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A Review of Aerosol Generation Mitigation in International Dental Guidance

Clare Robertson [a*], *Jan E. Clarkson* [b], *Magaly Aceves-Martins* [a], *Craig R. Ramsay* [a], *Derek Richards* [b], *Thibault Colloc* [c], *on behalf of the CoDER Working Group*

[a] *Health Services Research Unit, University of Aberdeen, Aberdeen, UK*
[b] *School of Dentistry, University of Dundee, Dundee, UK*
[c] *Aberdeen Royal Infirmary, NHS Grampian, Aberdeen, UK*

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ABSTRACT

Introduction: The coronavirus disease 2019 (COVID-19) led to the worldwide closure of dental practices or reduction of dental services. By the end of April 2020, governments and professional organisations were publishing recommendations or guidance for the reopening/restructuring of dental services. The aim of this study was to assess how dental aerosol-generating procedures (AGPs) were defined in international dental guidelines, what mitigation processes were advised, and whether they were linked to COVID-19 epidemiology.

Methods: Electronic searches of a broad range of databases, along with grey literature searches, without language restriction were conducted up to 13 July 2020. Recommendations for the use of face masks and fallow times with patients without COVID-19 were assessed against the deaths per 1 million population in the included countries and country income level using Pearson Chi-squared statistics.

Results: Sixty-three guidance documents were included. Most (98%) indicated that AGPs can be performed with patients without COVID-19 with caveats, including advice to restrict AGPs where possible, with 21% only recommending AGPs for dental emergencies. Face masks were recommended by most documents (94%), with 91% also specifying the use of goggles or face shields. Fallow periods for patients without COVID-19 were mentioned in 48% of documents, ranging from 2 to 180 minutes. There were no significant differences in recommendations for face masks or fallow time in patients without COVID-19 by country death rate ($P = .463$ and $P = .901$) or World Bank status ($P = .504$ and $P = .835$). Most documents recommended procedural or environmental mitigations such as preprocedural mouthwash (82%) and general ventilation (52%). Few documents provided underpinning evidence for their recommendations.

Conclusions: While the amount of high-quality direct evidence related to dentistry and COVID-19 remains limited, it is important to be explicit about the considered judgements for recommendations as well as generate new evidence to face this challenge.

Introduction

The World Health Organisation declared the coronavirus disease 2019 (COVID-19) as a global pandemic on 11 March 2020.[1] Since then, dental services have been severely impacted, leading to the global closure of dental practices or a reduction of dental services. In many countries, the move to emergency care provision was rapid. By the end of April 2020, national and regional governments and professional organisations were publishing recommendations or guidance for the reopening/restructuring of dental services.[2]

In relation to the safe remobilisation of dental services, the uncertainty that exists regarding the risk from the use of aerosol-generating procedures (AGPs) in dentistry has led to

* *Corresponding author*. Health Services Research Unit, University of Aberdeen, AB25 2ZD, UK.
E-mail address: c.robertson@abdn.ac.uk (C. Robertson).

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variation in recommendations for procedural and environmental mitigation.

In May 2020, the COVID-19 Dental Services Evidence Review (CoDER) Working Group published an initial rapid review of 17 international dental guidance documents on the reopening of dental services.[2] Since publication, the review has been viewed more than 50,000 times, indicating the extent of the global level of interest during the pandemic. The review found that a highly variable level of detail was provided across the identified international sources.

A subsequent review was undertaken to understand the variance in recommendations related to the use and mitigation of AGPs as well as to inform work being undertaken by the Scottish Dental Clinical Effectiveness Programme to inform policymakers, and this review is described here.[3] The aims addressed by this study were to assess how dental AGPs were defined in international dental guidelines, what mitigation processes were advised, and whether they were linked to COVID-19 epidemiology. It was also hypothesised that more stringent personal protective equipment (PPE) recommendations may be made in high-income countries and that more stringent recommendations would be made in countries with higher death rates. The specific objectives were as follows:

- To assess how AGPs are defined and classified in international guidelines
- To identify what AGP mitigation is advised for patients both with and without COVID-19 and identify any mitigating factors that allow reductions in the length of fallow periods
- To report recommended time gaps (fallow periods) between treating patients with and without COVID-19 in the same surgery following provision of AGPs
- To assess whether there is a relationship between COVID-19 epidemiology and World Bank income status with PPE provision and fallow time in patients without COVID-19

The review did not consider recommendations for screening patients for COVID-19. It was anticipated that all patients would undergo some form of prescreening/assessment prior to having an AGP.

