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# How did the COVID-19 pandemic lockdown affect dental emergency care in children? Retrospective study in a specialized pedodontics center

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## List of abbreviations

| | |
|---|---|
| AGPs | Aerosol Generating Procedures |
| ECC | Early Childhood Caries |
| GA | General Anesthesia |
| HT | Hall Technic |
| MITs | Minimally Invasive Treatments |
| $N_2O$-$O_2$ | Nitrous Oxide – Oxygen |
| NAGPs | Non-Aerosol Generating Procedures |
| NRCC | Non-Restorative Caries Control |
| PPE | Personal Protective Equipment |
| SDF | Silver Diammine Fluoride |
| WHO | World Health Organization |

# 1 Abstract

**Background:** COVID-19 lead to the adoption of containment measures including temporary closure of dental clinics. Despite the risk of infection transmission, dental emergencies have not ceased during this pandemic and had to be managed also in the lockdown period.

**Aim:** To analyze the profiles and offered management options of pediatric patients presenting with dental emergencies during a COVID-19 lockdown.

**Design:** Retrospective analysis of patient records of children seeking emergency dental treatment during a 7-week lockdown period in 2020 in a university pedodontics clinic in Germany, compared to a similar cohort from 2019. Data on patient level, tooth level, and session level were collected. An analysis of the digital records after 6 months follow-up was performed for the patients who received Non-aerosol Generating Procedures (NAGPs) as management for dental emergency in the lockdown period in 2020.

**Results:** The 2020 cohort consisted of 83 patients, while the 2019 cohort included 46 patients showing 45% higher necessity for emergency treatment in 2020. Most common chief complaint was oral mucosal conditions in 2020 (26.4%), and irreversible pulpitis in 2019 (25.5%). Dental caries (without spontaneous pain) was the second most chief complaint in both cohorts (20.7% and 23.4% respectively). 20.3% of the interventions in 2020 were Minimally Invasive Treatments (MITs) such as the Hall Technique (HT) and Silver Diammine Fluoride (SDF), which were in 2019 not considered. 16.9% of the cases in 2020 were managed by pharmacological treatment which was in 2019 with 35.9% also highly used. The 6 months follow up for the NAGPs revealed benefit in management of the acute dental problem, by either direct treatment or by postponing the treatment need to a later time period.

**Conclusion:** The COVID-19 pandemic led to increase in emergency pediatric dental visits and shifted treatment options towards less invasive procedures. In challenging situations, where aerosols increase the risk of infection transmission, NAGPs are a viable option in the management of dental emergencies, especially in pediatric dentistry.

# 2 Introduction and aim

Dental care provision was affected by the strict regulations developed with the COVID-19 pandemic in 2020; many dental clinics suspended elective dental care and provided it only to patients demanding urgent care.

Affected persons with SARS-CoV-2 may be asymptomatic, but can have the living virus in their saliva, which may consequently spread in a closed room, especially if dental procedures generated aerosols. Those potentially harmful aerosols might stay for hours in the dental clinic and cause an infection either for the dental team or for consequent patients. If dental treatments were to be performed, proper personal protective equipment (PPE) was essential for dental care providers in order to reduce the exposure to pathogens. However, PPE was in shortage worldwide due to the high worldwide demand. In these challenging situations, most private dental clinics had to close temporarily to minimize the spread of the SARS-CoV-2.

On the other hand, (pediatric) dental emergencies have not taken a break in the times of COVID-19 and some dentists or hospital dental clinics had to overtake the responsibility of managing acute dental problems under challenging conditions.

The aim of this comparative retrospective study was to analyze the patient and treatment profiles of children attending a pediatric dentistry university center during the COVID-19 lockdown in 2020 in Germany in comparison with a cohort of a similar period of the previous year (2019) in order to understand the COVID-19 pandemic related changes in these aspects. Moreover, a further analysis aimed to assess the benefits of NAGPs in the management of acute dental emergencies in children based on a 6 months follow-up of a group of patients treated in the 2020 lockdown period in the same pediatric dentistry university center.

# 3 Literature review

## 3.1 COVID-19 pandemic

In the late 2019, increased number of unexplained cases with Pneumonia was observed in the city of Wuhan, China. This was proven to be due to the emergence of the novel Corona virus SARS-CoV-2 [WHO 2021a]. The surprisingly increased number of cases in China and the rapid widespread of the disease worldwide led to the announcement of the Corona disease as a pandemic in 11$^{th}$ of March 2020 [WHO 2020b].

Worldwide governments have taken then strict containment measures (including social distance regulations, contact restrictions, etc.) to hold back the spread of the pandemic. In Germany, early March 2020, the German states determined school and kindergarten closures, rescheduling university semesters, banning visits to nursing homes to protect the elderly, even borders to the majority of neighboring countries like Austria, Denmark, France, Luxembourg and Switzerland were closed for a significant period of time [RKI 2020].

SARS-CoV-2 is the virus causing the COVID-19 pandemic and can be present in nasopharyngeal secretions and in the saliva of infected patients, and the routes of transmission of the virus are by direct contact with salivary droplets in case of proximity to someone with respiratory symptoms (e.g., coughing or sneezing) or by aerosols [Meng et al. 2020]. The uncertainty about the route of transmission of the virus lead to many changes in the recommendations of the World Health Organization (WHO) and in the precautions and regulations of governments worldwide. As an example, social distancing was recommended at the beginning of the pandemic with 2-meter distance, but changed afterwards to 1.5 meters. Another example is the protection method using a face mask, where any textile piece covering the mouth and nose was accepted at the beginning of the pandemic and was only necessary in closed rooms, but was changed afterwards to FFP2 masks (where FFP stands for filtering facepiece) in specific situations with special ventilation conditions, especially in closed rooms.

## 3.2 Effect of the COVID-19 pandemic on dentistry

As the dentists were considered in danger of receiving the corona infection as well as being a route of transmission to healthy dental patients probably due to aerosols, most dental clinics in Germany suspended elective dental care and provided it only to patients demanding urgent care as per suggestion by the national health authorities [BZÄK 2020a].

### 3.2.1 Aerosol generating procedures (AGP) and risk of transmission of diseases

Dental treatment procedures involving the use of a bur in highspeed handpiece or an ultrasonic tip cause a raise in the temperature in the dental tissues reaching the pulp chamber, which may consequently cause a reversible or irreversible inflammation of the pulp tissue. Therefore, such dental procedures should only be used with cooling water [Farah 2019]. The strong flow of cooling water hitting the tooth surface in highspeed causes water particles to fly in the air outside the oral cavity (Figure 1).


Figure 1: Water particles flowing out of a dental handpiece with a brushing head.

These water particles depending on their size and if contaminated would either drop down to the ground level causing infection as droplets only if inhaled in close proximity to their source, or would stay longer viable in the air as aerosols and probably cause

infection in a susceptible recipient also further away from their source and also after a period of time in a closed environment (Figure 2 [Ge et al. 2020]).

