu, W. L. & Wang, J. ACE2 expression in kidney and testis may cause kidney and testis damage after 2019-nCoV infection. Preprint at https://www.medrxiv.org/content/10.1101/2020.02.12.2 0022418v1 (2020).
19. Tian, X. et al. Potent binding of 2019 novel coronavirus spike protein by a SARS coronavirus-specific human monoclonal antibody. Emerg. Microbes. Infect. 9, 382–385. https://doi.org/10.1080/22221751.2020.1729069 (2020).
20. Zhao, Y. et al. Single-cell RNA expression profiling of ACE2, the putative receptor of Wuhan 2019-nCov. Preprint at https://www.biorxiv.org/content/10.1101/ 2020.01.26.919985v1 (2020).
21. Guy, J. L., Lambert, D. W., Warner, F. J., Hooper, N. M. & Turner, A. J. Membraneassociated zinc peptidase families: comparing ACE and ACE2. Biochim. Biophysi. Acta 1751,2 –8 (2005).
22. Hoffmann, M. et al. The novel coronavirus 2019 (2019-nCoV) uses the SARScoronavirus receptor ACE2 and the cellular protease TMPRSS2 for entry into target cells. Preprint at https://www.biorxiv.org/content/10.1101/2020.01.31.92 9042v1. full (2020).
23. Huang, Q. & Herrmann, A. Fast assessment of human receptor-binding capability of 2019 novel coronavirus (2019-nCoV). Preprint at https://www.biorxiv.org/ content/10.1101/2020.02.01.930537v1 (2020).
24. Lei, C. et al. Potent neutralization of 2019 novel coronavirus by recombinant ACE2Ig. Preprintathttps://www.biorxiv.org/content/10.1101/2020 .02.01.929976v2 (2020).
25. November- Rider d, Bray KK,Eklund K, Williams KB, Mitchell TV Massachusetts dental public health program directors practice behaviours and perceptioons of infection control. J Dent Hyg 2012; 86(3):248-2555
26. Versaci, M.B. CD Remind clinician to use standard precaution , recommends isolating patient with coronavirus symptoms. ADA 2020 Feb 7
27. Liu, L. et al. Epithelial cells lining salivary gland ducts are early target cells of severe acute respiratory syndrome coronavirus infection in the upper respiratory tracts of rhesus macaques. J. Virol. 85, 4025–4030 (2011).
28. Lu,C.-W.,Liu,X.-F.&Jia,Z.-F.2019-nCoV transmission through the ocular surface must not be ignored. The Lancet https://doi.org/10.1016/S0140-6736(20)30313-5 (2020).
29. Huang, C et al. clinical feature of patient infected with 2019 novel corona virus in wuhan , china. Lancet 395 , 497-506(2020).
30. To, K. K.-W. et al. Consistent detection of 2019 novel coronavirus in saliva. Clin. Infect. Diseases https://doi.org/10.1093/cid/ciaa149 (2020).
31. Guan. W.J. et al. clinical characteristics of 138 hospitalized patient with 2019novsl corona virus

infected pneumonia in wuhan china JAMA 2020.1585 (2020).
32. Backer, J. A., Klinkenberg, D. &Wallinga, J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Euro. Surveill. https://doi.org/10.2807/1560-7917.Es.2020.25.5.2000062 (2020)32.
33. Musher DM, How Contagious are common respiratory tract infections? N Engl J Med 2003; 348:1256-1266.
34. Gerone PJ, Couch RB, Keefer GV , Douglah RG , Derrenbacher EB, Knight V. accessment of experimental and natural viral aerosols. Bacterial Rev 1996;30:576-588.
35. J.A. Otter et al , Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination., journal of hospital infection.92(2016)235-250.
36. Wei, J. & Li, Y. Airborne spread of infectious agents in the indoor environment. Am. J. Infect. Control 44, S102–S108 (2016).
37. Cleveland, J. L. et al. Transmission of blood-borne pathogens in US dental health care settings: 2016 update. J. Am. Dent. Assoc. (1939) 147, 729–738 (2016).
38. TiwariA, Patnayak DP, Chander Y, Parsad M, Goyal SM, Survival of two avian respiratory viruses on porous and non porous surfaces. Avian Dis 2006:50;284-287.
