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RISK OF TRANSMISSION OF COVID-19 AND PRE- PROCEDURAL RINSE AS A PREVENTIVE MEASURE IN DENTISTRY: A NARRATIVE REVIEW

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ABSTRACT :

The SARS-CoV-2 virus has led to the COVID-19 pandemic, which has become a global burden on health (mental and physical), economy, health care facilities and humanity. It created a dilemma in the minds of the policy makers, clinicians because of its multiple modes of transmission and rapidly changing clinical presentations. Pre-procedural rinse should be an integral part of infection control, as a significant number of aerosol generating procedures are performed in the dental operatory. Therefore, CDC recommended additional modes of prevention, including the use of pre-procedural rinse and adequate PPE to minimize the risk of transmission of COVID-19 disease in dental office as a considerable number of COVID-19 positive patients do remain asymptomatic. Pre-procedural mouth-rinse could a cost-effective strategy in minimizing the risk of disease transmission in dental office.

KEYWORDS : Severe acute respiratory syndrome-corona virus(SARS-CoV-2), Povidone Iodine, Aerosol, Dental procedures, Transmission, Pre-procedural mouth rinse

INTRODUCTION :

COVID-19 is a highly contagious viral disease which emanated in Wuhan, China in the year end of 2019. The disease has varied clinical presentations due to rapid mutating ability of the SARS-CoV 2 (Severe acute respiratory syndrome corona virus 2) [1]. The disease was declared as a pandemic by World Health Organisation on 11th March 2020 [2]. As of 8th October 2020 worldwide, total number of cases are 36.2 M which includes 25.3 M recovered and 1.06 M deaths. India has around 6.84 M cases which includes 5.83 M recovered and 106 K deaths. Hence witnessing the alarming spread of the disease along with coupled factors like unavailability of any definitive therapeutic treatment and vaccine against SARS-Cov 2 virus, knowledge about its transmission and prevention measures are the key factors to tackle the disease perse in dental office.

SARS-CoV 2 virus is a single stranded, enveloped, positive sense RNA (Ribo-nucleic acid) virus which fits into the beta-coronaviridae family which also includes SARS-CoV and MERS-CoV viruses responsible for causing epidemics like SARS(Severe acute respiratory syndrome) 2003-04 and MERS(Middle East Respiratory Syndrome) 2012 respectively[3,4,5]. The SARS-CoV 2 virus is considered highly infectious compared to its counterparts which can be attributed to its rapid multiplication rate (R_o value ranging between 2 to 6.75), proportionately long prodromal stage, the asymptomatic carrier stage[6,7].

MODES OF TRANMISSION :

Highlighting the modes of transmission of COVID-19 disease, it is known to spread both directly and indirectly [8]. The direct modes of transmission include those mediated via aerosols, respiratory droplets, body fluids and secretions like saliva, urine, tears, semen and via mother to child. Indirect modes of transmission is mediated contact with infected fomites or surfaces or objects used by infected persons [8,9,10].

TABLE 1: MODES OF TRANSMISSION OF SARS-CoV -2 [11]

Animal to human	**Human to human**	**Faeco-oral**	**Surgical procedures and organ transplantations**
In the early stages, COVID-19 was considered as a zoonotic disease transmitted via bats	Horizontal transmission in humans can be via 3 main routes:	Gastrointestinal system may be a critical route for viral transmission though it is not common.[12]	1. Pulmonary and upper respiratory surgeries are at higher risk of transmission[13]
	1. Direct Contact : Via virus contaminated surfaces, objects or fomites		2.Vertical transmission though not common but cannot be ruled out.
	2. Aerosol : Formed during surgical and dental procedures as outlines by WHO.		
	3. Droplet (<5µm in size) : formed during coughing and sneezing from oral cavity and respiratory tract.		

As seen in Table 1, a systematic review concluded that SARS-CoV 2 transmission is predominantly human to human mediated through aerosols (oral and respiratory) and other routes like virus laden droplets contaminating the environment, have a less important role in disease propagation [11]. Doremalen at al stated that SARS-COV -2 can remain viable in the aerosols for atleast 3 hours and its stability on different surfaces varies from 4 to 72 hours.[14]

It is important to note that maximum viral load concentrated in nasal cavity, nasopharynx and oropharynx, can be attributed to the ability of SARS-CoV 2 to bind to human Angiotensin Converting Enzyme 2(ACE 2) receptors which are present in highest quantity on goblet cells (in salivary glands), respiratory epithelium [15,16,17,18]. This possibly explains presence of SARS-CoV 2 in secretory saliva [18,19]. To et al, concluded that saliva of 91.7% of COVID-19 patients demonstrated the presence of SARS-CoV 2. Hence it contains risk of transmission of the disease via direct or indirect contact with infected objects [20]. Viral shedding can be identified from nasal swabs before, during, after the acute illness phase and also in the seropositive antibody converted convalescent cases [16,17].