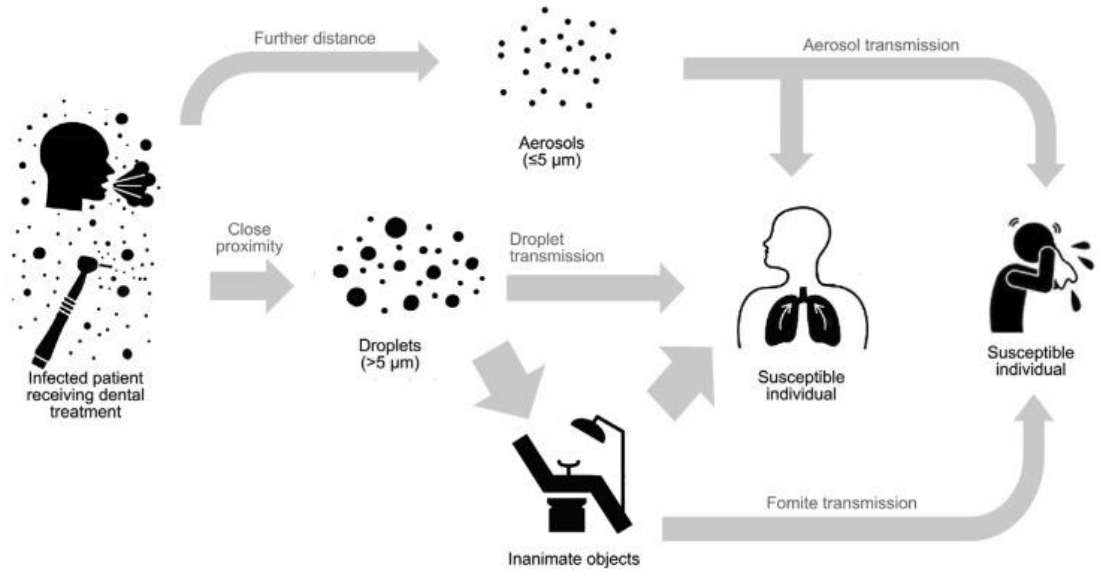



Figure 2: Different routes of transmission in dental settings: aerosol, droplet, and fomite [Ge et al. 2020].

A recent review was conducted with the aim of identifying the level of consensus on dental AGPs [Virdi et al. 2021]. Although the authors noted the lack of consistency in reporting which procedures were deemed as AGPs, they were able to show, that the great majority of dental procedures can be considered either aerosol generating or probably aerosol generating.

The mechanism of transmission of the SARS-CoV-2 is yet unclear. Although the main transmission route is thought to be airborne, the specific mechanism of transmission as droplets or aerosols is still not widely researched [Kumbargere Nagraj et al. 2020, Rabaan et al. 2021]. As a result, the regulations and recommendations for the prevention of the corona disease are prone to change anytime, which makes a proper protection in dental clinics more challenging.

### 3.2.2 Protective measurements in the dental practice during the COVID-19 pandemic

For decades, the use of intraoral suction devices was considered as a sufficient protective measurement to prevent airborne transmission of infection in the dental

practice during treatments. However, with the novel situation in the COVID-19 pandemic, the risk of transmission of the SARS-CoV-2 was considered to be very high in the dental clinics. Some studies recommended therefore the use of improved suction systems such as a combination of high-volume evacuation (Figure 3) combined with intraoral suction devices [Suprono et al. 2021], while other studies showed more contamination reduction using an extraoral dental aerosol suction device in conjunction with low volume saliva ejector [Noordien et al. 2021].

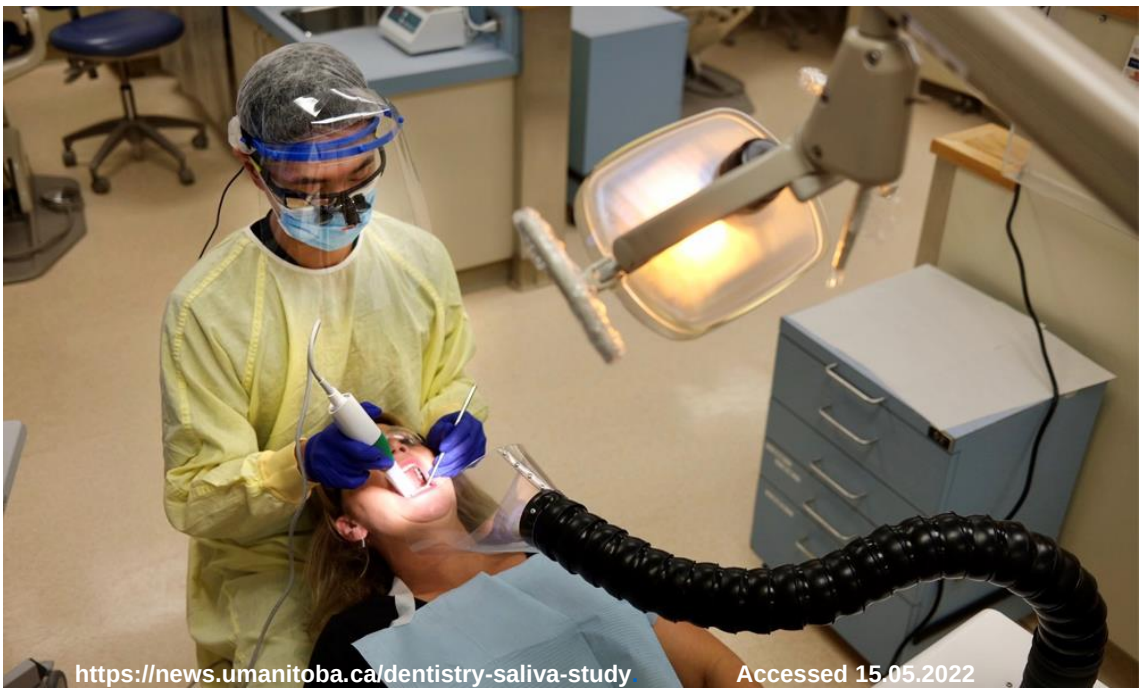



Figure 3: High-volume evacuator systems used by students in the University of Manitoba to vacuum away aerosols generated in some dental procedures.

Since such systems are not regularly available in dental practices, and because installing such systems would be not only complex but also costly, some dental practices and hospitals had to use innovative techniques to prevent a potential aerosol transmission of infection during dental procedures. An example of such techniques was a see-through box that would aerosols from reaching the dental team directly. But aerosols can stay in the air for longer period of times, as a consequence, extensive surface and room disinfection teams were needed if multiple patients were planned to be treated within a short period of time. The effort to reduce the risk of aerosols was not only during or after the dental treatment, but also prior to it, as many studies recommended the use of mouth rinses before starting dental treatments to reduce the

potential virus count in the oral cavity [Moosavi et al. 2020, Vergara-Buenaventura et al. 2020, Reis et al. 2021].

Proper PPE should be used by dental care providers in order to reduce the exposure to pathogens [WHO 2020c]. During the COVID-19 pandemic, it was necessary to have extra PPE, such as FFP2 masks or face shields. However, PPE was in shortage worldwide due to the high demand [Burki 2020], which made infection control during the pandemic very challenging.

To sum up this section, that included the challenges faced by dentists in order to obtain the maximum infection control during the COVID-19 pandemic, it is worth noting, that with increasing time living in a pandemic, the medical health communities in general and the dentists in specific has adapted to the challenging situations. Moreover, there are meanwhile tens of published papers including recommendations for infection control in dental clinics during the COVID-19 pandemic. The most important recommendations are as following [Amato et al. 2020, Izzetti et al. 2020, Jamal et al. 2021]:

- Patient triage: Patients should be asked about a possible contact to infected persons with the SARS-CoV-2 in the last 14 days, and about having any symptoms, that could be due to an infection with the SARS-CoV-2, such as fever or coughing.
- The use of mouth rinses prior to dental treatment to reduce the potential virus count in the oral cavity.
- Strict hand hygiene: Thorough hand washing and sanitization before and after contact with patients and nondisinfected surfaces or equipment as well as avoiding touching the mouth/nose/eyes with nondisinfected hands.
- PPE for dental practitioners: Using gloves, masks, protective outerwear, protective surgical glasses, and shields.
- Limitation of AGPs and using rubber dam if such procedures are necessary.
- Regular cleaning and disinfection of potentially contaminated surfaces.
- Avoidance of the use of intraoral radiographs, if possible.

