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Dental Prophylaxis in Times of the COVID-19 Pandemic – a Critical Analysis/Review

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For over a year now, the SARS-CoV-2 (Severe Acute Respiratory Syndrome Corona-Virus type 2) virus originating in Wuhan (China) has dominated public, private and professional life. On 11 March 2020, the WHO declared COVID-19 a pandemic, referring to the "alarming levels" of spread and the severity of the disease, confirming that it is a pandemic caused by a coronavirus [1].

The 1st lockdown (spring lockdown) was marked by lack of knowledge, fear and uncertainty not only in the public and private domain. At the beginning of the pandemic, fear of infection combined with a lack of knowledge of SARS-CoV-2 (COVID-19) also determined the decisions of most practice owners, as did the official information provided by political and professional organisations. In this mix of anxiety and fear, many decisions were based purely on emotions. Fear and panic have never been good advisors; they led and lead to irrational decisions and irrational behaviour. Practice closures or partial closures (only acute emergencies were treated) were the consequences. Both in the practice and among patients, wrong decisions led to considerable uncertainty, which to some extent persists to this day. This is also borne out by the statistics. In a letter, the Bavarian State Dental Association [*BLZK*] stated that in March and April approx. 650,000 fewer preventive examinations (acc. to the German uniform value scale for dental services, *BEMA 01*) were carried out in Bavaria alone [2]. According to the German Association of Statutory Health Insurance Dentists [*KZBV*], the volume of services provided by dental practices dropped by over 40% in this period compared with the previous year [3]. Professional dental prophylaxis treatment is particularly affected by the decline in treatment, as it is closely linked with aerosols.

After a half-year learning curve, we now know that only 39 cases with a positive test result were reported in German dental practices [2]. The American Dental Association (ADA) found that the infection rate in dental practices is less than one percent [4]. Our strict hygiene and protection measures, long since integrated in the practices, have also proven their worth under SARS-CoV-2 conditions. This was already demonstrated by the groundbreaking study from Wuhan [5].

It has also taken a long time to recognise that dentistry and prophylaxis are systemically relevant. In case of infection with coronavirus, concomitant dental diseases represent a further risk factor. Poor oral health is generally a risk factor for systemic diseases or for severe courses of disease, and this also applies to COVID-19 diseases. Therefore, it is fundamentally relevant to study oral health in corona patients [6]. For practical purposes, this means: The health of mouth and teeth must be maintained – even during the pandemic. It is important to treat tooth defects and inflammation in good time and ideally as a preventive measure. Especially in times of pandemic, prophylaxis is of particular importance for our patients' health! The decisions made by the German government and the leaders of the federal state governments are the logical consequence of these findings. Today, they consider dentistry to be systemically relevant and there are no restrictions on practising dentistry, provided hygiene measures are observed.

Ignorance does not protect against Recommendations

Considerable confusion and unnecessary unease have been caused by the incorrect use of the term "aerosol". Droplets and especially aerosols and spray mist (back spray mist from dental instruments) were lumped together and used synonymously. The recommendations from the German Dental Association [*BZÄK*] on how to avoid aerosols were particularly unfortunate in this context [7]:

1. Minimise/avoid the use of ultrasonic handpieces, piezoelectric powered ultrasonic and surgical equipment.
2. Minimise/avoid the use of powder jet equipment (e.g. "AIRFLOW").
3. Minimise/avoid the use of turbines.

With these recommendations, modern dentistry, which is indispensably associated with water-cooled tools, was called into question! The recommendation should have been: Modern dentistry, including prophylaxis, is not possible without spray mist. For practical purposes, delimitation and exact definition of the terms (droplets, aerosols, spray mist) would have been very helpful. The recommendations raise other questions:

- Why was there no mention of droplets, the main mode of transmission of SARS-CoV-2?
- Why was no distinction made between aerosols and spray mist? The terms are of huge relevance for assessing risk and reducing the risk of infections and should therefore be applied with their correct meaning [8].
- Why is there no mention of sonic devices, which have been shown to produce significantly more spray mist than ultrasonic scalers [9]?
- Why was the turbine explicitly mentioned, but other water-cooled instruments, such as straight and contra-angle handpieces, which are also used in prophylaxis, not mentioned?
- Were the water-cooled tools not mentioned only omitted so as not to impose an occupational ban on dentistry?

Summary

Would it not have made more sense to point out that, thanks to excellent hygiene measures, infection prevention has worked outstandingly well for all previous infectious diseases (influenza, tuberculosis, hepatitis, HIV)?

Would it not have made more sense to recommend to the practices ways of minimising the risk of infection via droplets, aerosols and spray mist and to take a stand for modern oral medicine on the grounds of its systemic relevance?