COVID-19 IMPACT ON DENTITSRY :

According to World Economic Forum [21] and O*Net Bureau of Labour Statistics of the USA [22] dental health professionals are at the highest risk of contracting the COVID-19 infection. This could be explained by the following interlinked factors:

a.) COVID-19 is primarily transmitted through inhalation of respiratory droplets or aerosols from infected [23] and asymptomatic individuals [24] produced within 1meter radius of the individual or through touching of surfaces contaminated with these droplets [25,26,27,28]. These may be produced during speaking, breathing, coughing, sneezing, singing [24] or during certain surgical, dental and respiratory pathway procedures as classified under Aerosol generating procedures [29,30].

b.) Dental health care professionals work in close proximity of patients while performing dental procedures, most of which are aerosol generating, like use of dental handpieces, ultrasonic instruments etc [23,33]

c.) High viral load of the oropharynx which comprises of oral cavity, also predisposes to the risk of nosocomial transmission in dental operatory [31,32].

Aerosol and splatter are terms commonly used in dentistry in relation to microbiological risk of nosocomial transmission. In Dentistry, Aerosols are defined as a suspension of fine solid or liquid particles in the air having size less than 50 µm in diameter whereas splatter are the larger liquid particles in the air having size more than 50 µm in diameter. Major difference between the two is that aerosols are non-ballistic, hence remain suspended in the air for longer time periods whereas splatters are ballistic, hence they tend to fall on a surface and break apart. This explains why aerosols are linked to higher chances of airborne transmission while splatter leads to contact transmission [31,32,33,34].

Dental procedures like use of high and low speed dental handpieces, air-water syringes, ultrasonic scalers, air abrasion units etc which tend to aerosolize viral particles laden saliva from the patient can markedly increase chances of disease transmission in dental operatory [31]. So to conclude, a large volume of aerosols produced in the dental operatory along with the SARS-CoV 2 contaminated saliva irrespective of the patient (symptomatic or carrier) risks the entire dental staff working in the operatory. Hence it is must to take both airborne as well as droplet precautions [23,36].

PREVENTIVE MEASURES AND ITS BASIS:

Hence prevention of COVID -19 in dental operatory begins from point patient initiates contact with dentist in following ways:

1. Foremost step, is to provide tele-consultation to the patient and tele-triage preferably. However, it should be followed by in office triage if need arises for the patient to visit dental office [23].
2. Infection Control and asepsis should act as a guide to prevention of disease transmission in dental office. From patients view point, it begins right from entry of patient in dental office where patient's hands need to be sanitized, instructions need to be given to the patient to avoid touching of any object/surface, following of proper masque etiquette, frequent disinfection of the highly touched surfaces and recommended social distancing [23,29,36,37,38].
3. From the dental health care worker point of view, asepsis in present scenario has a broader range. It includes use of pre-procedural mouth rinse; recommended personal protective equipment; rubber dam wherever possible; high volume evacuator; sterilization and disinfection of instruments, materials and other devices used in treatment; frequent disinfection of highly touched surfaces in both the clinical as well as waiting area; decontamination of the clinical environment; adequate ventilation and the required air-changes in the clinical area; appropriate biomedical waste management along with screening of the dental health care workers and patients every day in the dental office[23,39,40,41,42].

Since there is no single definitive way to completely eradicate risk of COVID-19 transmission in dental office, ***Harrel and Molinari*** *described 3 layers of defense coupled against aerosols to minimize it* [31]. The first layer includes the use of appropriate personal protective equipment comprising of respiratory protection devices (surgical face masks/ Filtering face piece respirators), gowns or coveralls, face shields or goggles [43]. The second layer includes the use of pre-procedural antiseptic rinse. The third layer includes use of high-volume evacuator (HEV) and additional use of high efficiency particulate air (HEPA) filters [31].

PRE-PROCEDURAL ORAL RINSE:

Use of pre-procedural rinse in the dental setting is a cost-effective measure that can be adopted to reduce the viral load in the oral cavity, hence decreasing the risk of disease transmission in dental office. This review has been conducted to get an insight about the efficacy of different solutions used as pre-procedural rinse which is often not extensively studied.