### 3.2.3 Challenges in the management of dental emergencies during the COVID-19 pandemic and the lockdown period

A typical dental emergency involves patients presenting with acute dental and facial pain not manageable with non-prescription pain killers, dental traumatic injuries, soft-tissue infections, etc. [Tulip et al. 2008]. Even in times of COVID-19 lockdown, dental emergencies, particularly in pediatric populations, remain prevalent, and clinicians are faced with the complex task of delivering safe dental care while limiting the contact of clinicians and staff to patients, and also to ideally offer long-term solutions. With the temporary closure of many dental practices and suspension of ‘’elective’’ dental treatments, an increase in the proportion of dental emergency complaints was anticipated. Since the management of dental emergencies, especially in pediatric dentistry, could not be postponed even in the lockdown period during a pandemic with a high risk of infection of the dental team, and due to the lack of the proper PPE with the high risk of potential infection with the SARS-CoV-2, the dental clinics (especially in hospitals) had to improvise and be innovative in the PPE to minimize the infection risk, such as wearing diving equipment (Figure 4).

Figure 4: Innovation in PPE for medical health teams during the COVID-19 pandemic with the shortage of available PPE worldwide due to the high demand.

Dentists should be attentive to recommended management protocols that ought to insure and protect the patient’s well-being, as well as their-self to avoid further viral transmission [Mallineni et al. 2020]. However, the challenges in pediatric dental

emergencies are not only in infection control, but also in the management of the emergency case, especially with limited cooperation of the child.

In pediatric dentistry, there is a scarce literature on protocols or recommendations for the management of acute pain. In general, pediatric dental emergencies range from simple complaints such as oral mucosal problems (ulcers, gingivitis causing pain during toothbrushing, eruption problems, etc.), where minimal interventions are needed, to more serious complaints such as extraoral swellings and dental trauma. Moreover, dentin caries causing reversible or irreversible pulpitis causes pain and should be managed always as soon as possible. Currently, the implementation of MITs in pediatric dentistry has become more important than ever before. These management approaches generate little or no aerosol and share modern caries control concepts, which have proved to be effective for disease control in teeth with no pulpal involvement [Santamaría et al. 2020, Splieth et al. 2020]. As such dental treatments generate no or little aerosols, they have less potential of infection transmission and might be advantageous in times of a pandemic.

The aim of this comparative retrospective study was to analyze the patient and treatment profiles of children seeking emergency dental treatments in a pediatric dentistry university center during the COVID-19 lockdown in 2020 in Germany in comparison with a cohort of a similar period of the previous year (2019) in order to understand the changes in patient and treatment profiles, that may be caused by the COVID-19 pandemic. Moreover, a further analysis aimed to assess the benefits of NAGPs in the management of acute dental emergencies in children based on a 6 months follow-up of a group of patients treated in the 2020 lockdown period in the same pediatric dentistry university center.

# 4 Materials and methods

## 4.1 Ethical aspects

This study is part of a series of retrospective studies to evaluate clinical interventions at the Department of Preventive and Pediatric Dentistry in the University of Greifswald, approved by the research ethics committee of the university under protocol number BB 28/16.

## 4.2 The dental clinic in the University of Greifswald during the COVID-19 pandemic and the lockdown period

The administration of the Medical Clinic (Universitätsmedizin) of the University of Greifswald provided recommendations and guidance for the triage of SARS-CoV-2 suspected or positive cases following national and regional recommendations [BZÄK 2020b]. Routine treatments at the Department of Preventive and Pediatric Dentistry were deferred, in order to spare medical resources, and minimize risk to patients and staff. Patients whose appointments were postponed by telephone and who called to make an appointment were given a telephone consultation. The importance of brushing teeth with fluoridated toothpaste (at least 1000 ppm fluoride), optimizing the use of fluoride (e.g., with sodium fluoride gel once a week for permanent teeth) to prevent the development of caries and arrest active lesions, as well as nutritional advice were emphasized. The universal precautions from the WHO to avoid infection with the SARS-CoV-2 were routinely followed [WHO 2020c].

In normal times before the pandemic, around 200 children a week are treated at the Department of Preventive and Pediatric Dentistry. Normally, treatments are carried out chairside, under Nitrous Oxide/Oxygen ($N_2O$-$O_2$) sedation, or General Anesthesia (GA), as required. During the COVID-19 lockdown period in 2020, dental treatments under GA were not possible.

## 4.3 Study design and data collection

A retrospective assessment of the clinical digital records and outcomes was performed for all patients seeking emergency dental care in the Department of Preventive and

Pediatric Dentistry between March 17th to April 30th in the year 2020. In those seven weeks, no regular dental treatments in the dental clinics of the university hospital were permitted, and the clinics were only open for dental emergencies after short risk assessment regarding COVID-19 infection with questions regarding contact with COVID-19 positive patients, fever, or other related symptoms. Suspected cases were further asked about the complaint to determine the treatment need and were refused entrance to the clinics if no acute treatment need existed.

The main inclusion criterion for this study was to have sufficient patient and clinical documentation. All necessary information related to patient complaints and treatment session(s), as well as related patient characteristics including age, gender, caries levels ($d_3$mft/$D_3$MFT), type of available radiographs, etc. were recorded. On the session level, the method of examination (clinical, telemedicine), treatment setting (chairside, $N_2O$-$O_2$ sedation), as well as child's cooperation during treatment were collected.

Patient's cooperation is regularly assessed by treating dentists using a four-point behavior rating scale [Frankl 1962], which ranges from ''definitely negative'' behavior, when the child refuses the treatment, cry, etc., to ''definitely positive'' behavior, when the child is completely cooperative.

Regarding patient complaints, the recorded data included main, and minor complaints (if reported), pain symptoms (e.g., spontaneous pain, pain by eating, etc.), and the type of the tooth causing the problem (primary/permanent - anterior/posterior).

The factors and variables associated with the treatments provided were collected and analyzed. This included: type of intervention, treatment setting, type of radiographs (panoramic or periapical radiograph, etc.), type of prescribed medicaments, use and type of local anesthesia, further appointments (if required), and the need of an inter-consultation with other dental specialties. Moreover, data from cases in which telemedicine was used to assess or manage the emergency case were also recorded.

To be able to find out the influence of the pandemic on patients' profiles seeking dental emergency treatment and on the spectrum of the management options, digital records of patients who visited the Department of Preventive and Pediatric Dentistry from the same period of time in the previous year (full seven weeks in 2019 from March 18th to

May 3rd) were collected following the same recording method, analyzed, and served as a control group.

## 4.4 Categorizing dental emergencies and treatment options

Reasons for seeking emergency treatment for both cohorts (2020 and 2019) were categorized according to diagnosis for the main and minor complaints, resulting in seven categories:

- Plaque-induced gingivitis, and other oral mucosal clinical conditions.
- Dental caries (dentin half-way or deep lesions with asymptomatic pulp, or reversible pulpitis, not causing spontaneous pain).
- Irreversible pulpitis (deep dentin lesions causing spontaneous pain) or necrotic pulp.
- Odontogenic infection conditions.
- Restoration loss (causing pain or discomfort, however without clinical evidence of a carious lesion).
- Space maintainer complaints.
- Traumatic dental injuries.

The management options of the dental emergency were as well categorized to allow analysis of the data as following:

- Pharmacological treatment.
- Treatment of oral mucosal problems.
- Space maintainer procedures (e.g., removal, adjustment, impression, etc.).
- Filling or stainless-steel crown.
- MIT: Non-Restorative Caries Control (NRCC) / SDF / HT.
- Pulp therapy (e.g., pulpotomy, root canal treatment, intercanal medication).
- Tooth extraction.
- Counselling (no acute treatment needed after the detailed examination and diagnosis).
- Dental trauma management (e.g., tooth reimplantation or adjustment and fixation, etc.…).
- Dental trauma follow-up.