Define Terms and use them correctly

Droplets

The main mode of transmission for SARS-CoV-2 is respiratory ingestion of virus particles in droplets. Depending on particle size and physical properties, a distinction is made between larger droplets and smaller aerosols. Droplets and aerosols are mainly produced by humans coughing, sneezing and speaking (singing). Droplets are defined to be larger than 4–5 µm. The size of most droplets is between 4 and 8 µm. The larger the droplets, the more particles can be transported, and the viral load can be very high (example calculation particle size to volume: 5 µm to 65.5 μ^3 and 10 µm to 523.6 μ^3). The amount of droplets emitted with particles containing bacteria for sneezing : coughing : speaking is in the ratio 400 : 7 : 1 [10–12]. If the droplets are larger than 8 µm, they settle on surfaces immediately, or after 20 minutes at the latest. If droplets are suspended in the air, they lose water depending on the relative humidity, becoming so-called droplet-nuclei [10]. In still room air (without ventilation), the size of the droplets reduces from 12–21 µm to about 4 µm within about 10 minutes [13]. These droplet-nuclei are the size of aerosols. The loss of water from the droplets may kill or inactivate the bacteria and viruses contained in the droplet. The transition of droplets into droplet-nuclei or into aerosols can lead to a reduction in the infectivity of the micro-organisms contained [10]. There is still no agreement on the amount of virus necessary for infection with SARS-CoV-2 (viral load) [14]. On average, 1000 particles are sufficient to cause an infection. The individual range of variation is between 100 and 5000 particles [15].

Aerosols

Aerosols can also have a high viral load in sick people. Aerosols are defined as a suspension of liquid and solid particles with a diameter of up to 5 µm. The transition from droplets to aerosols is fluid. Aerosols are expired when breathing and speaking, but even more so when shouting and singing [16–25]. Because aerosols are small, they can remain airborne for hours and over long distances by air movements [10]. Whether aerosols drop and how quickly or remain suspended in the air depends not only on the size of the particles but also on a number of other factors, including temperature and humidity [26]. The statements from experimental studies on the detection of replicable SARS-CoV-2 viruses in aerosol differ depending on the environmental conditions described. Virus particles have been detected in aerosols in some studies [26, 27]. In a study with experimentally prepared aerosols enriched with SARS-CoV-2, replicable viruses were detectable in the aerosol after 3 hours [27].

Effective exchange of air can reduce the aerosol concentration in a room [28].

From the studies conducted so far, no conclusive statement can yet be made regarding the infectivity of the virus particles in these aerosols.

Spray mist

Spray mist arises from the coolant that comes from dental equipment, primarily originating from non-contaminated, aseptic or low-bacteria water. For precise linguistic differentiation, aerosols produced by the use of machine-operated devices in dentistry should rather be referred to as spray mist (or back spray mist or bioaerosol). The synonymous use of the term aerosol for both aerosols and spray mist has led to unnecessary uncertainty. The right choice of words can help to clear up the existing confusion.

Rotation and vibration of mechanical devices (handpieces, sonic-ultrasonic devices) cause coolant to be returned from various structures of the oral cavity (spray mist). The same mechanism can be observed with Airflow Technology. Aerosols and droplets in the back spray mist have a particle size of 0.5–20 µm [9]. Due to its low sedimentation speed, spray mist can travel several metres in suspension and can be detected in room air for up to 30 minutes. This spray mist contains a high proportion of coolant. Current evidence is insufficient in confirming or ruling out aerogenic transmission of SARS-CoV-2 in dental treatment [9].

Summary

Emission of droplets, aerosols and spray mist from the patient's oral cavity cannot be completely avoided. For this reason, procedures to reduce the spray mist during dental treatment take on great importance.

Droplets are bodily fluids. They are the main source of infection for SARS-CoV-2. The most important measures to reduce the risk of infection are passive protective measures (keeping distance, disinfecting hands and surfaces, wearing masks).

Natural aerosols are also bodily fluids and can be sources of infection for SARS-CoV-2. In addition to passive measures (see above), active measures are also implemented (regular ventilation or technical air change, reducing the number of people in the room, gargling with antiviral mouthrinses) [29].

In the case of artificial spray mist, it is not yet clear whether aerogenic transmission of SARS-CoV-2 is possible from dental treatment. Nevertheless, additional protective measures should be taken. Besides passive protective measures (as above), specific active protective measures must be applied to minimise risk (see section below Prophylaxis).