Methods

The review was conducted between 1 and 27 July 2020 using methods based on the World Health Organisation and the Alliance for Health Policy and Systems Research.[4] COVID-19 –specific dental guidelines were identified as part of a routine monthly dental guidelines search undertaken by the information scientist of Cochrane Oral Health.

The search was undertaken in a broad range of databases (Google Scholar, MEDLINE and Embase Guidelines International Network, National Institute for Health and Care Excellence, New Zealand Guidelines Group, and Canadian Agency for Drugs and Technologies in Health) using the following search terms: guideline/policy/consensus/guidelines/recommendations combined with a broad range of dental and COVID-19 terms (strategy available on request). No language restrictions were applied to the searches, and members of our research group were able to translate documents published in Dutch, French, German, Italian, Portuguese, and Spanish, with Google Translate being used for other languages when necessary. Searches continued to 13 July 2020 with data being extracted up to 15 July 2020.

The single data extraction method was undertaken using a standardised form developed for the review by members of the CoDER working group (membership details are provided as supplementary material). Data queries were reconciled by members of the working group. Information relating to COVID-19 epidemiology (number of cases and deaths) was obtained from the https://www.worldometers.info/coronavirus/ website on 15 July 2020. High death rate was defined as ≥301 deaths/1 million, medium death rate was defined as 101-300 deaths/1 million, and low death rate was defined as 0-100 deaths/1 million. Information on country income was retrieved from the World Bank. Recommendations for the use of face masks and fallow times in patients without COVID-19 (defined as patients not diagnosed with COVID-19) were assessed against the deaths per 1 million population in the included countries and country income level according to the World Bank using Pearson Chi-squared statistics. Descriptive statistics were used to describe the underpinning evidence linked to recommendations. We intended to quality assess this evidence; however, the diversity and indirectness of studies limited the value of such an approach.

Results

Seventy-five guidance documents were identified from 72 countries. Of these, 32 documents were from Europe, including 4 from the UK constituent countries; 9 were from Africa, including 2 from Kenya; 3 were from North America, including 2 from the United States; 10 were from South America; 6 were from Central America; 9 were from Asia; 4 were from the Middle East; and 1 document each was identified from Australia and New Zealand. Documents from Hong Kong, South Korea, the Latin American Paediatric Association Guideline, and Sweden and one of the documents identified from Kenya were excluded as they provided no information on AGPs. Translated versions of documents from 7 countries (Albania, Bosnia Herzegovina, Israel, Moldova, Nepal, Palestine, Turkey) were not obtained before our deadline. In total, data related to AGPs were extracted from 63 documents.

AGP definitions and types of procedures

A definition of AGPs was provided by 21 of the 63 documents (33%), and a list of procedures was provided in 39 documents (62%). Procedures identified as AGPs by more than 20% of the documents were high-speed handpieces (56%), 3-in-1 syringes (56%), powered (sonic/ultrasonic) scalers (43%), slow-speed handpieces (29%), and surgical handpieces (22%). Only 8 documents provided references for AGP definitions, with just 5 documents providing references for AGPs.

While 98% of documents indicated that AGPs can be performed in patients without COVID-19, caveats were suggested. These included general advice to restrict AGPs where possible, with 13 documents (21%) only recommending AGPs

for dental emergencies. Scotland, in July 2020, was the only country not allowing AGPs in patients without COVID-19 in primary dental care. The majority of documents (92%) indicated that treatment could be provided for patients with suspected or confirmed COVID-19. Twenty-two recommended only treating dental emergencies, with most (16) indicating that this should take place in specialised clinics or hospital and not a general dental practice. Comparisons for AGP procedures in patients with and without COVID-19 are available on a country-by-country basis in Appendix A (supplementary material). Just 4 documents provided references related to the provision of AGPs in patients without COVID-19, and there were none for patients with confirmed COVID-19.