## 4.5 Follow-up to evaluate the management of dental emergencies with NAGPs provided in the lockdown period

The patients, who received NAGPs to manage the dental emergency in the lockdown period (March-April 2020) were followed for a period of 6 months to evaluate the consequences or the benefits of the provided treatments.

## 4.6 Data analysis

Two researchers were responsible for data collection from patient's digital records. To prevent any inconsistency, the two authors agreed on a unified pattern to follow in data collection. In cases of uncertainty, a third experienced researcher was consulted. Patients' data were excluded when the available information was not enough for data analysis, or when patients had a regularly scheduled visit and did not follow the notice of restrictions applied.

Patients' data were encoded, entered and analyzed in SPSS for Windows (version 17.0.; Chicago, IL, USA). Descriptive statistical analysis was performed to report the frequency distributions (mean and standard deviation) of the assessed variables. The t-test was used for the analysis of continuous variables. Differences between the two cohorts were analyzed using non-parametric Mann-Whitney U test. The level of significance was defined as $p<0.05$.

# 5 Results

## 5.1 Baseline Characteristics (Cohorts 2020 and 2019)

For the lockdown cohort from 2020, 92 patient records were analyzed, of which 83 (90.2%) were included. Data from 9 patients (9.8%) were excluded due to insufficient documentation (n=3) or because the patient had attended the clinic for regular check-up missing the notice of the applied restrictions (n=6).

The 83 included patients required a total of 101 clinical sessions. The 18 extra sessions were either planned sessions related to treatment follow-ups or continuing the treatment (n=14; 13.9% of all sessions), and for treating patients with recurrent pain (n=4; 4% of all sessions). Patient's ages ranged from1 to 17 (mean 7.9 ±4.1). A 28-year-old patient with mental disability, who is a regular patient at the department, was also treated during this time frame resulting in a total age range from 1 to 28 years (mean 8.2 ±4.6). In total, 42 patients (50.6%) were boys, and 41 (49.4%) were girls. The majority of treatments were performed on known patients (n=71; 85.6%), while 6 (7.2%) were newly referred patients, and 6 (7.2%) were new patients presenting without referral (Table 1). Treatments were provided by pediatric dentists or dentists with special training on pediatric dentistry (n=9).

From the same time frame of the previous year (2019), a cohort of patients seeking emergency dental treatment was analyzed and used for comparison. In total, 46 patients receiving 60 treatment sessions were included and analyzed. Children's ages ranged from 2 to 17 years (mean 7.9 ±3.8), 21 (45.7%) were boys, and 25 (54.3%) were girls. The treatments were provided by pediatric dentists and dentists with special training in pediatric dentistry (n=10) or by postgraduate pediatric dentistry students (n=12) following a master program under the supervision of the specialists.

The need for emergency dental treatment was 45% higher in the 2020 cohort as compared to 2019, without statistically significant differences in patient age (p=0.74), gender (p=0.73) or $d_3$mft/$D_3$MFT values (p=0.26/0.93). In addition, the distance travelled by patients to reach the clinic was longer in the 2020 cohort (34.4 ±31.2 km) as compared to 2019 (19.8 ±23.6 km; p=0.007). Table 1 shows comparatively the differences in general characteristics of the patients from the lockdown period in 2020 and the comparator cohort from 2019.

Table 1: General characteristics of children seeking emergency dental care during the COVID-19 lockdown in 2020 and the comparator cohort from 2019.

| **Characteristics** | | | **Lockdown cohort 2020** | **Comparator cohort 2019** |
|---|---|---|---|---|
| Total sample (n) | | | 83 | 46 |
| Age (mean ±SD) | | | 7.9 ±4.1† | 7.9 ±3.8 |
| Gender (%) | Girls | | 41 (49.4%) | 25 (54.3%) |
| | Boys | | 42 (50.6%) | 21 (45.7%) |
| Distance travelled to reach the clinic in Km (mean ±SD) | | | 34.4 ±31.2 | 19.8 ±23.6 |
| Type of tooth causing problem (%) | Primary | | 45 (55.6%) | 24 (63.2%) |
| | Permanent | | 36 (44.4%) | 14 (36.8%) |
| Kind of tooth causing problem (%) | Front | | 24 (29.6%) | 10 (26.3%) |
| | (Pre)Molar | | 57 (70.4%) | 28 (73.7%) |
| New patient (%) | No | | 71 (85.6%) | 29 (63%) |
| | Yes | With referral | 6 (7.2%) | 5 (10.9%) |
| | | No referral | 6 (7.2%) | 12 (26.1%) |
| $d_3mft/D_3MFT$ (mean ±SD) | $d_3mft$ | | 4.9 ±3.6 | 4.1 ±3.4 |
| | $D_3MFT$ | | 2.1 ±3.8 | 2.1 ±3.8 |
| $d_3t/D_3T$ (mean ±SD) | $d_3t$ | | 2.0 ±2.8 | 2.6 ±3.2 |
| | $D_3T$ | | 0.8 ±1.4 | 1 ±1.6 |
| Pre-existing medical condition (%) | Yes | | 9 (10.8%) | 7 (15.2%) |
| | Healthy | | 74 (89.2%) | 39 (84.8%) |

† Excluding a 28-year-old patient from the calculation of age range.

## 5.2 Reasons for seeking emergency dental treatments

In the lockdown period in 2020, 87 main complaints were reported by 83 patients as 4 patients (4.8%) re-attended the clinic due to recurring pain after initial treatment. The main cause of seeking emergency care was plaque-induced gingivitis and other oral mucosal clinical conditions (e.g., eruption problems; n=23; 26.4%), followed by dental caries (without spontaneous pain; n=18; 20.7%). Besides the chief complaint, 10 (non-related) minor complaints were reported by 9 patients, which included space maintainer problems (n=3; 30%), oral mucosal clinical condition (n=1; 10%), and reversible pulpitis due to the presence of an active carious lesion (n=6; 60%). On the other hand, in the comparator cohort from 2019, 47 main complaints were reported by 46 patients (one patient re-attended the clinic due to recurring pain). The main reason for pursuing an emergency treatment was irreversible pulpitis (causing pain; n=12; 25.5%), followed by dental caries (without spontaneous pain; n=11; 23.4%). The distribution of the chief complaints for the two cohorts is presented in Table 2.

Table 2: Reason of seeking dental emergency care in the lockdown period in 2020 and the comparator cohort from 2019

| **Reasons for dental emergency** | **Lockdown cohort 2020 (%)** | **Comparator cohort 2019 (%)** |
|---|---|---|
| Plaque-induced gingivitis, or other oral mucosal clinical conditions | 23 (26.4%) | 9 (19.1%) |
| Dental caries (including half-way or deep lesions with asymptomatic pulp or reversible pulpitis) | 18 (20.7%) | 11 (23.4%) |
| Irreversible pulpitis or necrotic pulp | 17 (19.5%) | 12 (25.5%) |
| Traumatic dental injuries | 10 (11.5%) | 6 (12.8%) |
| Odontogenic infection conditions | 7 (8.1%) | 7 (14.9%) |
| Space maintainer complaints | 7 (8.1%) | 2 (4.3%) |
| Restoration loss (causing pain or discomfort) | 5 (5.7%) | 0 (0%) |
| **Total** | **87 (100%)** | **47 (100%)** |

## 5.3 Treatment outcomes

In the 2020 cohort, a total of 118 treatment procedures were performed, of which 101 (85.6%) for treatment of chief complaints, while 17 procedures (14.4%) were required for follow-up appointments or for minor complaints. In general, MITs such as NRCC, SDF application or the HT were the most common implemented treatment modalities (n=24, 20.3%), followed by pharmacological treatment (n=20, 16.9%). Procedures which required aerosol generation such as dental fillings (n=8, 6.8%) or pulp therapy (n=5, 4.2%) were less frequently performed.

