BRAZ J INFECT DIS. 2021;xxx(xx):xxx–xxx

The Brazilian Journal of
INFECTIOUS DISEASES

www.elsevier.com/locate/bjid

Original Article

Effect of work environment and specialty degree of dentists on cross-infection control in COVID-19 pandemic

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ARTICLE INFO

Article history:
Received 5 March 2021
Accepted 5 May 2021
Available online xxx

Keywords:
COVID-19
Dentists
SARS-CoV-2
Infection control
Attitude to Health

ABSTRACT

Objectives: The aim of this study was to evaluate the effect of the work environment and expertise/specialty degree of dentists on their behavior, awareness, and attitudes regarding cross-infection control during the COVID-19 pandemic.

Design: The study population consisted of Turkish dentists who work in private clinics, public clinics, and university hospitals. The demographic information of the participants, their awareness of the COVID-19 acute respiratory disease, and clinical measures taken against cross-infection were evaluated with an online survey. Between the 10th and 20th of November 2020, 2,400 surveys were e-mailed to dentists.

Results: A total of 454 professionals answered the survey. According to the results, 29.3% of the participants performed only urgent care during the pandemic period, whereas 59.9% of them performed both urgent and routine treatments. Among the responding dentists, 90.6% stated that they were worried about aerosol-generating dental procedures, but there was no differences between genders ($p = 0.119$). Most participants, especially specialists ($p = 0.160$), applied strict cross-infection control methods during the COVID-19 pandemic (77.2%). These dentists used personal protective equipment (PPE) at rates that varied between 75.5% and 98.4%. Nonetheless, the rate of PPE use was different between genders and degrees of expertise: women used PPE more frequently than men ($p = 0.025$), and specialists used PPE more often than the other dentists ($p = 0.04$). Finally, there was a weak positive correlation between the level of PPE use and expertise ($r = 0.121$; $p = 0.010$).

Conclusions: Despite the overall knowledge of the participants regarding COVID-19 symptoms, transmission routes, and the guidelines needed to prevent the virus from spreading, the dental specialists followed infection control methods more strictly. Even though the participants were concerned about dental practices that create microbial aerosols during the pandemic period, they continued their clinical routines using high PPE levels and taking extra clinical precautions to avoid cross-infection.

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https://doi.org/10.1016/j.bjid.2021.101592

Please cite this article as: M. Mutluay and E. Egil, Effect of work environment and specialty degree of dentists on cross-infection control in COVID-19 pandemic, Brazilian Journal of Infectious Diseases (2021), https://doi.org/10.1016/j.bjid.2021.101592

Introduction

In late December 2019, several patients with viral pneumonia were epidemiologically associated with a seafood market in Wuhan, China. The identified coronavirus that caused the infections was designated as "2019 novel coronavirus" (COVID-19) using next-generation sequencing.[1,2] The infection by COVID-19, confirmed by droplet transmission and human-to-human transmission, is a significant public health problem, with 88 million reported infection cases and over 1.9 million deaths globally.[3,4] COVID-19 uses the angiotensin-converting enzyme II (ACE2), which is an enzyme and a cell entry receptor to invade the host cells.. The typical clinical symptoms of infected patients are fever, dry cough, dyspnea, headache, and pneumonia. The progression of the disease may result in respiratory failure, pneumonia, alveolar damage, and even death.[5]

Aerosols are suspensions of liquid or solid particles containing all kinds of microorganisms and are responsible for the airborne transmission of microorganisms.[6,7] Aerosols consist of small particles called droplet nuclei (1–5 μm) or droplets (> 5 μm). Aerosols can contaminate surfaces in a range of one meter and form a potential infection route in the lungs because they can penetrate the alveoli.[7,8]