PPE recommendations

Face masks were recommended by 59 of 63 guidance documents (94%), with most (91%) also specifying the use of goggles or face shields. For patients without COVID-19, the type of face mask was not indicated by 5 countries (Costa Rica, Dominican Republic, Myanmar, Portugal, and Ukraine). Twenty-one guidance documents (33%) specified surgical masks for use with patients without COVID-19, with 44 countries (70%) recommending FFP2/N95 masks and 12 (19%) recommending the use of FFP3 masks.

Of those countries recommending surgical masks, 10 advised the use of FFP2/N95 masks if these were available. Nine of the 44 countries recommending FFP2 masks for use with patients without COVID-19 advised the use of FFP3 masks where available. Fit testing of FFP2/3 masks was only advised in 19 documents. For patients without COVID-19, 42 countries (67%) advised use of surgical gowns and 32 (51%) recommended surgical caps/hats. Disposable aprons were recommended by 32 countries (21%) and shoe covers by 11 (17%). Double gloving was advised in 5 countries: Bolivia, Ecuador, Philippines, Portugal, and Spain. Over half (54%) of documents providing recommendations for treating patients with COVID-19 recommended the same level of face mask as for patients without COVID-19, with only 12 documents suggesting that the specification should be upgraded.

Data for the association between recommendations for the use of face masks and the deaths per 1 million population are reported in Table 1, and country income level according to the World Bank status is shown in Table 2. Only 54 countries could be included in the mask data analysis due to nonreporting of the level of mask that was recommended. For the death rate data, 27% of high–death rate countries used surgical masks as a minimum compared with 50% of medium–death rate countries and 41% of low–death rate countries ($P = .463$). Comparing World Bank high-income countries, there was no significant difference in recommendations for surgical masks as a minimum (42% in high-income countries, 33% in medium/low income countries, $P = .504$).

Procedural mitigation

The use of preprocedural mouthwash to reduce bioaerosols was recommended by 82% of documents, with 38 recommending hydrogen peroxide, 30 recommending povidone iodine, and 29 recommending either. Three documents recommended cetyl pyridinium mouthwash, and 3 recommended mouthwash without indicating a type. Paraguay and South Africa recommended a mouthwash despite indicating that there was no evidence of effectiveness, while 10 documents provided references of evidence to support the use of mouthwash. Forty-six documents (73%) recommended use of a rubber dam for patients without COVID-19. The use of high-volume suction was recommended for patients without COVID-19 by 46 (73%) documents. China, France, Italy, Malaysia, Philippines, and South Africa provided evidence to support the use of rubber dams and high-volume suction.

Environmental mitigation

Thirty-three documents (52%) mention aspects of general ventilation of the dental clinic for patients without COVID-19. Most commonly (15 documents), this relates to ensuring that treatment rooms are well ventilated, including the opening of (exterior) windows and use of air conditioning. Turning off air conditioning is recommended in the Argentinian document, while others indicate that it can be used, but not in recirculating air mode. The use of a negative pressure room or unidirectional airflow is recommended in 6 documents, while Guatemala, Honduras, India, Italy, Malaysia, Paraguay, Philippines, Poland, and South Africa recommend the use of high-efficiency particulate air filtration devices. Specific details on the number of treatment room air changes per hour, including a detailed table of the impact of different numbers of air changes, was provided in the Canadian document. Only 6 of the 33 documents providing information on general ventilation provided any references to support the recommendations.

Fallow period

Following the provision of AGPs to patients without COVID-19, 30 of the 63 (48%) documents mentioned a fallow period. Of these documents, 26 (41%) specified a time period, with times ranging from 2 to 180 minutes. Only 2 documents provided links to any references to support the recommendation. Eight countries (Belgium, Canada, China, Croatia, England, Malaysia, Malta, Northern Ireland) provided information on potential mitigation factors which included minimising the use of AGPs, opening windows, increasing the number of air changes per hour, and using high-efficiency particulate air filters or negative pressure rooms.

For AGPs in patients with COVID-19, 5 documents suggested a longer fallow period than for patients without COVID-19, but the majority (21/30) recommended similar durations as for patients without COVID-19. The Canadian document recommended that where information on the number of air changes per hour was unavailable, the minimum fallow period should be 3 hours following treatment of patients with COVID-19.