In the comparator cohort from 2019, 64 treatment procedures were required. MITs (e.g., NRCC or SDF) were not used, while pharmacological management of pain was the most common treatment modality (n=23, 35.9%). The results for both cohorts are presented on Figure 5.

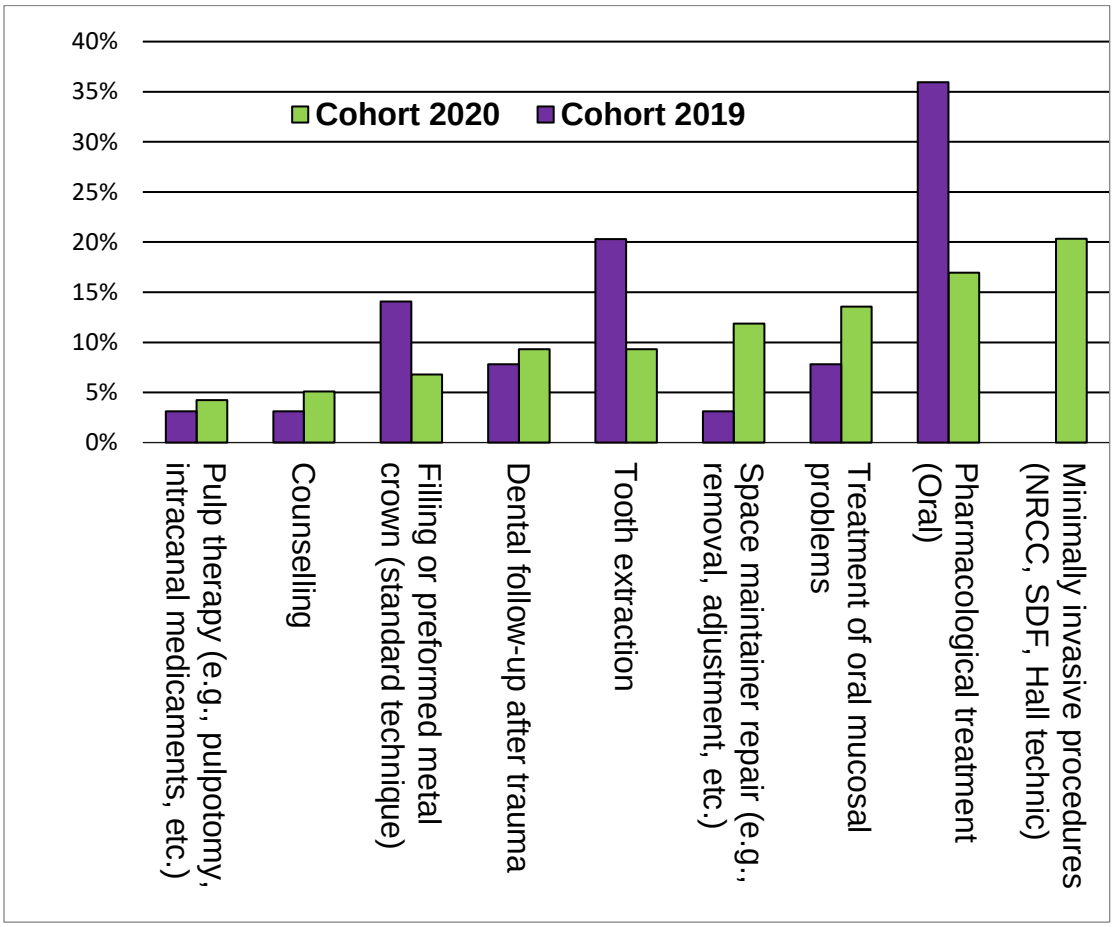



Figure 5: Treatment procedures performed on children seeking emergency dental care in lockdown period in 2020 and the comparator cohort from 2019.

## 5.4 Other variables on the session level

For the cohort 2020, telemedicine was used in five cases (4.9%), three of these digitally sent photos with the teeth/oral situation to the dentists. The reported clinical diagnosis in these cases were cavitated carious lesion (irreversible pulpitis; n=1), odontogenic infection (with facial swelling; n=2), and Early Childhood Caries (ECC) without spontaneous pain (n=2). The two ECC cases received oral hygiene and dietary counselling, including the use of fluoridated toothpaste (1000 ppm F) to support carious lesion arrest. For the other three cases pharmacological treatment was recommended, and a prescription was sent electronically directly to patients and pharmacies. Parents of children were advised to contact the clinic in about one week or if symptoms persisted with no improvement at the short-term.

Radiographs in the lockdown cohort in 2020 (n=21) were required for 18 patients (21.7% of all patients). In two cases, a combination of panoramic and periapical radiograph was made, and in one other case two periapical radiographs were necessary. On the other hand, in the comparator cohort from 2019, 20 x-rays were made on 18 patients (39.1% of all patients), In one case, a combination of panoramic and periapical radiograph was made, and in one other case two periapical radiographs were necessary.

Consultation with the oral surgery department for both cohorts was needed in one case from each cohort. The case of 2020 was a severe dental trauma, while the case of 2019 was a severe odontogenic infection.

Comparing both cohorts, there were no significant differences in the prescription of pharmacological treatment (p=0.081), utilization of local anesthesia (p=0.313), provision of x-rays for diagnosis (p=0.091), or treatment setting (excluding GA, on account of unavailability in the 2020 cohort; p=0.547). Patient behavior differed between cohorts, with more patients presenting a positive behavior in the 2019 cohort (72%) as compared to 2020 (46.1%; p=0.090).

An overview of the variables on the session level for both cohorts can be seen in table 3.

Table 3: Overview of the variables on the lockdown period in 2020 and the comparator cohort from 2019

| Variable | | Lockdown cohort 2020 | Comparator cohort 2019 |
|---|---|---|---|
| Local anesthesia | | 19.8% (20 sessions) | 25% (15 sessions) |
| Treatment setting | Chairside | 89.2% (90 sessions) | 88.4% (53 sessions) |
| | Nitrous oxide | 5.9% (6 sessions) | 8.3% (5 sessions) |
| | General anesthesia | 0% (no session) | 3.3% (2 sessions) |
| | Telemedicine | 4.9% (5 sessions) | 0% (no session) |
| X-rays | Required | 21.7% (18 patients) | 39.1% (18 patients) |
| | Available | 32.5% (27 patients) | 26.1% (12 patients) |
| Type of x-ray | Panoramic | 66.7% (14 x-rays) | 65% (13 x-rays) |
| | Periapical radiographs | 33.3% (7 x-rays) | 35% (7 x-rays) |
| Pharmacol-ogical treatment | Total cases | 16.9% (20 cases) | 35.9% (23 cases) |
| | Antibiotics with/without pain killers | 65% (13 cases) | 34.8% (8 cases) |
| | Prescription of analgesic/anti-inflammatory drugs | 15% (3 cases) | 17.4% (4 cases) |
| | Recommendation of analgesic/anti-inflammatory drugs | 20% (4 cases) | 47.8% (11 cases) |
| Level of cooperation | Documented | 27% (26 session) | 41.7% (25 sessions) |
| | Definitely positive or positive | 46.1% (12 sessions) | 72% (18 sessions) |
| | Definitely negative or negative | 53.9% (14 sessions) | 28% (7 sessions) |