According to literature, special emphasis has been laid regarding use of mouth rinse prior to any dental procedure as it effectively reduces the count of micro-organism in bio-aerosol produced during dental procedures [5,44]. Various solutions commonly used as mouth-rinse include:

a. Povidone -iodine (PVP-I)
b. Chlorhexidine Gluconate (CHG)
c. Cetylpiridynium chloride (CPC)
d. Benzalkonium chloride (BAC)
e. Benzethonium chloride (BEC)
f. Essential oils (Listerine)
g. Alkyldiaminoethyl-glycine hydrochloride (AEG)
h. Hydrogen peroxide(H_2O_2)

Inactivation of SARS-CoV 2 by use of chemical agents is mediated by disruption of the lipid bio-membrane of the enveloped virus which is highly susceptible to chemicals like alcohol [45]. This forms the basis of use of chemicals antisepsis to decontaminate fomites, human body surfaces as well as intra-oral and nasal passages. It causes considerable reduction in viral load decreasing aerosolized viral particles and ultimately decreasing the risk of SARS-CoV-2 transmission [46].

TABLE 2: Studies which show effectiveness of different mouth-rinse against the available array of micro-organism ranging from bacteria to virus to fungi.

S. No.	Title of study	Year	Methodology	Outcome of study
1.	Reduction of microbial contamination from ultrasonic scalers [47]	1978	CHG used as pre-procedural rinse for 2 minutes	Noted a significant reduction in aerosols produced by ultrasonic scalers.
2.	Reduction of Salivary Bacteria by Pre- Procedural Rinses with Chlorhexidine 0.12%.[48]	1991	2 consecutive pre-procedural rinses with 15 ml of 0.12% CHG for 30 seconds	Demonstrated reduction in salivary bacterial load upto 97% with sustained anti-bacterial effect.
3.	Reducing bacterial aerosol contamination with a chlorhexidine gluconate pre-rinse.[49]	1995	Chlorhexidine gluconate, essential oils, water used for pre-treatment rinse	CHG significantly reduced bacterial aerosol contamination generated by an air polishing device.
4.	Preventing post-treatment bacteraemia: comparing topical Povidone-Iodine and Chlorhexidine. [50]	1995	Pre-treatment irrigation done with: [1] 10% Povidone iodine solution [2] 0.2% Chlorhexidine [3] Sterile water	Study demonstrated lower levels of bacteraemia with Povidone iodine compared to Chlorhexidine solution. Povidone iodine should be preferred as mouth rinse as it is more potent bactericidal.
5.	Inactivation of Human Viruses by Povidone-Iodine	1997	Solutions used: 1.PVP-I	PVP-I was found to inactivate both enveloped and non-enveloped viruses including adenovirus, mumps,