Sixty-two documents reported AGP use in patients with COVID-19 and were included in the analysis. With regard to death rate data (Table 1), 50% of high–death rate countries did not recommend a fallow time, and 55% of medium–death rate countries and 51% of low–death rate countries did not recommend a fallow time ($P = .901$). Comparing World Bank data (Table 2), there was no significant difference in fallow

Table 1 – Face mask and fallow time recommendations and COVID-19 deaths per 1 million population.

Country	Covid deaths H, M, L*	Surgical mask	FFP2 or N95	FFP3	Fallow time
Argentina	Low	Yes	Yes	No	Yes
Australia	Low	Yes	No	No	No
Austria	Low	Yes	No	No	No
Belgium	High	Yes	Yes	No	Partial
Bolivia	Medium	Yes	Yes	No	Yes
Brazil	High	No	Yes	Yes	Yes
Bulgaria	Low	Yes	Yes	Yes	Yes
Burkina Faso	Low	Yes	Yes	No	No
Canada	Medium	No	Yes	Yes	No
Chile	High	No	Yes	No	No
China	Low	No	Yes	Yes	Yes
Colombia	Medium	No	Yes	No	No
Costa Rica	Low	NR	NR	NR	No
Croatia	Low	No	Yes	No	No
Denmark	Medium	Yes	No	No	No
Dominican Republic	Low	NR	NR	NR	Yes
Ecuador	Medium	No	Yes	No	Yes
Estonia	Low	Yes	No	No	Yes
Finland	Low	Yes	Yes	Yes	No
France	High	No	Yes	No	Yes
Germany	Medium	Yes	No	No	Yes
Greece	Low	NR	Yes	Yes	No
Guatemala	Low	No	Yes	No	Partial
Honduras	Low	No	Yes	No	No
India	Low	Yes	Yes	No	No
Ireland	High	No	Yes	No	No
Italy	High	No	Yes	No	Yes
Kenya	Low	NR	NR	NR	No
Kosovo	N/A	No	Yes	No	No
Malaysia	Low	Yes	Yes	No	Partial
Malta	Low	No	Yes	No	Yes
Mexico	High	No	Yes	No	No
Montenegro	Low	No	Yes	No	Yes
Morocco	Low	No	Yes	No	Yes
Mozambique	Low	No	Yes	No	No
Myanmar	Low	No	No	No	No
Netherlands	High	Yes	No	No	No
New Zealand	Low	Yes	Yes	Yes	No
Norway	Low	Yes	No	No	No
Panama	Medium	No	Yes	No	No
Paraguay	Low	NR	NR	NR	Yes
Peru	High	Yes	Yes	No	No
Philippines	Low	No	Yes	No	Yes
Poland	Low	No	Yes	Yes	Partial
Portugal	Medium	No	No	No	No
Romania	Medium	Yes	Yes	Yes	Yes
Singapore	Low	Yes	No	No	Yes
Slovakia	Low	No	Yes	No	No
Slovenia	Low	No	Yes	No	No
South Africa	Low	No	Yes	No	No
Spain	High	No	Yes	Yes	Yes
Switzerland	Medium	Yes	Yes	No	Yes
Tunisia	Low	No	Yes	No	Yes
UAE	Low	No	Yes	No	Yes
UK: England	High	No	No	Yes	Yes
UK: Northern Ireland	High	No	No	Yes	Yes
UK: Scotland	High	NR	NR	NR	No
UK: Wales	High	No	Yes	Yes	Yes
Ukraine	Low	No	No	No	Yes
Uruguay	Low	No	Yes	No	No
USA (CDC)	High	No	Yes	No	No
USA (ADA)	High	Yes	Yes	No	No
Zimbabwe	Medium	NR	NR	NR	No

ADA, American Dental Association; CDC, Centers for Disease Control and Prevention; NR, no recommendation.

* High risk (H) = 301+ deaths/1 million; medium risk (M) = 101-300 deaths/1 million; low risk (L) = 0-100 deaths/1 million.

Table 2 – Face mask and fallow time recommendations and World Bank income status.