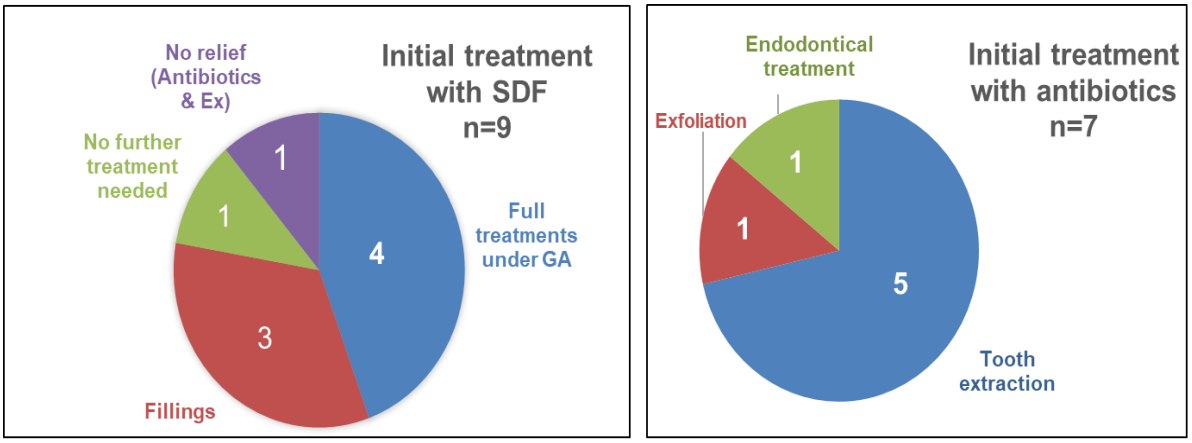
## 5.5 Evaluation of the management of dental emergencies with NAGPs provided in the lockdown period

For this analysis, only patients who received NAGPs due to a dental emergency during the lockdown period were included (n=22). Retrospective data collection of baseline treatments and a 6-months follow-up was performed (Figure 6).

The treatments of 22 patients (mean $d_3$mft 5.75 ±3.07 / mean $D_3$MFT 2.22 ±2.9) were categorized according to the clinical diagnosis: Category I (n=10; 45.5%, mean age 4 ±2.6) included patients with active carious lesions (ICDAS 3-5) and reversible pulpitis, mainly ECC. Nine out of ten patients (90%) were treated with SDF, and one (10%) with the HT.

In the SDF-treated patients, one patient presented shortly after with pain and was medicated. The other 8 cases presented no complications during the follow-up period and affected teeth were later either restored or left with no restoration.

Category II included teeth with irreversible pulpitis or facial swelling of dental origin (e.g., submucosal abscess; n=12; 54.5%; mean age 8.3 ±3.6). Treatments provided were extraction (n=5; 41.7%), or antibiotics prescription (n=7; 58.3%) of whom five patients received extraction after the lock-down with no patient having recurrence of pain. In one case the primary tooth exfoliated and in another case endodontic treatment was provided later-on.




Outcome after 6 months for patients treated initially with SDF

Outcome after 6 months for patients treated initially with antibiotics

Figure 6: Outcome of the initially performed NAGPs in the lockdown period in 2020 with SDF and antibiotics after 6 months of follow up.

# 6 Discussion

Dental emergencies, particularly in pediatric populations, remain prevalent even in times of COVID-19, and clinicians are faced with the complex task to deliver safe dental care while limiting the contact of clinicians and staff to patients, and also to ideally offer long-term solutions for dental emergencies. This non-interventional, retrospective, comparative study aimed mainly to analyze the profiles of pediatric patients treated due to dental emergencies during a COVID-19 lockdown in a pediatric specialized university clinic in Germany, and to analyze the offered management options for these children, as well as to compare these outcomes with results from a cohort of children treated in the same period of time in 2019 under regular conditions before the COVID-19 pandemic.

## 6.1 Change in profiles of pediatric patients seeking emergency dental treatments in the lockdown period

The main findings of the present study showed that the number of patients seeking emergency dental treatments in 2020 was almost doubled in comparison to 2019 (n=83 vs. n=46, respectively). This agrees with a similar study analyzing dental emergencies during the lockdown period in 2020 in India compared to the same period of time in 2019, where the percentage of ‘’emergency’’ visits was also almost doubled in 2020 compared to 2019 [Samuel et al. 2021]. Similarly, the mean distance travelled by patients to reach the dental clinics in 2020 was almost two times further than the mean distance in 2019 (34.4 km vs. 19.8 km, respectively). Certain aspects might have caused this difference, one of which is that a substantial number of private dental clinics were closed during the lockdown period or were not able to treat patients due to the limited availability of necessary (recommended) PPE. Consequently, patients were referred or went directly to university and hospital clinics. This could explain the increased number of new patients who visited the university dental clinics, despite the fact, that the university dental clinics in Greifswald were open mainly for emergency treatments of regular patients. On the other hand, there is some evidence showing that during the COVID-19 pandemic young children presented often higher self-perceived dental pain, and caregivers have had greater parental distress and fear for their

children [Samuel et al. 2020]. This may possibly have led parents to seek emergency dental treatment with any small signs of dental discomfort or mild pain. Moreover, kindergartens and schools were closed in the lockdown period, and a large group of caregivers worked from home, which provided them greater chance to detect any symptomatic or acute dental problem at an early stage. These reasons would also explain the higher proportion of patients in the cohort of 2020 seeking emergency dental treatments due to oral mucosal problems or with space maintainer complaints, which might have not been considered as an acute emergency case with immediate treatment need before the lockdown.

Dental caries into dentin causing pain (on stimuli) contributed to 20.7% of the dental emergency visits in 2020 compared to 23.4% in 2019. This agrees with a similar study from Italy regarding visits of pediatric patients to the emergency room in a children hospital during the lockdown in 2020 compared to 2019 [Carmagnola et al. 2022]. Such a high proportion of dental caries related emergency visits emphasizes the necessity for early management of dental caries in pediatric dentistry and the importance prevention of caries even at very young age.

Overall, the general characteristics of the patients in both cohorts, such as age, gender, mean $d_3$mft/$D_3$MFT, type of tooth causing pain, or pre-existing medical conditions showed no significant differences between the two included cohorts.

## 6.2 Change in treatment modalities of pediatric dental emergencies in the lockdown period

The novel SARS-CoV-2 was detected in the saliva of infected persons [To et al. 2020]. Although some studies reported, that the virus existing in saliva was not detected in generated aerosols during dental treatments [Meethil et al. 2021], it cannot be ruled out, that these aerosols may potentially contain the SARS-CoV-2 from saliva of the infected patient. Thus, aerosols can be considered hazardous for dental workers during the COVID-19 pandemic. Some dental procedures such as caries removal with high-speed burs or the use of ultrasonic scaling are reported to produce significant amount of aerosol compared to other dental treatments [BaniHani et al. 2020, Kun-Szabo et al. 2021]. The risk of transmission of the SARS-CoV-2 in the dental practice was therefore considered high, but a total closure of all dental practices would be