Cross-contamination is the spreading of pathogens from one source to another through direct patient-to-patient contact, patient-to-clinical staff contact, or droplet transmission. The conjunctival, nasal, or oral mucosa from infected people produces droplets and aerosols containing microorganisms.[8,9] Dentists are at a high risk of cross-contamination due to frequent direct or indirect contact with dental instruments and surfaces contaminated with aerosols, blood, and saliva.[10] Aerosols containing microorganisms in the oral cavity of the patient are created when high-speed handpieces and air/water sprays are used in dental procedures Aerosols[11,12] emitted into the air from high-speed handpieces used during caries removal or composite resin polishing increase the cross-contamination risk for dentists. Tooth preparation, removal of old fillings, debonding or removal of orthodontic composite remnants, scaling with a dental ultrasonic scaler, and oral prophylaxis are procedures that carry a cross-contamination risk.[11,13] However, the infectious character of aerosols produced in dental procedures depends on the virulence dose, the pathogenicity of the microorganism, and the contaminated contents of the patient, such as plaque, blood, calculus, and saliva.[14,15]

According to the American Dental Association (ADA), the practice of the dental profession during the COVID-19 pandemic poses a unique challenge due to the high amount of aerosols and droplets produced, which are inevitable during routine dental procedures.[16] Therefore, effective infection control strategies are needed to prevent the spread of COVID-19 during dental procedures.[9] For this purpose, the American Centers for Disease Control and Prevention (CDC) recommends the performance of additional infection prevention, control procedures, and standard clinical practices during the COVID-19 pandemic. Such extra clinical precautions, which should be applied to all patients and not only to those with suspected or confirmed COVID-19 cases, can prevent the spread of microbial aerosols and the contamination of dental equipment and materials. [17,18]

The aim of this study was to evaluate the effect of the work environment and expertise/specialty degree of dentists on their behavior, awareness, and attitudes regarding cross-infection control during the COVID-19 pandemic.

Methods

Sample size

The study population consisted of Turkish dentists who worked in private, public clinics, and university hospitals. The sample size required for the study was calculated based on the total number of dentists (34,045) in Turkey. With a 95% confidence interval, the power analysis estimated that 384 or more people should be involved. The Ethics Committee of the Istanbul Gelisim University approved the study protocol (ethical approval number: 2020/29).

Survey instrument

The study questionnaire consisted of two parts and contained 20 closed-ended questions. The first part of the questionnaire aimed to learn the demographic characteristics of the participants (i.e., sex, age, work experience, workplace profile). The second part of the questionnaire aimed to evaluate the awareness of the participants about COVID-19 and clinical precautions against cross-infection based on the "COVID-19 infection control guidelines" published by the CDC.[17] Experts previously examined the content adequacy of the questionnaire to evaluate the construct validity of the questions.

As a first pilot evaluation, the questions were sent to five dentistry specialists (two pediatric dentists, a restorative dentistry specialist, a statistician, and a general dentist). The questionnaire was revised according to the suggestions made by the experts. Two experts (a pediatric dentist and a restorative dentistry specialist) retested the questionnaire to check whether they were consistent with semantics and conceptual framework. After a language suitability review by a Turkish language expert, the questionnaire was created with Google Documents and directed to dentists by e-mail. The e-mail announced that participation was voluntary and that the personal data would remain confidential. The study was designed and implemented under the Helsinki Declaration.

Statistical analysis

The survey results were analyzed with descriptive statistics, such as total numbers and percentages. The data were analyzed using IBM ® SPSS ® (version 24.0; IBM, Chicago, IL, USA). The mean, standard deviation, range, and frequency of the variables were calculated. Pearson a chi-square analysis was used for the crosstab of variables. The Spearman's rank correlation test was used to evaluate the correlation between gender, specialty, and attitudes of the dentists toward cross-infection. A p-value of <0.05 was considered statistically significant.

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Results

Between November 10th and 20th, 2020, 2,400 questionnaires were e-mailed to the dentists, and 454 of them returned their responses, indicating a response rate of 18.9%. The demographic data revealed that 41% of the study population were aged < 30 years, 39.2% were aged between 31–40 years, and 19.8% had > 40 years. A total of 67.8% of the participants were female (Table 1).

In terms of professional experience, 33.5% of participants had > 10 years, 33.5% had 5–10 years, and 33% had approximately five years of professional experience. A large proportion of participants (51.8%) were either general dentists, dental specialists (32.4%), or post-graduate students (15.6%). A total of 46% of the respondents worked in private clinics, 22.9% in public clinics, and 31.1% in university hospitals (Table 1).