Country	World Bank status, H, M, L*	Surgical mask	FFP2 or N95	FFP3	Fallow time
Argentina	2	Yes	Yes	No	Yes
Australia	2	Yes	No	No	No
Austria	2	Yes	No	No	No
Belgium	2	Yes	Yes	No	Partial
Bolivia	1	Yes	Yes	No	Yes
Brazil	1	No	Yes	Yes	Yes
Bulgaria	1	Yes	Yes	Yes	Yes
Burkina Faso	0	Yes	Yes	No	No
Canada	2	No	Yes	Yes	No
Chile	2	No	Yes	No	No
China	1	No	Yes	Yes	Yes
Colombia	1	No	Yes	No	No
Costa Rica	1	NR	NR	NR	No
Croatia	2	No	Yes	No	No
Denmark	2	Yes	No	No	No
Dominican Republic	1	NR	NR	NR	Yes
Ecuador	1	No	Yes	No	Yes
Estonia	2	Yes	No	No	Yes
Finland	2	Yes	Yes	Yes	No
France	2	No	Yes	No	Yes
Germany	2	Yes	No	No	Yes
Greece	2	NR	Yes	Yes	No
Guatemala	1	No	Yes	No	Partial
Honduras	1	No	Yes	No	No
India	1	Yes	Yes	No	No
Ireland	2	No	Yes	No	No
Italy	2	No	Yes	No	Yes
Kenya	1	NR	NR	NR	No
Kosovo	1	No	Yes	No	No
Malaysia	1	Yes	Yes	No	Partial
Malta	2	No	Yes	No	Yes
Mexico	1	No	Yes	No	No
Montenegro	1	No	Yes	No	Yes
Morocco	1	No	Yes	No	Yes
Mozambique	0	No	Yes	No	No
Myanmar	1	No	No	No	No
Netherlands	2	Yes	No	No	No
New Zealand	2	Yes	Yes	Yes	No
Norway	2	Yes	No	No	No
Panama	2	No	Yes	No	No
Paraguay	1	NR	NR	NR	Yes
Peru	1	Yes	Yes	No	No
Philippines	1	No	Yes	No	Yes
Poland	2	No	Yes	Yes	Partial
Portugal	2	No	No	No	No
Romania	1	Yes	Yes	Yes	Yes
Singapore	2	Yes	No	No	Yes
Slovakia	2	No	Yes	No	No
Slovenia	2	No	Yes	No	No
South Africa	1	No	Yes	No	No
Spain	2	No	Yes	Yes	Yes
Switzerland	2	Yes	Yes	No	Yes
Tunisia	1	No	Yes	No	Yes
UAE	2	No	Yes	No	Yes
UK: England	2	No	No	Yes	Yes
UK: Northern Ireland	2	No	No	Yes	Yes
UK: Scotland	2	NR	NR	NR	No
UK: Wales	2	No	Yes	Yes	Yes
Ukraine	2	No	No	No	Yes
Uruguay	2	No	Yes	No	No
USA (CDC)	2	No	Yes	No	No
USA (ADA)	2	Yes	Yes	No	No
Zimbabwe	0	NR	NR	NR	No

(*continued*)

Table 2 (*Continued*)

Country	World Bank status, H, M, L*	Surgical mask	FFP2 or N95	FFP3	Fallow time
World Bank status		**Code**			
High income: non-OECD		2			
High income: OECD		2			
Upper middle income		1			
Lower middle income		1			
Low income		0			

ADA, American Dental Association; CDC, Centres for Disease Control and Prevention; NR, no recommendation; OECD, Organisation for Economic Co-operation and Development.

* High risk (H) = 301 + deaths/1 million; medium risk (M) = 101–300 deaths/1 million; low risk (L) = 0–100 deaths/1 million.

time recommendations, with 56% of high-income countries and 48% in medium-/low-income countries not recommending a fallow time ($P = .835$).

Underpinning evidence for recommendations

Only 21 of 63 guidance documents (33%) referenced a total of 33 individual articles as underpinning evidence for the recommendations made. There was little consistency across documents in terms of supportive evidence.