	in comparison with other Antiseptics. [51]		2.CHG 3.BAC 4.BEC 5.AEG	rotavirus, poliovirus (types 1 and 3), coxsackie virus, rhinovirus, herpes simplex virus, rubella, measles, influenza and human immunodeficiency virus. CHG, BAC, BEC, AEG were ineffective against adenovirus, poliovirus and rhinovirus
6.	Evaluation of aerosol contamination during debonding procedures.[52]	2001	Pre-procedural rinse with 15 ml of 0.2% CHX for 1 minute.	No significant reduction in the viable bacterial count was observed.
7.	Prevention of respiratory infections by povidone-iodine gargle.[53]	2002	Gargling with Povidone iodine	Noted that Povidone iodine reduced by half the infections associated with Pseudomonas aeruginosa, Staphylococcus aureus (including MRSA) and Haemophilus influenzae
8.	Evaluation of the bactericidal activity of Povidone-Iodine and commercially available gargle preparations.[54]	2002	Pre-rinse with [1] PVP-I (dilluted 15,30,60 fold) [2] CPC [3] CHG	[1] PVP-I demonstrated rapid killing of all three strains (gram positive: MRSA and gram-negative bacteria: Pseudomonas aeruginosa and Klebsiella pneumoniae) after 30s of exposure [2]CPC was effective only against gram-negative strains after 60 s of exposure [3] CHG was ineffective
9.	Committee for the Japanese Respiratory Society Guidelines in Management of Respiratory Prevention of hospital-acquired pneumonia [55]	2004	Gargling with PVP-I	PVP-I Gargling may be an effective method of preventing the spread of respiratory viruses through airborne/droplet route or after uptake via the mouth.
10.	Reduction of potential respiratory pathogens by oral hygienic treatment in patients undergoing endotracheal anaesthesia [56]	2003	Use of PVP-I for gargling	Significant reduction in oropharyngeal bacterial counts was found in patients requiring intubation after use of PVP-I gargle for prophylaxis.
11.	An *in vivo* study of the plaque control efficacy of Persica: a commercially available herbal mouthwash containing extracts of Salvadorapersica [57]	2004	[1] Herbal agent as mouthwash [2] CHG [3] Listerine	This study concluded that herbal mouth rinse produced the largest zones of microbial inhibition when compared to Listerine and 0.12% Chlorhexidine
12.	In vitro short-time killing activity of Povidone-Iodine (Isodine Gargle) in the presence of Oral Organic matter. [58]	2006	[1.] PVP-I gargle/mouthwash (0.23–0.47%) [2.]0.02%BEC [3.]0.002% CHG	PVP-I was found effective against MRSA, Pseudomonas aeruginosa, within 15-60 s in the presence of oral organic matter whereas 0.02% BEC and 0.002% CHG were found ineffective.
13.	Inactivation of SARS Coronavirus by the means of Povidone-Iodine, physical conditions and chemical reagents. [59]	2006	PVP-I products used in concentration of 0.23–1% for 1–2 min	The study noted a significant reduction was found in SARS-CoV virus infectivity from 1.17×10^6 $TCID_{50}$/ml to below detectable levels.
14.	Outbreak of highly Pathogenic avian influenza in Japan and ant-influenza virus activity of povidone-iodine products.[60]	2006	PVP-I products in different concentrations including 0.23% gargle and throat spray	Study concluded that the PVP-I gargle (0.23%) and throat spray significantly reduced the infectious viral titres of avian influenza A viruses (H5N1, H5N3, H7N7 and H9N2) to undetectable levels within 10 seconds of incubation.
15.	Subgingival irrigations with povidone- iodine as adjunctive treatment of chronic periodontitis [61]	2009	10% Povidone iodine solution used for sub-gingival irrigation	This study yielded better reduction in probing depth, gingival inflammation and more attachment gain in the irrigated regions.
16.	The effect of chlorhexidine on reduction of viable organisms in aerosol produced by ultrasonic scaler.[62]	2009	Pre-operative use of 0.1% CHG as mouth rinse, lavage	CHG significantly reduces microorganisms in aerosol produced using ultrasonic scaler. Use of 0.1% CHG as lavage is more effective in microbial reduction.
17.	Efficacy of preprocedural rinsing in reducing aerosol contamination during dental procedures [63]	2009	Pre-procedural rinse with 0.12% Chlorhexidine gluconate (CHG) for 30 seconds	Pre-rinsing was found to consistently decrease the CFU. The study concluded that use of CHG is an effectual measure in reducing aerosol cross-contamination when using devices like high speed hand piece or ultrasonic scaler in dental operatory.
18.	The effectiveness of a Pre-procedural mouth-rinse	2010	Pre-procedural mouth rinse with	It concluded that 0.05% CPC and 0.12% CHG were equally effective in reducing the level of bacterial