Of all the respondents, 81.9% indicated that they followed the current developments regarding COVID-19, and 74.2% followed the guidelines and recommendations published by national or international authorities regarding the COVID-19 pandemic. There was no statistically significant difference between the responses given by men and women ($p = 0.374$, $p = 0.974$, respectively) or between specialists and other dentists ($p = 0.061$, $p = 0.137$, respectively). Around 5.7% of the participants had symptomatic COVID-19 infection, 2.2% experienced a non-symptomatic infection, 73.5% did not have the disease, and the remaining participants indicated that they were not sure whether they had it or not (Table 2).

Most respondents knew that droplet inhalation (98.2%), nasal mucosa (78.6%), fecal-oral route (26.7%), eye mucosa (74.7%), saliva/blood (54.2%), and contaminated sharp instruments (20.3%) were COVID-19 transmission routes. The knowledge level of specialist dentists about the COVID-19 transmission routes was higher than others ($p = 0.012$). There was no statistically significant difference between the

Table 1 – Description of the demographic and professional characteristics of participants.

Characteristics	N	(%)
Sex		
Male	146	32.2
Female	308	67.8
Age		
<30 yr	186	41
31-40 yr	178	39.2
>40 yr	90	19.8
Experience		
0–5 yr	141	32
5–10 yr	128	29
<10 yr	172	39
Professional Qualification		
General dental practitioner	235	51.8%
Specialist	147	32.4%
Postdoctoral student	71	15.6%
Place of Occupation		
Private clinic	209	46%
Public hospital	104	46%
University hospital	141	31.1%

Table 2 – Dentists' awareness of the COVID-19 pandemic and their answers about cross infection control measures

Question	N	(%)
Do you follow the current developments regarding the Covid-19 pandemic?		
Yes	372	81.9
No	78	17.2
Sometimes	4	0.9
Do you follow the guidelines and recommendations published by national or international authorities on the Covid-19 pandemic?		
Yes	337	74.2
No	26	5.7
Sometimes	91	20
Did your patient evaluation criteria change during the Covid-19 pandemic?		
Yes, I do not treat patients during the pandemic period.	23	5.1
Yes, I am just performing oral examination.	26	5.7
Yes, I only treat emergency patients.	133	29.3
No, I treat both emergency and routine patients	272	59.9
Have you ever been infected with Covid-19?		
Yes, I had the infection symptomatically.	26	5.7
Yes, I had the infection asymptomatically.	10	2.2
No, I did not have the infection.	334	73.6
I am not sure	84	18.5
What are the transmission ways of Covid-19 virus? (multiple choice)		
Droplet inhalation	446	98.2
Nasal mucosa	357	78.6
Fecal-oral route	121	26.7
Eye mucosa	339	74.7
Saliva, blood	246	54.2
Sharp tools	92	20.3
Fecal route	25	5.5
Do you adhere to strict cross infection control measures during the Covid-19 pandemic period?		
Yes	344	77.1
No	78	17.5
Sometimes	24	5.4
Which of the personal protective equipment do you use during the Covid-19 pandemic? (multiple choice)		
Glove	442	98.4
Surgical mask	409	91.1
N95 mask	382	85.1
Bonnet	340	75.5
Visor	411	91.5
Glasses	229	51
Protective clothing	387	86.2
Do you use an antiseptic mouthwash before dental procedures during the Covid-19 pandemic? If so, what is the content?		
No I do not use.	224	50.1
Yes, with chlorhexidine gluconate	68	15.2
Yes, with hydrogen peroxide	102	22.8
Yes, with povidone-iodine content	78	17.4
Yes, with cetylpyridinium chloride	5	1.1
Did you take any extra precautions regarding dental unit care and unit water during the Covid-19 pandemic?		
Yes	145	32.4
No	221	49.4
Not quite sure	81	18.1
Did you take any extra precautions regarding the sterilization of hand and tools during the Covid-19 pandemic?		