The most frequently referenced articles were Peng et al. (2020) and Meng et al. (2020), neither of which report primary research findings but provide key knowledge around COVID-19 and recommendations for patient management protocols in dental settings.[5,6] In total, 12 of the cited articles provided some form of narrative literature review, letter, or overview of the topic area without a formal assessment of the research evidence. Two additional documents referred to other guidance or regulatory documents (Kohn et al., 2003; Li et al., 2004).[7,8] Two systematic reviews were cited, one focused on preprocedural mouthwashes in the reduction of bacteria in aerosols (Marui et al., 2019) and the other focused on PPE for preventing highly infectious diseases due to exposure to contaminated body fluids in health care staff (Verbeek et al., 2020).[9,10]

There were a number of clinical studies that evaluated the effectiveness of rubber dams for preventing contamination during dental procedures (Cochran, 1989; El-Din et al., 1997; Samaranayake et al., 1989); the spread of bacterial aerosol contamination during dental treatment (Chuang et al., 2014; Legnani et al., 1994); and the bactericidal activity of povidone iodine (Shiraishi and Nakagawa, 2002).[11–15] These studies represented a selection of available primary studies that have been included in more recent systematic reviews.[16,17] The remainder of the references were for in vitro or simulation studies that have no direct applicability to COVID-19.

Discussion

This study focused on available international guidance documents found in the published and grey literature and through the authors' own networks. Some documents were not included because they were retrieved after the search cutoff date, and it is possible that other published guidance was missed. However, guidance from a wide range of countries with varying COVID-19–related mortality rates and country income levels is included. It is also possible that some of the regulations reviewed for this manuscript may have been adjusted since completion of the review to align more closely with emerging data.

This study found that the definition and categorisation of AGPs were either absent or varied amongst international guidance documents or were not reported. Recommendations for procedural and environmental mitigation differed across countries, with more than half not advising a fallow time. No significant differences were observed between countries for levels of recommendations for face masks or fallow time in patients without COVID-19 according to each country's COVID-19–related mortality rates and income levels.

While the recommendations included in the identified guidance documents were generally clear and actionable, they were often not evidence-based. It is appreciated that in a pandemic situation, there is a need for a timely response regarding the production of guidance for the profession. This may require some compromise compared with an extensive formal guidance development process such as that employed by organisations like the National Institute for Health and Care Excellence, which can take between 1 and 3 years to produce. However, processes for rapidly developing guidance in public health emergencies have been described and could have been followed.[18]

Having a global collaborative approach during the pandemic may have avoided duplication of effort and variation in recommendations. For example, in the UK, separate guidance documents were produced by the 4 constituent countries (England, Northern Ireland, Scotland, and Wales), but there was little variation in terms of the recommendations made by each individual country.[3] Our collaboration with the Cochrane Oral Health Group allowed a summary of recommendations from 63 guidance documents and assist urgent policymaking decisions. Furthermore, this review was used to inform the development of the Scottish Dental Clinical Effectiveness Programmes Mitigation of AGPs in Dentistry: A Rapid Review.[3] Following this, a single UK-wide guidance document was published, which adopted the Scottish Dental Clinical Effectiveness Programme recommendations on the categorisation of AGPs and led to a reduction in fallow time recommendations from a period of 60 minutes to a minimum of 10 minutes.[19]

Conclusions

The challenge of delivering dental care while complying with the current restrictive measures to limit transmission of

COVID-19 means that future guidelines need to consider complex interactions. While the amount of high-quality direct evidence related to dentistry remains limited, it is important to be explicit about the considered judgements for recommendations and generate new evidence to face this challenge.

Research is required regarding the future delivery of dental services using contemporary equipment and common outcome measures to aid data synthesis. Establishing international agreement on the definition and categorisation of AGP procedures would assist the conduct of research and reduce confusion amongst the profession. If a fallow time is considered necessary, further investigation into how environmental technologies might allow for a reduction in its length are required. Eliminating the need for a fallow time by developing technologies designed to limit aerosol production without compromise to clinical treatment should be investigated. The outcome measures should include both potential benefits and potential harms, including the impact on service delivery and capacity. Also, understanding the interaction between AGPs and PPE requirements is crucial to dental treatment provision.

Conflicts of interest

None disclosed.

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