	containing Cetyl Pyridinium Chloride in reducing bacteria in the Dental office [64]		[1] 0.05% CPC [2] 0.12% CHG [3] Water	contamination in the spatter produced during ultrasonic scaling. Hence CPC could be a good alternative especially in patients who develop mucosal irritation or complain of tongue stain.
19.	Comparison of efficacy of pre-procedural rinsing with Chlorhexidine mouth rinse and Essential oil containing mouth rinse. [65]	2011	Pre-procedural mouth rinse used: [1] 10 ml 0.2% CHG for 60 sec [2] Herbal extracts mouthwash: 15ml for 60 sec [3] Essential oils: 15ml for 60 sec	Concluded that 0.2% CHG most effectively reduced the CFU (bacterial load in aerosol) when used as a pre rinse followed by essential oils and herbal extract mouthwash respectively.
20.	Efficacy of 0.2% tempered chlorhexidine as a pre-procedural mouth rinse: A clinical study.[66]	2012	[1] sterile water [2]0.2% CHG for 60 sec (non-tempered) [3]0.2% CHG for 60 sec (tempered)	Study concluded that pre-procedural rinse significantly reduces the viable microbial content of dental aerosols and tempered chlorhexidine was more effective than non-tempered one
21.	The Efficacy of Preprocedural Mouth Rinse of 0.2% Chlorhexidine And Commercially Available Herbal Mouth Containing Salvadora Persica In Reducing The Bacterial Load In Saliva And Aerosol Produced During Scaling.[67]	2014	[1] 0.2% CHG for 60 sec [2] Herbal mouthwash for 60 sec	Stated that 0.2% chlorhexidine gluconate mouthwash, reduces the bacterial count in both saliva and aerosols produced during scaling more substantially compared to the herbal mouth wash.
22.	Efficacy of Preprocedural Mouth Rinsing in Reducing Aerosol Contamination Produced by Ultrasonic Scaler: A Pilot Study [68]	2014	Pre-procedural mouth rinse used: [1] 10.2% CHG [2] Herbal extracts mouthwash:	Study concluded that the pre-procedural mouth rinsing with 0.2% chlorhexidine was more effective than herbal mouthwash in eradicating the bacterial aerosols generated using an ultrasonics in dental practice.
23.	Efficacy of adjunctive usage of hydrogen peroxide with chlorhexidine as pre-procedural mouth rinse on dental aerosol [69]	2015	Pre-procedure rinse: [1] 15 ml 0.2% CHX for 2 min [2] topical application of 1.5% Hydrogen peroxide for 1 min followed by rinse with 15 ml 0.2% CHX for 2 min	Study showed that adjunctive use of hydrogen peroxide with chlorhexidine is superior to using of chlorhexidine alone in combating the infected dental aerosols.
24.	Povidone-iodine hand wash and hand rub products demonstrated excellent in vitro virucidal efficacy against Ebola virus and Modified Vaccinia virus Ankara, the new European test virus for enveloped viruses. [70]	2015	PVP-I tested in different concentrations: [1]4 % PVP-I skin cleanser; [2]7.5 % PVP-I surgical scrub; [3]10 % PVP-I solution; [4]3.2 % PVP-I/alcohol solution	Study clearly demonstrated the virucidal activity of PVP-I 4% skin cleanser, 7.5% surgical scrub,10% solution and 3.2% PVP-I/alcohol solution rapidly within 15 seconds against enveloped viruses i.e., Ebola virus and MVA wherein the viral titres were significantly diminished by >99.99% to >99.999% under clean and dry conditions.
25.	Rapid and effective virucidal activity of Povidone-Iodine products against Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and Modified Vaccinia Virus Ankara (MVA). [71]	2015	3 formulations of PVP-I were studied in clean and dirty conditions: 1]4 % PVP-I skin cleanser [2]7.5 % PVP-I surgical scrub [3]1 %PVP-I gargle/mouthwash	Study illustrated that all three formulations of PVP-I showed significant virucidal activity against MVA and MERS-CoV within 15 s of exposure at room temperature. Therefore, it is recommended to use the PVP-I based hand wash, gargle/mouthwash as adjunctive measure to prevent transmission of MERS-CoV and other respiratory viruses by considerably reducing the viral load in the skin, oral cavity and oropharynx respectively.
26.	Determination of efficacy of pre-procedural mouth rinsing in reducing aerosol contamination produced by Ultrasonic Scalers[72]	2015	Pre-procedural rinse done with 10 ml of 0.2% chlorhexidine	Study clearly indicated that preprocedural mouth rinse with 0.2% chlorhexidine gluconate was significantly effective in reducing the aerosol contamination during use of ultrasonic scaling in dental practice. It significantly reduces viable microbial content of dental aerosols.