unethical, which meant some dentists had to overtake the responsibility and switch from a patient-centered to a community-centered paradigm to perform dental emergency treatments [Ritwik et al. 2021]. While some interventions could be easily postponed in times of increased risk of COVID-19 infection, other treatments especially for children cannot be longer delayed. Teeth having deep caries with pulpal involvement require an endodontic treatment or should be extracted, with the extraction being more advantageous in times of a pandemic and high risk of infection transmission especially if the compliance of the child is not sufficient for a longer session of pulpectomy. For this reason, the dental extraction predominated in the previously mentioned Indian study group in the 2020 lockdown period compared to a similar period of time in 2019, where pulpectomy was more performed [Samuel et al. 2021]. In our study group, pulp treatment in primary and permanent teeth represented only 4.2% of all dental emergencies treated in 2020, and without significant differences compared to the cohort of the previous year. This difference between our results and the previously mentioned Indian study, is due to the direction of management of such cases in our cohorts towards pharmacological therapy (17% in 2020 and 36% in 2019), with no significant differences between the groups ($p>0.05$). The prescription of medicaments (analgesics/anti-inflammatory, antibiotics, or in combination) shows great advantages in pediatric dentistry, especially if the patients as in our cohorts live far away from the dental clinic, where a prescription can sometimes be sent per post (Telemedicine). Moreover, a great proportion of our patients has poor compliance and require more appointments and preparation before achieving invasive dental procedures such as a tooth extraction. A recent study from Saudi Arabia regarding the characteristics of pediatric dental emergencies during the COVID-19 pandemic also showed an increase use of medication to manage localized dental abscess and caries deep into the pulp during the lockdown [Alzahrani et al. 2021]. Since reports in the literature advocate the use of pharmacological therapy as an initial treatment of acute dental emergencies in pediatric dentistry, as well as for the initial management of such cases with non-compliant patients [AAPD 2020, Paudel et al. 2010], it should be considered as the foremost treatment approach during the COVID-19 pandemic, especially in times of lockdown or in areas with increased incidence of the virus, because aerosol generating treatments should be in such situations minimized or possibly avoided.

However, dental caries with pulpal involvement is not the only problem that should be managed as soon as possible, management of deep dental caries with no pulpal involvement especially if starting to cause pain on stimuli should also not be postponed, as it might progress rapidly to pulpal involvement and cause spontaneous pain [Luo et al. 2021]. Early treatment of carious lesions presenting without irreversible pulp involvement does not always require tissue removal, and modern MITs are proven to be effective in arresting the progression of carious lesions and should be therefore considered [Mallineni et al. 2020, Sales et al. 2021], especially during the COVID-19 outbreak [Al-Halabi et al. 2020, Cagetti et al. 2021]. In a randomized clinical trial comparing NRCC (opening-up the cavity and applying fluoride varnish) and HT with conventional restorations in primary teeth with occluso-proximal caries; NRCC showed a similar survival rate as the conventional restoration (70.5% and 67.2%, respectively; $p>0.05$), while the HT showed significantly better results (92.5%) [Santamaría et al. 2018]. Even without the problem with aerosols and the COVID-19 pandemic, recent systematic reviews are emphasizing the benefits of MITs in caries management in pediatric dentistry due to economic factors as well as the possibility to apply them even with limited compliance of the child. For these reasons, MITs should be considered a mainstream option rather than a compromise option in pediatric dentistry, especially if costs or cooperation are problematic [Ferreira et al. 2012, BaniHani et al. 2021].

Despite their effectiveness, MITs like NRCC, SDF application, or the HT are not generally considered for emergency dental treatment. Our findings from the 2019 cohort confirm this statement with zero treatments provided under this modality. However, in situations of limited capability for providing the standard treatment, these management options were considered for carious process control, as in our findings from the 2020 cohort, where MITs were very common. This difference could be attributed to the non-aerosol generation privilege of MITs, which is considered a valuable asset in the times of an aerosol transmissible disease outbreak.

Three of the 13 patients (23%) who received antibiotic prescription in the 2020 cohort had counselling via telemedicine. This highly dynamic diagnostic option provides a reasonably fast opportunity for diagnosis and decision-making, saves transport costs for children/caregivers to dental clinics, and most importantly limits the contact and potential infection transmission between patients/caregivers and the dental team during the COVID-19 outbreak [Hollander et al. 2020, Portnoy et al. 2020]. In addition,

telemedicine offers the possibility to provide oral hygiene and dietary counselling to patients without direct patient-clinician contact. Our 2020 cohort records showed that two patients (2.4% of all patients in 2020) contacted the clinic due to ECC (without spontaneous pain) and were provided with specific oral hygiene counselling focused on biofilm disturbance, fluoridated toothpaste use (>1000 ppm F), as well as diet advice in order to promote caries arrest also per telemedicine without patient-clinician contact. Even before the outbreak of the COVID-19 pandemic, a systematic review in 2018 showed evidence of the benefits of telemedicine mainly in cost effectiveness, especially in pediatric dentistry [Estai et al. 2018]. In the COVID-19 Pandemic and lockdown periods, more evidence is emerging supporting telemedicine an essential tool for delivering health care and services at-a-distance minimizing unnecessary contact with patients [Hollander et al. 2020, Portnoy et al. 2020].

It is well known that intraoral x-rays are the most commonly used and available radiographs in dental practices; however, their use can stimulate salivary secretion and consequently evoke coughing, inevitably generating undesirable excess of aerosol [Vandenberghe et al. 2010]. Therefore, the use of extraoral radiographs for diagnostic purposes should be preferred during the COVID-19 pandemic [WHO 2020d]. Moreover, the use of panoramic radiographs is being increasingly used in pediatric dentistry, probably due to the possibility to check the permanent teeth germs and detect teeth aplasia. However, more studies are still required in order to proof the accuracy of panoramic radiographs in pediatric dentistry and produce clinical guidance [Timms et al. 2021]. In this study, the most common radiograph used was the panoramic radiograph (66.7%). In these cases, the possibility of aerosol production could be minimized, and the underlying tooth/teeth and adjacent (carious) teeth could be assessed. In the 2020 cohort, more than half of the performed periapical radiographs (57.1%) were done in cases of dental trauma to achieve a more precise assessment.

Our results showed that $N_2O$-$O_2$ sedation was used for four patients (six sessions in total; 5.9%) in the 2020 cohort. The use of $N_2O$-$O_2$ sedation has been reported to be effective and safe in pediatric dentistry [Ferrazzano et al. 2020]. Due to the exceptional situation, treatments under GA were cancelled due to the prioritization of medical staff, who were assigned to respond to possible medical emergencies. Therefore, in cases when additional behavior management techniques were required, $N_2O$-$O_2$ sedation

showed to be highly useful and effective, causing no extra risks of SARS-CoV-2 transmission in the dental setting as gases are exchanged via a nasal mask in a closed breathing circuit. However, choosing the appropriately sized nasal mask is crucial for providing a good nasal seal [Yee et al. 2019], and hence reduce the risk of SARS-CoV-2 transmission. Moreover, the risk burden can be further reduced by using a rubber dam and an extra-oral suction system [Namineni et al. 2020].

## 6.3 Benefit of NAGPs in a pandemic

The follow up of the NAGPs emergency dental treatments, that were performed in the lockdown period revealed a great benefit in reducing the risk of the exposure to aerosols, and thus the risk of infection transmission of the SARS-CoV-2 in the dental practice. Thus, it can be concluded, that NAGPs are viable options for managing caries related emergency cases in pediatric dentistry and are advantageous to postpone the need of an immediate treatment in case of high risk of infectious transmission.

## 6.4 A look in the future of pediatric dentistry in the COVID-19 pandemic

After many years in a pandemic and outstanding challenges in all aspects of life with huge losses in the lives of people and on the economic level as well, the humanity has managed to overcome the difficulties and learned to adapt to the life with the SARS-CoV-2. Although a great proportion of dentists would still consider dental treatments in the COVID-19 pandemic risky and feel themselves despite proper PPE not protected [Khoury Absawi et al. 2022], the great majority of dentists are resuming their daily practice on a regular basis. Our experience showed, that dentists got infected with SARS-CoV-2 mostly due to contact to infected persons in private occasions and not during dental treatments. However, there are in the meantime many published papers stating recommendations for the post lockdown period in order to minimize the risk of transmission of the SARS-CoV-2 in dentistry and especially in pediatric dentistry. Following are some of the most recommendations found in the literature [Al-Halabi et al. 2020, Paglia 2020]:

- Minimization of the use of AGPs and the air syringe.
- Case-based selection of biological, non-invasive or minimally invasive methods.