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Table 2 (*continued*)

Question	N	(%)
Yes	133	29.8
No	258	57.8
Not quite sure	55	12.3
Are you worried about dental procedures that generate aerosol during the Covid-19 pandemic?		
Yes	405	90.6
No	30	6.7
Not quite sure	12	2.7
Which of the dental procedures that generates aerosol during the Covid-19 pandemic did you discontined? (multiple choice)		
Cleaning tartar with cavitron	187	42.2
Restorative procedures	110	24.8
Endodontic procedures	74	16.7
Orthodontic treatments	74	16.7
Intraoral radiography	64	14.4
Asymptomatic tooth extraction	73	16.5
Esthetic dental procedures	165	37.2
None	207	46.7
Do you use minimally invasive techniques during the Covid-19 pandemic?		
Yes	277	63
No	120	27.3
Sometimes	43	9.8
Do you apply rubber-dam during dental procedures during the Covid-19 pandemic?		
Yes	50	11.2
No	340	76.4
Sometimes	55	12.4
Do you apply an extraoral vacuum during the dental procedure during the Covid-19 pandemic?		
Yes	72	16.3
No	343	77.6
Sometimes	27	6.1
After the Covid-19 pandemic, what measures did you take regarding the clinic waiting room?		
Phone call before appointment	193	43.4
Use of masks in the waiting room	413	92.8
Social distance measures in the waiting room	401	90.1
Availability of hand sanitizer in the waiting room	381	85.6
No magazines, food or drinks in the waiting room	295	66.3
Patients should come with minimum company	385	86.5
During the Covid-19 pandemic period, which ones do you apply regarding clinical assistant personnel?		
Special training course for staff	282	64.7
Monitoring the symptoms of clinical staff	239	54.8
Assistant personnel wear masks in rooms	303	69.5
Social distance measures in the rest rooms of the staff	303	69.5
Use of personal protective equipment	402	92.2

answers provided by female/male participants regarding their knowledge of COVID-19 transmission routes ($p = 0.258$).

Only 5.1% of the participants stated that they did not perform dental procedures during the pandemic, whereas 5.7% stated that they only performed oral examinations. Also, 29.3% of the professionals mentioned that they only performed urgent procedures. Most respondents (77.2%) followed strict cross-infection control methods, and no statistically significant difference among genders ($p = 0.261$) was observed regarding the cross-infection control methods. On the other hand, specialists performed cross-infection controls more strictly than the others did ($p = 0.16$).

The PPE usage rates varied from 75.5% to 98.4% among the participants (Table 2). The rate of PPE usage was higher in females than in their male counterparts ($p = 0.025$) and specialists compared to other dentists ($p = 0.04$). There was a weak positive correlation between the frequency of PPE use and the expertise of the professionals ($r = 0.121$; $p = 0.01$). Among the respondents, 90.6% stated that they were worried about aerosol-generating dental procedures, and no statistical difference between genders was detected ($p = 0.119$). A total of 46.7% of the participants reported that they did not suspend any dental procedures. Of these, 11.3% used a rubber dam and 16.3% used an oral aerosol vacuum during the dental procedures to prevent COVID-19 infections. Still, this difference was not statistically significant between genders ($p = 0.235$) regarding this question. The use rate of rubber dam by general dentists was statistically higher than that of the other professionals ($p = 0.005$). Still, there was no difference regarding the use of the oral aerosol vacuum.

About half of the respondents (49.9%) reported performing antiseptic mouthwashes on patients before the dental procedure. The use of hydrogen peroxide mouthwash by specialists was significantly higher ($p = 0.008$), but no significant difference was observed for other types of mouthwashes ($p > 0.05$).

Extra precautions regarding the dental unit and sterilization of hand instruments were reported by 32.4% and 29.8% of the participants, respectively. Around 92.8% of the participants took precautions toward patients and their relatives/companions in the waiting room, whereas 92.2% took precautions toward the dental staff to prevent contamination.

Discussion

Dental procedures include the use of high-speed handpieces and air/water sprays and other processes that generate droplets and aerosols. Due to the microorganisms that survive in these particles, dental clinics are among the highest-risk environments for cross-contamination and COVID-19 infections.[15,19] Therefore, all dental staff, especially dentists, face cross-infection risk caused by aerosols that can move deeper into their respiratory systems and even the lungs during the COVID-19 pandemic.[8,20] The presence of COVID-19 in the saliva of infected patients poses an additional risk after an aerosol-forming dental procedure.[21] A recent report suggests that coronaviruses associated with severe acute respiratory syndrome can survive in aerosols for at least three hours, even if their infectious potential is reduced.[22] It is necessary to establish and implement cross-infection control criteria according to evidence-based principles during the COVID-19 pandemic to minimize the microbial load of the aerosols produced.[8,19]

This research aimed to evaluate the effect of the expertise/specialty degree of dentists and their work environment on their behavior, awareness, and attitudes toward cross-infection control during the COVID-19 pandemic. The results of

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this questionnaire are crucial for highlighting the transmission prevention strategies by professionals during the COVID-19 pandemic.