27.	Role of preprocedural rinse and high-volume evacuator in reducing bacterial contamination in bioaerosols. [73]	2016	Preventive methods compared in study: [1] 10 ml of 0.12% CHX pre-rinse for 30 sec [2]10 ml of 0.12% CHX pre-rinse for 30 sec and HVE [3] HVE	Study concludes that combined use of HVE and pre-operative CHX mouth rinse are most effective at decreasing dental bioaerosols compared to their separate use.
28.	Comparative Evaluation of Two Different Ultrasonic Liquid Coolants on Dental Aerosols.[74]	2016	Two antiseptic solutions used as an ultrasonic liquid coolant [1]2% povidone iodine [2] 0.12% CHX	Conclusions of the study included: [1]Chlorhexidine and povidone iodine when used as ultrasonic liquid coolant instead of distilled water can cause less contamination of waterlines. [2] It also diminished the contamination of aerosol produced during dental procedures like root canal treatment, ultrasonic scaling, caries management.
29.	In Vitro Bactericidal and Virucidal Efficacy of Povidone-Iodine Gargle/Mouthwash Against Respiratory and Oral Tract Pathogens [75]	2018	PVP-I 7% gargle/mouthwash was diluted 1:30 with water to a concentration of 0.23%. It was tested for its bactericidal and virucidal activity in-vitro.	Study suggested that PVP-I had effective bactericidal activity against Klebsiella, Streptococcus pneumoniae and rapid virucidal effect on SARS-CoV, MERS-CoV, Influenza virus A (H1N1) and rotavirus leading to their inactivation within 15 s of exposure. As a result, PVP-I can be recommended to be used as a preventive measure in patients at high risk of oral and respiratory infections.
30.	Do exposures to aerosols pose a risk to dental professionals?, [76]	2018	An extra-oral evacuator system was used to measure bacterial and fungal aerosols, which were then identified using biochemical tests.	Study concluded that: [1] There was a significant increase in the concentration of bacteria and fungi in air during dental treatment sessions. [2] The microflora contained mainly Gram-positive, rod-shaped bacteria and those creating endospores and non-porous bacteria as well as mould fungi. [3]Exposure to these microorganisms is not a significant occupational health risk for dental professionals. [4] It emphasized on following of appropriate infection control measures in dental practise.
31.	Efficacy of preprocedural mouthrinses in the reduction of microorganisms in aerosol: a systematic review. [77]	2019	A systematic review which compared the efficacy of pre-procedural mouth rinses compared to placebo, water in reducing the number of microorganisms disseminated by means of the aerosol generated via dental procedures	Review outlined that overall, the use of a preprocedural mouthrinse resulted in a mean reduction in the number of CFUs of 64.8% (95% confidence interval, 50.4% to 79.3%; I2 ¼ 37%) compared with control. A meta-analysis showed that the use of preprocedural mouth rinse, including chlorhexidine(CHG), essential oils, and cetylpyridinium chloride (CPC), resulted in a significant reduction in colony-forming units in dental aerosol.
32.	Virucidal Efficacy of Different Oral Rinses Against Severe Acute Respiratory Syndrome Coronavirus 2 [78]	2020	Compared the virucidal activity of 8 different solution against 3 different SARS-CoV -2 isolates mimicking nasopharyngeal secretions. Solutions used: 1.Hydrogen peroxide, 2.Chlorhexidine D Gluconate 3.dequalium and Benalkonium chloride 4.0.2% Chlorhexidine D Gluconate 5.Povidone iodine 6.Ethanol, essential oils 7.Octinidine hydrochloride 8.Polyaminopropyl Biguanide	Study concluded that commercially available oral rinses can effectively reduce SARS-CoV 2 within 30 seconds of exposure. Formulations containing Dequalium & Benalkonium chloride, Povidone iodine, Ethanol & essential oils were able to significantly reduce virucidal activity of SARS-CoV 2 to undetectable levels
33.	Rapid In-Vitro Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Using Povidone-Iodine Oral Antiseptic Rinse.[79]	2020	Evaluated contact time and concentration for virucidal activity of solutions containing Povidone iodine against inactivation of SARS-CoV 2.	Study showed that PVP-I inactivated SARS-CoV 2 at all three concentrations of 0.5%,1.0%,1.5% within 15 seconds of contact. Whereas 70% ethanol inactivated the virus only after 30 seconds.

			[1] PVP-I was tested at three different concentrations of 0.5%, 1.0%, 1.5%. [2] 70% ethanol and water were used as positive and negative control respectively.	PVP-I oral antiseptic preparations rapidly inactivated SARS-CoV-2 virus in vitro and its virucidal activity is seen even at the lowest concentration of 0.5 % PVP-I and at the lowest contact time of 15 seconds. Hence it can be justified to use PVP-I (for patients and health care providers) as pre-procedural oral rinse as an supportive strategy to personal protective equipment, for dental and surgical specialties especially associated with aerosol generating procedures during the COVID-19 pandemic.
34.	Povidone-Iodine Demonstrates Rapid In Vitro Virucidal Activity Against SARS-CoV-2, The Virus Causing COVID-19 Disease.[80]	2020	Study compared viricidal activity of 4 different concentrations of PVP-I against SARS-CoV 2. Solutions used : 1.Antiseptic solution (PVP-I 10%) 2.skin cleanser (PVP-I 7.5%) 3.Gargle and mouth wash (PVP-I 1%) 4. Throat spray (PVP-I 0.45%)	Study showed that all the PVP-I products tested demonstrated ≥99.99% virucidal activity against SARS-CoV-2 within 30 seconds of contact time period which corresponds to ≥ 4 log10 reduction of virus titre.
35.	Efficacy of commercial mouth-rinses on SARS-CoV-2 viral load in saliva: Randomized Control Trial in Singapore[81]	2020	Trial tested the efficacy of three commercial mouth-rinses in reducing salivary SARS-CoV-2 viral load in COVID positive patients at three different time intervals of 5 minutes, 3 hours, 6 hours [1] povidone-iodine (PI), [2] chlorhexidine gluconate (CHX) [3] cetylpyridinium chloride (CPC) [4] water (control)	First Randomized controlled trial conducted on COVID -19 positive patients observed that : [1] CPC and PI mouth-rinses have sustained effect upto 6 hours in reducing viral load in saliva in COVID positive patients [2] CPC mouth-rinse can decrease the salivary SARS-CoV-2 levels within 5 minutes of its use.