- During procedures that generate aerosols, the use of proper PPE to minimize the risk of transmission.
- The use of double suction and a rubber dam, if possible.
- Organize the appointments schedule possibly in categories for AGPs and NAGPs.
- Organize the treatment times of patients to reduce contact of patients in the waiting room.

# 7 Conclusions and recommendations

- Our results confirm a lockdown-related change in the profiles of pediatric patients who sought emergency treatment, as well as a change in the management options of such patients in a specialized pediatric dental center in university clinic.
- The lockdown period in 2020 due to the widespread of SARS-CoV-2 led to a change in the patient's profiles of children seeking emergency dental treatments, resulting in more visits with less acute treatment need compared to previous years.
- Counselling in cases of pediatric dental emergency per telemedicine is a very useful option to minimize the unnecessary contact to patients.
- The use of pharmacological treatment when applicable is encouraged to postpone interventions until the high risk of SARS-CoV-2 transmission is minimized.
- NAGPs are viable options for managing caries related emergency cases in pediatric dentistry and are advantageous to postpone the need of an immediate treatment in case of high risk of infection transmission.

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# 9 Publication

This work is published in the international peer-review journal *Quintessence international* (journal impact factor 2021: 1.677).

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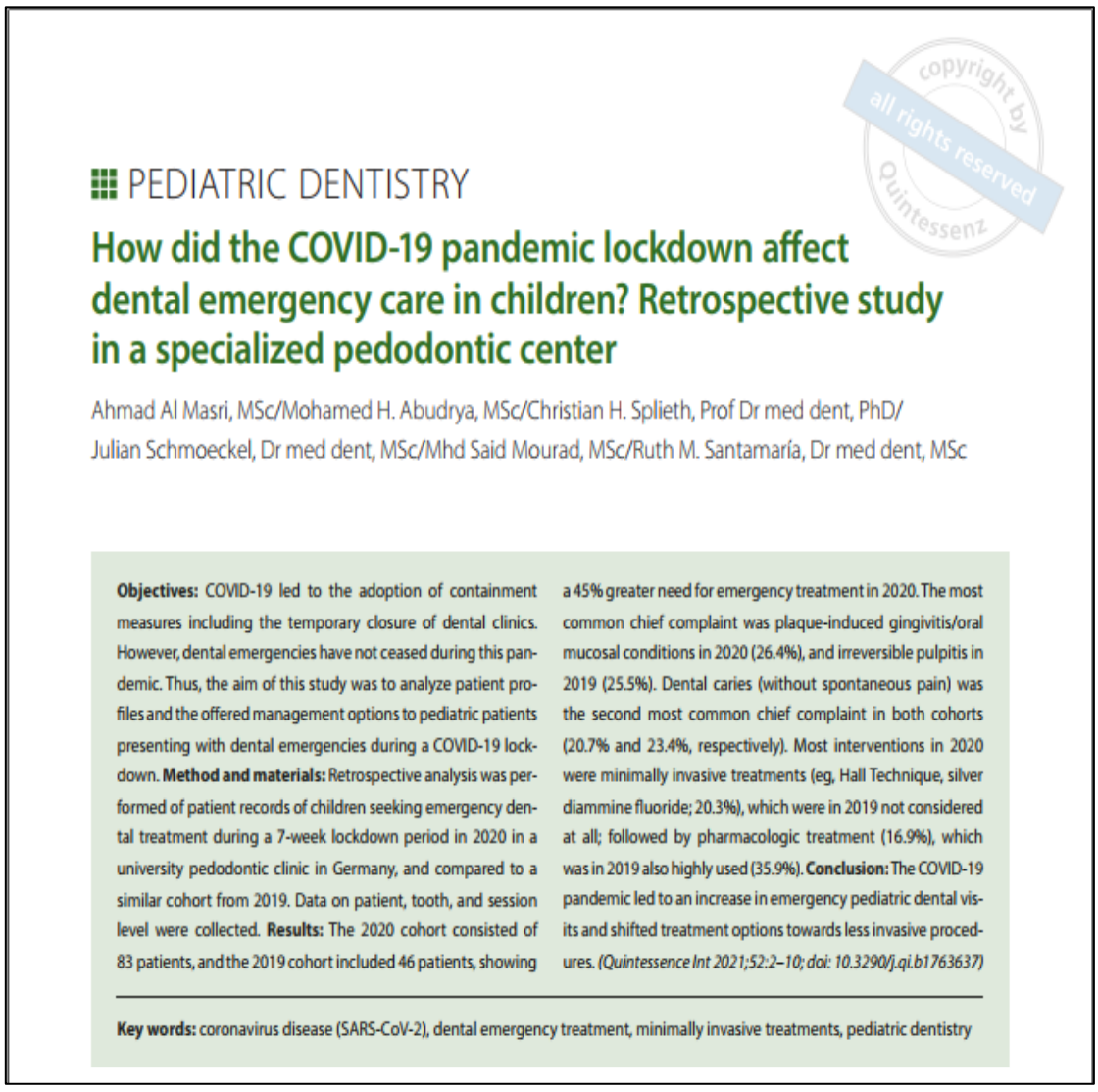



PEDIATRIC DENTISTRY

## How did the COVID-19 pandemic lockdown affect dental emergency care in children? Retrospective study in a specialized pedodontic center

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**Objectives:** COVID-19 led to the adoption of containment measures including the temporary closure of dental clinics. However, dental emergencies have not ceased during this pandemic. Thus, the aim of this study was to analyze patient profiles and the offered management options to pediatric patients presenting with dental emergencies during a COVID-19 lockdown. **Method and materials:** Retrospective analysis was performed of patient records of children seeking emergency dental treatment during a 7-week lockdown period in 2020 in a university pedodontic clinic in Germany, and compared to a similar cohort from 2019. Data on patient, tooth, and session level were collected. **Results:** The 2020 cohort consisted of 83 patients, and the 2019 cohort included 46 patients, showing a 45% greater need for emergency treatment in 2020. The most common chief complaint was plaque-induced gingivitis/oral mucosal conditions in 2020 (26.4%), and irreversible pulpitis in 2019 (25.5%). Dental caries (without spontaneous pain) was the second most common chief complaint in both cohorts (20.7% and 23.4%, respectively). Most interventions in 2020 were minimally invasive treatments (eg, Hall Technique, silver diammine fluoride; 20.3%), which were in 2019 not considered at all; followed by pharmacologic treatment (16.9%), which was in 2019 also highly used (35.9%). **Conclusion:** The COVID-19 pandemic led to an increase in emergency pediatric dental visits and shifted treatment options towards less invasive procedures. *(Quintessence Int 2021;52:2–10; doi: 10.3290/j.qi.b1763637)*

**Key words:** coronavirus disease (SARS-CoV-2), dental emergency treatment, minimally invasive treatments, pediatric dentistry

# 10 Affirmation statement

I hereby declare that I have written this dissertation independently and have not used any auxiliary materials other than those indicated.

The dissertation has not yet been submitted to any other faculty or scientific institution.

I declare that I have not yet unsuccessfully completed any doctoral procedure and that there has been no withdrawal of a doctoral degree already acquired.

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## Eidesstattliche Erklärung

Hiermit erkläre ich, dass ich die vorliegende Dissertation selbständig verfasst und keine anderen als die angegebenen Hilfsmittel benutzt habe.

Die Dissertation ist bisher keiner anderen Fakultät, keiner anderen wissenschaftlichen Einrichtung vorgelegt worden.

Ich erkläre, dass ich bisher kein Promotionsverfahren erfolglos beendet habe und dass eine Aberkennung eines bereits erworbenen Doktorgrades nicht vorliegt.

…… ……

Ort, Datum Unterschrift

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