The findings of present study suggested that 5.7% of participants reported having had symptomatic COVID-19 infection (Table 2). According to a study conducted in Lombardy, Italy, 4.43% of participants had suffered one or more symptoms referable to COVID-19, and only 2% of dentists were confident in avoiding infection.[23]

The present study determined the knowledge of the participants regarding most common COVID-19 transmission routes was acceptable (76.42%). The awareness of specialist dentists on this question was higher than others (p = 0.012). In a similar study conducted in the Milan region, the awareness of dentists about transmission routes was reported to be 71.82%.[24]

According to Peng et al.[9], as dental professionals play essential roles in preventing the transmission of COVID-19, they should take extra infection control measures during dental practice to prevent person-to-person transmission routes in the clinics. During the COVID-19 pandemic, the first step of the infection control protocol recommended by the ADA[16] and CDC[17] is to evaluate whether the patient is in an emergency or not. Elective and non-emergency procedures should be postponed, and dental treatments should be performed after considering the risk of COVID-19 transmission during the pandemic. Since the pandemic has been present in Turkey since March 2020, this may be the reason why many dentists return to routine dental procedures in this study. As observed in Lombardy and Milan, the European regions where the pandemic causes the most deaths, most dentists continue dental routines by taking preventive measures.[23]

The findings of our study suggested that specialists followed cross-infection control methods during the COVID-19 pandemic more strictly (p = 0.16). Participants from a similar study followed rigorous cross-infection control methods, with rates ranging from 64% to 89%.[24]

The use of PPE against saliva or blood in dental procedures is considered the most crucial preventive strategy as the second step in the infection control protocol.[16,17,25]

In the present study, PPE use rate among the respondents was satisfactory (75.5% - 98.4%). It was found that the PPE use rate was statistically higher in females (p = 0.025) and specialists (p = 0.04) and there was a correlation between expertise and PPE use (r = 0.121; p = 0.01). The most commonly used PPE by Italian dentists were gloves (93.22%), surgical masks (74.56%), glasses/visors (91.28%), headsets (63.75%), and facial filters (58.84%). The PPE use rate among endodontists from the United States was reported to be as follows: N95 masks (83.1%), face shields (58.9%), protective suits (36.8%), and headsets (55.2%).[26]

Adopting professional precautions in dental practices that create microbial aerosols during the COVID-19 pandemic should be considered universally.[19] According to Dawson et al.[20] aerosols produced by rotary instruments can reach all levels of the respiratory tract. Therefore, aerosol-forming procedures, including the use of handpieces, air/water spray, and ultrasonic scalers, should be avoided, or professionals should use PPE during the pandemic to prevent infections.[16,20] According to a study that evaluated the bacterial load in dental treatments, the amount of bacterial load in bioaerosols at a distance of 1.5 m from the oral cavity of the patient was found to be higher than a 1 m distance. Handpiece use significantly decreased contamination at all sampled distances from the oral cavity of the patient (average 970 CFU/m^2/h).[18] According to the results obtained here, near 53.3% of the participants suspended aerosol-generating procedures, whereas 42.2%, 37.2%, and 24.8% stated they suspended oral scaling, aesthetic dental procedures, and restorative procedures, respectively.