PRE-PROCEDURAL RINSE IN THE CURRENT SCENARIO:

The direct effect of pre-procedural mouth rinse against coronavirus (SARS-CoV-2) is still not clear. However, it is being considered as one of the most important preventive measures against the assumed aerosol mediated transmission of COVID-19 in dental office. The reason being its effectiveness in reducing the microbial load as demonstrated in the aforementioned studies.

Evidence suggests that the dental aerosol is a matter of great worry in the dental office regarding airborne contamination because dental aerosol [31,82] can travel upto a distance of 1 to 3 metres from source compared to spatter [83,84] which reaches short distance and settles quickly. This leads to chances of both airborne, droplet as well as contact-based transmission [8,11,30]. SARS-CoV-2 is known to initially colonise upper respiratory tract of infected individuals [15]. If oropharynx acts as active site of viral multiplication during early stages (even before disease manifestation) when maximum viral shedding occurs, [15,85] use of antiseptic mouth rinses/gargles/throat sprays could lower the chances of virus particles being aerosolized hence reduce the risk of transmission of COVID-19[78,86].

POVIDONE IODINE:

PVP-I has been the time proven antiseptic being used in the hospital and community settings for around 60 years due to its wide antimicrobial spectrum and established safety profile hence can be easily incorporated into infection control protocols against the SARS-CoV-2[80]. Povidone iodine has numerous benefits, that cannot be overemphasized which includes its broad range of antimicrobial action against bacteria, bacterial spores, viruses, fungi, protozoa [51,60]. Bidra AS et al demonstrated that PVP-I completely inactivated SARS-CoV 2 within 15 seconds of contact when used in concentrations ranging from 0.5% to 1.5% [79]. PVP-I (0.23%) was found to inactivate SARS-CoV & MERS within 15 seconds in previous in-vitro studies. Hence, rapid virucidal activity of PVP-I solutions within a period of 15 seconds at concentrations as low as 0.23% makes it a material of first choice to be used as pre-procedural oral rinse [59,86]. Another benefit is the unaltered antiviral activity of PVP-I irrespective of the oral hygiene i.e., clean or dirty conditions. Also it showed that the effect remains sustained for a minimum of 4 to 6 hours, this is accordance with recently conducted clinical trial of commercial mouth rinses on viral load of SARS-CoV-2[71,86,87].

PVP-I use as oral rinse is not pristine to Dentistry as it has been used for oral antisepsis [88], periodontal therapy [89], pre-implant therapy [90] and post-extraction therapy [91]. PVP-I, can be used safely in oral and nasal cavity upto 5 % and 1.25% concentrations respectively [92]. A preprocedural rinse of PVP-I was shown to reduce the level of micro-organisms generated in aerosol and spatter during dental procedures with rotary instruments [93]. An electron micrographic study demonstrated that iodine (PVP-I) mediated degeneration of viral nucleoproteins was main mechanism of its virucidal activity and along with disruption of surface proteins of enveloped viruses [94,95]. Therefore pre- procedural rinse with PVP-I can be used as an additional protective barrier to the PPE, to minimize the disease transmission in dental office especially during aerosol generating procedures [79].

There are few contraindications to the use of PVP-I solutions which include patients with known allergy to iodine compounds, active thyroid disease, undergoing radioactive iodine therapy [96-98].

COMPARISON OF SOLUTIONS AVAILBLE AS PRE-PROCEDURAL RINSE:

PVP-I (0.23 – 1.0%) is highly potent virucidal, known to inactivate high (H5N1) as well as low pathogenic (H5N3, H7N7 and H9N2) strains of Influenza A virus, swine flu virus (H1N1, H3N2 and H1N2) to below detectable levels within 10 seconds and SARS-CoV within 2 minutes [59,60,99]. As cited by aforementioned studies it is noted that antiseptics like chlorhexidine, octenidine, polyhexanide, hexetidine, essential oils have a narrow range of antimicrobial action compared to povidone iodine [100]. Kawana et al, showed that PVP-I demonstrated highest virucidal activity and rapidly inactivated both enveloped and non-enveloped viruses while CHG, BAC, BEC, AEG were ineffective against adenovirus, poliovirus and rhinovirus [51]. An in vitro study found that three mouth-rinses containing different active components like dequalinium chloride/ benzalkonium chloride, polyvidone-iodine and essential oil could significantly reduce the SARS-CoV-2 viral load to undetectable level compared to chlorhexidine-based, hydrogen peroxide, octinidine hydrochloride based mouth-rinse which failed to reduce the viral load significantly [78].