Prophylaxis

As with all dental treatment, the very proximity to the patient also poses a risk of infection in prophylaxis. In addition to the proximity to the main sources of infection, i.e. mouth and nose (droplets, aerosols), spray mist is produced, which may be contaminated with bacteria and viruses from the patient. The risk of infection is particularly high in professional prophylaxis. Alongside water-cooled contra-angles, mechanical instruments (sonic scalers, ultrasonic scalers) and Airflow Technology, which produce a lot of spray mist, are also used. In this case, infection protection means that active protective measures must be taken in addition to standard passive protective measures.

As biofilms (bacteria) are the main cause of oral disease, biofilm management is the top priority in prophylaxis. There is sufficient literature on bacteria in spray mist and options for protecting against bacterial infection in prophylactic measures [30–34]. There is little literature on viral contamination from aerosols/spray mist during professional dental cleaning with handpieces, contra-angles, Airflow Technology and ultrasonic technology. Therefore, the bacterial situation is equated with the viral situation. Consequently, infection control measures to reduce the risk of infection from viruses and bacteria are the same.

As well as the generally applicable guidelines for infection prophylaxis from the Robert Koch Institute (RKI), which have been extended due to COVID-19, the following countermeasures also play a role in prophylaxis: additional eye protection with a protective shield, mouthrinsing before treatment, high-vacuum suction, correctly working devices and tools as well as a systematic clinical protocol for the prophylaxis session.

Face shield

In addition to safety goggles, a face shield can serve as additional protection, especially with spray mist. A visor does not offer protection against potentially virus-laden aerosol in the breathing air. A face shield or visor is no substitute for mouth and nose protection and may only be used in addition (▶ **Fig. 1**) [31].

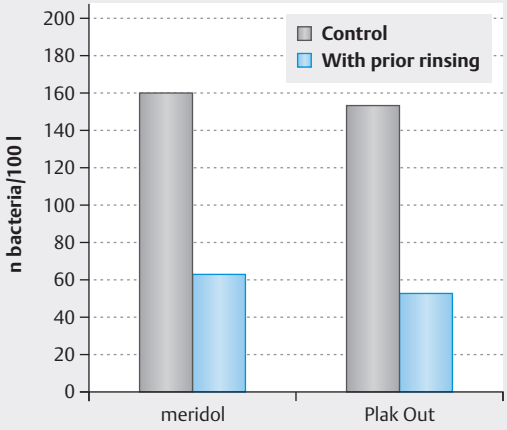
Mouthrinses

To clarify before discussing the literature: Both antibacterial and antiviral mouthrinses protect the practitioners above all!

Prior to the pandemic, the main focus in prophylaxis was on the efficacy of CHX against bacteria, also in aerosol and spray mist. There have been few findings to date on the virucidal effect of CHX. It is scientifically well documented that oral rinsing with a mouthrinse containing CHX for 30–60 seconds prior to dental treatment can reduce the bacterial load in the aerosol and spray mist by up to 70% (▶ **Fig. 2**) [32–37].

Studies show that SARS-CoV-2 infects cells via angiotensin-converting enzyme 2 (ACE2) receptors. An especially high concentration of these ACE2 receptors is found in the oral cavity and particularly on the tongue. During the 1st week after infection, very active replication of the virus particularly occurs in the pharynx and upper respiratory tract [38]. It makes sense to transfer the experiences with CHX to also include infection prophylaxis with viruses. Mouthrinse or gargling with mucosal antiseptics appears to reduce the virus concentration in the oral cavity and thus in the spray mist and aerosol in the short term [37].

▶ **Fig. 1** Additional protection with a visor. The visor is a prototype (Seybold/Bastendorf) with individual clearance adjustment. Adapted here for magnifying glasses with light.



▶ **Fig. 2** Reduction of the bacterial count in the spray mist with different mouthrinses.

It should be considered that almost all studies showing an antiviral effect of reducing SARS-CoV-2 are *in vitro* studies. There are currently no clinical studies on the reduction of SARS-CoV-2. There is evidence of limited virucidal activity (against enveloped viruses) for the following antiseptics: ≤ 0.1% octenidine, 1–1.5% H_2O_2 [39], 0.2% povidone-iodine [5, 40–42], 0.2% chlorhexidine [35–37], 0.2% cetylpyridinium chloride [44], ≤ 0.25% sodium hypochlorite [43], Dequonal [41], Listerine cool mint [41].

In addition to the products povidone-iodine, Listerine and Dequonal, which all contain alcohol (ethanol), mouthrinses with cetylpyridinium chloride (CPC) have come into focus.