39. Killingley B, Greatorex J, Cauchemez S, et al .virus shedding and environmental deposition of novel A(H1N1)pandemic influenznvirus:interin finding. Health technon assess 2010;14:237-354
40. Kampf, G., Todt, D., Pfaender, S. & Steinmann, E. Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. J. Hosp. Infect. https://doi.org/10.1016/j.jhin.2020.01.022 (2020).
41. Otter, J. A. et al. Transmission of SARS and MERS coronaviruses and influenza virus in healthcare settings: the possible role of dry surface contamination. J. Hosp. Infect. 92, 235–250 (2016).
42. Casanova LM, Jeon S, Rutala WA, Weber DJ, Sobsey MD. Effects of air temperature and relative humidity on coronavirus survival on surfaces. ApplEniron Microbial 2010; 76: 2712-2717.
43. Van Doremalen N, Bushmaker T, Munster VJ, Stability of Middle East respiratory syndrome coronavirus (MERS-CoV) under different environmental conditions. Euro Surveill 2013; 18, pii:20590.
44. Zuo Z, de Abin M, Chander Y, Kuehn TH, Goyal SM, Pui DY. Comparison of spike and aerosol challenge tests for the recovery of viable influenza virus from non woven fabrics. Influenza other Respl Viruses 2013 .
45. Dublineau A, Batejet C, Pinon A, Burguieere AM, Leeciercq I, Manuguerra JC, Persistance of the 2009 pandemic influenza A H1N1 virus in water and on non porous surface , PLos One 2011;6:e28043.
46. Wood JP,Chai YW, Chapple DJ, Rogers JV, Kaye JZ, Environmental persistence of highly pathogenic avian influenza (H5N1) virus . Environ SciTechnol 2010;44:7515-7520.
47. Chan KH, Peiris JS, Lam SY, Poon LL, Yuen KY, Seto WH. The effects of temperature and relative humidity on the viability of the SARS Coronvirus. AdvVirol 2011; 734690.
48. Doweff SF, Simmerman GM, Erdman DD, Et al. Severe acute respiratory syndrome corna virus on hospital surfaces Clin Infect Dis 2004;39:652/657
49. Rabenau HF, Cinatl J, Morgenstern Bauer G, Preiser W, Doerr HW. Stability and inactivation of SARS corona virus . Med Microbial Immunol 2005;194:1-6
50. Muller A, Tillmann RL, Muller A, Simon A, Schildgen O. Stability of human metapneumovirus and human coronavirus NL63on medical instruentsand in the patient environment. J Hosp Infect 20008;69: 406-408
51. Noyce JO, Michels H, Keevil CW. Inactivation of influenza A Vvirus on copper versus stainless steel surfaces. Appl Environ Microbial 2007; 73: 2748-2750.
52. Azza Mahmoud Tag EI-Din et al , Efficacy of rubber dam isolation as an infection control procedure in paediatric dentistry. Vol 3, no:3, 1997.
53. Miller RL, Micik RE, Air pollution and its control in the dental office. Dental linics of North America, 1978, 22:453-76.
54. Wenner JH, Greene VW, King KJ, Monitoring microbial aerosols in an operating room during restorative dentistry. Journal of dentistry for children, 1977, 44(1):25-9.
55. Cochran MA, Miller CH, Sheldrake MA, The efficacy of the rubber dam as a barrier to the spread of microorganisms during dental treatment. Journal of the American Dental Association, 1989, 119:141-4.
56. Legnani P et al. Atmosphere contamination during dental procedures. Quintessence international, 1994, 25(6):435-9.
57. Li Lui ,Qiang Wei , Xavier Alvarez, Epithelial Cells Lining SalivaryDucts Are Early Target Cells Of Severe Acute Respiratory Syndrome Coronavirus Infection In the Upper Respiratory tracts of Rhesus Macaques..
58. Wang, W. K., et al. 2004. Detection of SARS associated coronavirus in throat wash and saliva in early diagnosis. Emerg Infect. Dis 10:1213-1219.
59. Kelvin Kal Wang To, Owen Tak –Yin Tsang et al, brief report consistent Detection of 2019 Novel Coronavirus in Saliva. Infectious Disease Society of America.
60. Yan J, Grantham M, Pantelic J, et al; EMIT Consortium , Infectious virus in exhaled breadth of symptomatic seasonal influenza cases from a college community. Proc Natl Acad Sci USA 2018; 115:1081-6.
61. Joseph T, Moslehi MA, Internationaln pulmonologists consensus on COVID-19