Chlorhexidine gluconate is associated with significant reductions in colony forming units or microbial contamination of saliva and dental aerosols according to literature [48,49,62,63,66,67,72]. Some studies also say that it reduces aerosol production while using ultrasonic scalers especially if used as a coolant [47]. But these studies demonstrated that CHG has a prominent action against bacteria and fungi while its virucidal activity is not significant. It has been proven that CHX when used as surface disinfectant was effective against several infectious viruses, including herpes simplex virus (HSV), human immunodeficiency virus (HIV), and hepatitis B virus (HBV) but not effective against some enveloped viruses like human corona virus [101]. O'Donnell et al. also suggested that chlorhexidine gluconate could only weakly inactivate coronavirus strains [102]. Also the literature review suggested that no evidence of microbial resistance have been clinically reported with respect to PVP-I compared to Chlorhexidine [103,104]. Also a disadvantage with chlorhexidine is that it demonstrates poor antimicrobial action in the presence of organic matter [58].

Cetyl pyridinium chloride(CPC) demonstrated a mixed antimicrobial response between spectrum of povidone iodine (PVP-I) and chlorhexidine gluconate (Chlorhexidine Gluconate). Shiraishi et al demonstrated that PVP-I gargle rapidly inactivated both gram positive and negative bacterial strains within 30 seconds whereas CPC was effective only against gram negative strain after 60 seconds of exposure and chlorhexidine failed to eradicate any of the strains effectively [54]. It has been observed that 0.05% CPC and 0.12% CHG were equally effective in reducing the level of bacterial contamination of dental aerosol and spatter [64,77]. Popkin et al demonstrated anti-viral activity of CPC against influenza viruses mediated directly through disruption of viral envelope [105]. A randomised controlled trial observed that intra- oral topical administration of ointment containing CPC demonstrated antiviral action against influenza, coronavirus, rhinovirus effectively [106].

Hexetidine demonstrated a narrow antimicrobial spectrum compared to PVP-I and CHG, which was proved by a study showing its minimal effectiveness in reducing the dental plaque bacteria compared to CHG [107,108].

Essential oil containing mouth rinses have also demonstrated an intermediate level of antimicrobial response. Suresh S et al illustrated that 0.2% CHG most effectively reduced the CFU (bacterial load in aerosol) when used as a pre rinse followed by essential oils and herbal extract mouthwash respectively [65]. A clinical trial showed that essential oil containing mouth rinse effectively reduced the viron level of herpes simplex virus completely within 30 seconds and the effect was sustained for 60 min [109].

Although efficacy of hydrogen peroxide as a pre-procedural rinse or mouth wash has not been extensively studied but the mechanism of its action provides a bearing for it use against this virus. Hydrogen peroxide has an oxidative potential due to which they can cause disruption of the bilipid layer of the virus. It has been found that SARS CoV-2 is susceptible to disruption by oxidation hence use of pre-procedural mouth rinse with solution containing oxidative agents like 1% H2O2 has been recommended [39]. It has been recommended that 0.5-1% hydrogen peroxide mouth rinse can be used as pre-procedural, as it has non-specific virucidal activity against corona viruses [40,110].

RECOMMENDATION OF ASSOCIATIONS:

The extensive review of literature suggests that use of pre-procedural mouth rinse can efficiently reduce the microbial count in the saliva, aerosols and spatter produced during dental procedures. [39,40,59,86]. Hence, various associations have given recommendations regarding use of pre-procedural oral rinse to avoid the risk of SARS-CoV-2 transmission during dental treatment.

[1] US Centre for Disease Control and Prevention and Australian Dental Association have suggested the pre-procedural oral rinse with PVP-I prior to dental treatment [112,113].
[2] New Zealand Dental Association suggested pre-procedural mouth rinse with 1% hydrogen peroxide, 0.2% chlorhexidine (CHX),2%povidone-iodine or 2% Listerine for 30 s prior to procedures [114]. Alternative use of a swab soaked in 1% hydrogen peroxide or 1% CHX is recommended if mouth rinsing is not possible.
[3] Indian Endodontic Society (IES) and National Health Commission of the People's Republic of China have highlighted the weak effectiveness of 0.2%CHX against SARS-COV-2, and hence recommended the use of 1% hydrogen peroxide or 0.2% povidone-iodine as

pre-procedural mouth rinse [42,115]. Also American Dental Association[116] and Scottish Dental Clinical Effectiveness programme [117] recommend the same in their guidelines.
[4] American Association of Endodontics recommended use of 0.2% povidone-iodine as a preprocedural mouth rinse to minimise the risk of transmission in dental office.[40]
Therefore, use of pre-procedural rinse can be an effective strategy to control infection in dental clinical settings where there is significant aerosol generation.[81]

CONCLUSION:

Pre-procedural rinse stands as one of an undisputed preventive measure in the dissemination of SARS-Cov-2 by minimising the risk of its transmission in the dental operatory.

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