Other recommended methods to minimize droplet and aerosol spreading are to apply minimally invasive/atraumatic restorative techniques, a high-powered saliva ejector, and a rubber dam.[17] The rubber dam isolation can reduce airborne particles by up to 70% within a 3-feet diameter from the operational field.[9,27]

The current questionnaire results revealed that 11.3% and 16.3% of the participants preferred rubber dam and oral aerosol vacuum during the dental procedure, respectively. General dentists used the rubber dam at a higher rate than the other dentists (p = 0.005). Although 80% of endodontists from the United States stated concerns about dental procedures, 82% reported that they performed treatments during the pandemic. Most of them used the rubber dam, and 16.9% added the oral aerosol vacuum to their practice.[26]

Mouthwashes containing antimicrobials (i.e.chlorhexidine gluconate, essential oils, povidone-iodine or cetylpyridinium chloride) can be used to reduce the COVID-19 viral load or prevent contamination.[17,25] According to the obtained results, hydrogen peroxide was the preferred mouthwash by 22.8% of dentists, and most of the specialists (38.7%) preferred hydrogen peroxide mouthwash (p=0.008). Koletsi et al.[19] reported using 0.2% tempered chlorhexidine (CHX) before routine ultrasonic scaling resulted in a significant reduction in aerosol-associated bacterial load. Peng et al.[9] suggested that CHX may not effectively kill the COVID-19 virus because it is vulnerable to oxidation, and it is recommended to use an oxidative mouthwash before the procedure.

During the pandemic, attention should be paid to the maintenance of dental units and clinical equipment. One should be aware of the potential risks of contaminated water intake and colonization by pathogenic microbial species.[28] Due to the pandemic, using water filters in dental units, 3–6% hydrogen peroxide disinfection, CHX, or specially designed biofilm removal systems is recommended.[29] Attention should also be paid to the standard maintenance of the dental unit and unit water system. The water quality of the clinic must follow the safe drinking water standards (<500 CFU/mL).[30] Extra-precaution regarding the dental unit and sterilization of hand instruments was reported by 32.4% and 29.8% of the participants. However, routine cleaning and maintenance of autoclaves, air compressors, suction systems, aspirators, radiography equipment, amalgam mixers, and other dental equipment should be meticulously done according to the manufacturer's instructions to decrease cross-infection risks. It is also recommended to use suction systems and aspirators with high suction power and antiseptic agents applied to the water system of the dental units.[28,30] Additionally, COVID-19 has been shown to remain active at room temperature from two hours to nine days and more infectious in 50% relative

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humidity than 30%. Therefore, maintaining a clean and dry environment in the clinic will help reduce COVID-19 persistence.[9]

Providing cross-infection control training to dental staff, maintaining only the required sterile equipment for the dental procedure, maintaining all other materials away from possible contamination in a closed cabinet, and carefully sterilizing contaminated equipment after the procedure are other essential strategies to prevent COVID-19 infections.[17]

When participants were asked about the precautions they had taken regarding dental staff and administrative order, PPE use (92.2%), social distancing measures (69.5%), and providing special courses (64.7%) were reported. According to Table 2, the suggested precautions by the participants to prevent COVID-19 transmission in the waiting rooms include contacting patients by phone before the appointment and questioning about their COVID-19 symptoms (43.3%), using face masks (92.8%), applying social distance (minimum distances of 6-feet) measures (90.1%), using 60% alcohol-based hand sanitizer (85.6%) removing objects frequently touched by clients, removing foods and beverages, and limiting the number of relatives/companions of patients (66.3%).

Conclusion

Although the knowledge of participants about the COVID-19 symptoms, transmission routes, and adherence to the infection prevention guidelines were sufficient, dental specialists must follow infection control methods more strictly. Participants were concerned about dental procedures that create microbial aerosols during the pandemic period, yet they continued to deliver dental care using high PPE levels and took extra clinical precautions to avoid cross-infection by COVID-19. Higher adherence by healthcare professionals to high-level cross-infection methods during dental procedures that generate microbial aerosols will undoubtedly reduce pandemic spreading.

Author Contributions

M.M., design, data analysis, and interpretation, drafted and critically revised the manuscript; E.E. contributed to conception, data acquisition, contributed to analysis and interpretation, critically revised the manuscript; All authors gave final approval and agree to be accountable for all aspects of the work.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

No funding

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Please cite this article as: M. Mutluay and E. Egil, Effect of work environment and specialty degree of dentists on cross-infection control in COVID-19 pandemic, Brazilian Journal of Infectious Diseases (2021), https://doi.org/10.1016/j.bjid.2021.101592

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