In vitro experiments show degradation of the lipid bilayer of the envelope of several strains of influenza virus treated with 0.05% CPC. These results suggest that CPC may be effective in inactivating viruses with a lipid envelope, which includes coronavirus [44]. In a clinical study, a group of subjects received 0.10% CPC as a spray for 75 days. The subjects had a lower incidence of upper respiratory viral infections [45]. It is therefore assumed that CPC may have a preventive effect on infections caused by viruses such as influenza virus, adenovirus, rhinovirus, respiratory syncytial virus and coronavirus [46].

Mouthrinses that are antibacterial (CHX) and antiviral (CPC) are particularly interesting for use in prophylaxis. In this context, an article should be mentioned in which an as yet unpublished *in vitro* study is cited, which focused on the protective effect of pre-treatment rinsing (combined CHX and CPC) on SARS-CoV-2. It showed that BacterX Pro (EMS, Nyon) eliminates SARS-CoV-2 after one minute of rinsing and can thus reduce the "load" for practice staff [47].

High-vacuum suction (HVS)

Modern high-vacuum suction systems (300 l suction volume/minute), appropriately matched diameter-optimised suction cannulas (≥ 10 mm) and a good suction technique (2-hand or 4-hand technique) allow a two-thirds reduction of the spray mist and aerosols to be achieved (▶ **Fig. 3**) [9, 49–51]. This makes an important contribution to infection reduction.

The correct sitting position can also help to reduce the practitioner's spray mist load. This was shown in a paper by Graetz et al. [9, 50]. The lowest spread of spray mist in the room is found when working in the 8 o'clock position.

Donnet et al. [30] conducted a practice application observation to better understand the risk of aerosol/spray mist contamination when using Airflow and Piezon technology. The aim of this study was to measure the bacterial load in the room air during Airflow or Piezon application in order to obtain evidence for assessing the risk of aerosol contamination for practitioners, the practice team and patients during the use of the AIRFLOW®, PIEZON/PS® Technology. This study showed that no change in bacterial room air contamination could be measured in treatment using saliva ejector, pre-treatment mouthrinsing (BacterX Pro) and high-vacuum suc-

tion (two-hand technique with Optragate). If the protective measures were not applied, the room air contamination was approx. 3 times higher (▶ **Fig. 4**).

The suction capacity during professional dental cleaning can also be improved with a suction cannula specially developed for prophylaxis by Dürr Dental [52].

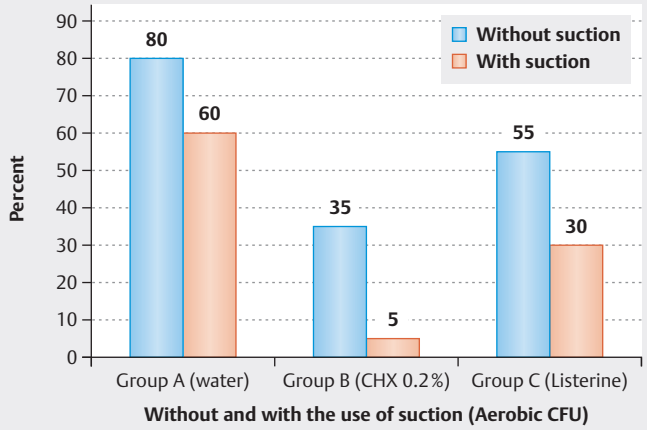
Technical aids

In order to reduce the contamination of aerosols and spray mist, attention must be paid to ensure the maintenance and proper functioning of the equipment and auxiliary parts used (ultrasonic tips and Airflow nozzles). Only then can the professional goals and the desired minimisation of infection risks be achieved. Graetz et al. [9, 50] point out that in Airflow Technology, if nozzles are contaminated, embedding of the powder in the water jacket no longer occurs. Technological advancement can also help to reduce spray mist. EMS (Nyon, Switzerland) has launched a new airflow handpiece (AIRFLOW MAX) that works with laminar technology. This technology by its very nature leads to a reduction of spray mist; additionally, the laminar jet can be suctioned off better. Also, in ultrasonic technology, only original tips from the manufacturer should be used, which are not damaged or worn.

The function of the suction system as well as the suction power can also be reduced for different situations and should be checked regularly by the technician.

Clinical prophylaxis protocol

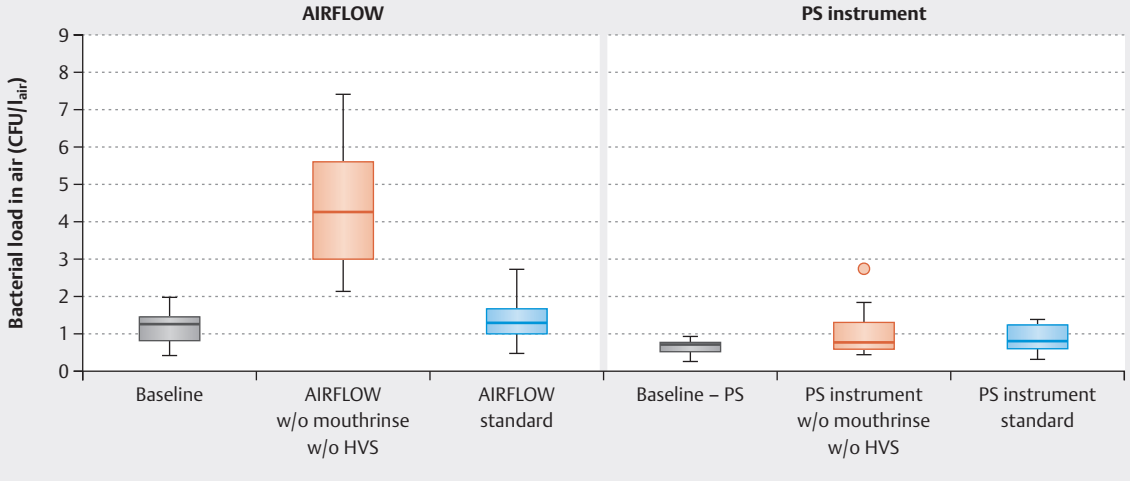
A reduction of spray mist can also be achieved with a modern workflow protocol for the "prophylaxis session", such as Guided Biofilm Therapy (GBT). On the one hand, supragingival biofilm is stained and then specifically removed only where biofilm really exists. Only then are the mineralised coatings removed. With this approach, the ultrasonic application time can be reduced by approximately 8 minutes compared to the classical approach [53].



▶ **Fig. 3** Reduction of bacteria (CFU) in the spray mist with different mouthrinses and HVS.

Summary

The corona pandemic has once again made us aware just how high the risk of infection in dentistry is. Those who have chosen a career in dentistry have been made aware that dental treatment is always associated with a risk of infection. In dentistry, the short distance to the patient's oral cavity and nose means general exposure to the patient's saliva, blood, droplets, aerosols, spray mist and sulcus fluid [39]. On the other hand, we in dentistry have



▶ **Fig. 4** Bacterial load in the room air (CFU/l) during treatment with AIRFLOW and PIEZON/PS with and without mouthrinse and HVS.

always had excellent hygiene and protective measures integrated in our daily practice. These measures have been further improved in the wake of the corona pandemic.

Statements by various professional organisations on the risk of infection, especially regarding the incorrect use of the term “aerosol”, have led to great uncertainty in practices and among the general public and patients. This has led to the impression that has emerged among the general public and our patients that there is a high risk of transmission and infection with SARS-CoV-2 through “aerosols” in dental practices.

The risk of transmission and infection appeared to be especially high in prophylaxis, as most “aerosols” are produced with prophylaxis tools (Airflow, sonic, ultrasonic). Unfortunately, the main focus of most official recommendations for conduct was on avoiding “aerosols” and thus reducing prophylactic treatment. There was no distinction made between aerosols and spray mist. The importance of spray mist minimisation for infection prophylaxis has not been discussed sufficiently.

The logical consequence was that practices stopped prophylactic treatment completely during the spring lockdown. Others instead resorted to hand instruments for biofilm and calculus removal, despite all the known drawbacks.

What has been forgotten is that especially in times of medical crisis, such as COVID-19, good oral hygiene or a healthy oral cavity is more important than it ever was before. A healthy oral cavity is always a better immune barrier than a diseased oral cavity. In case of infection with coronavirus, concomitant oral diseases represent a further risk factor.

Today, prophylaxis can be undertaken without restrictions. The extended hygiene protection measures and the S1 guideline of the German Society of Dentistry and Oral Medicine [*DGZMK*] (Dealing with dental patients exposed to aerosol-transmissible pathogens *AWMF* [Association of the Scientific Medical Societies in Germany] register number: 083–046 as of September 2020) must be observed.

CONCLUSION FOR THE PRACTICE

- There has never been dentistry without the risk of infection! There will be no dentistry in the future without the risk of infection!
- Dentistry does not exist without droplets, aerosols and spray mist and will not exist in the future without droplets, aerosols and spray mist!
- Aerosols and spray mist cannot be avoided, but have to be controlled!

Conflict of Interest

In the interest of transparency, I, K.-D. Bastendorf, would like to inform that I work as a consultant for E. M. S. Electro Medical Systems S. A., 1260 Nyon, Switzerland.

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