

Commentary

Climate Change and Oral Health



Background

The effects of climate change on human health, including oral health, are detectable, now making this an acute and present situation. In 2015, global mean surface air temperature (SAT) reached 1°C above pre-industrial levels¹ and is predicted to increase rapidly to 1.5°C by about the 2030s and reach 2°C by the 2050s.¹ This rate of global warming and increased global mean SAT are associated with higher risks for adverse health outcomes^{1–4} that are measurable today.

The recent ‘Climate Crisis and Clinical Practice Symposium’³ aimed to demonstrate clinical implications of climate change on human health, suggest schemes that boost clinical practice resilience in the face of climate-related events, and urge engagement of health professionals in the climate crisis discussion. Similarly, oral healthcare providers must strategise for clinical practice resilience and consider clinical manifestations of climate change in their dental patients.

Oral conditions affected 3.9 billion people in 2010 with untreated dental caries being the most prevalent non-communicable disease (NCD) worldwide and with periodontal disease ranking sixth. Oral cancers rank among the 10 most common cancers globally.⁵ Efforts to tackle NCDs through common risk factor approaches focus on key factors such as sugar consumption, tobacco and alcohol use, stress, injuries, and poor hygiene.⁵ Wider social determinants of health such as economics, social policies, education, and inequitable distribution of resources, and even broader disease risk factors such as pollution and climate change must also be considered in any successful and equitable health promotion strategy.⁵ There are currently no published data regarding the impact of climate change on oral health.

Medical professionals are tasked with protecting the health of their patients and developing resilient healthcare delivery systems that can withstand challenges precipitated by climate crises.² This concept translates readily to dental practice where oral healthcare providers play a critical role in the provider-patient-climate triad. In addition to delivering patient care, dental care delivery systems must demonstrate resiliency to survive extreme weather events and, as is profoundly known now with COVID-19, pandemics. Moreover, given that climate crises and pollution disproportionately affect vulnerable populations, there exists an opportunity within the profession to narrow the ever-widening gap of health equity⁵ by mitigating environmental harm through improved dental waste management.

The purpose of this paper is to expand the discussion of global climate disruption⁴ to include considerations of oral health outcomes and dental practice crisis preparedness.

Climate change effects

Energy of the sun warms the earth and while much of that energy escapes back into space, some is held within the atmosphere by greenhouse gases (GHG). Because of human activity, a jump in GHG emissions in the past century has led to rising average global temperatures, more extreme weather events, rising sea levels and severe precipitation challenges (droughts and flooding). These exposure pathways^{1,2} lead to major health risks by way of:

- Heat stress
- Poor air quality
- Food/water insecurity
- Extreme weather events
- Vector-borne illnesses
- Social factors.

Heat stress

Excessive heat exposure can manifest itself in a variety of ways. Dental patients who are managed medically with diuretics or selective serotonin reuptake inhibitors are more susceptible to the effects of heat stress.² Several drugs found within standard emergency kits for dental offices are affected by heat. Typical drugs for handling asthma episodes (albuterol) or allergic reactions (epinephrine) become less efficacious when exposed to heat.² This is particularly concerning in places where operatories are not climate controlled as in many developing countries. Heat stress also contributes to increasing antibiotic resistance.² Less effective antibiotics, patients who are more susceptible to medical crises, and emergency medications that are less efficacious under extreme heat present possibilities of increased risk for adverse medical events in the dental setting.

Poor air quality

Asthma rates have increased dramatically and are associated with more intense wildfire seasons, longer/more intense pollen seasons, increased air pollution, and increased ground-level ozone, among other factors.⁴ Drugs often used to treat asthma include antihistamines (Benadryl™) that contain sucrose and bronchodilators (albuterol) that may cause dry mouth. Both sugar exposure and dry mouth are risk factors for dental caries. Asthma is associated with an increased risk of dental caries, gingival inflammation and alterations in the salivary pH⁶. Chronic pulmonary disease is linked to climate change through the same factors affecting air quality^{4,7} and is strongly associated with periodontal disease.⁸

Furthermore, air quality and rising temperatures cause depletion of the ozone layer which functions to absorb the sun's ultraviolet radiation.⁹ Exposure to ultraviolet radiation increases the risk of lip and skin cancers of the face, head and neck. Furthermore, heat and sunshine are associated with oral clefts.¹⁰

This underscores the importance of conducting a thorough medical history, regularly reviewing patient's medications, and meticulously conducting intra- and extra-oral examinations to screen for (pre-)cancerous lesions, periodontal diseases, caries and altered salivary flow. Oral health professionals must be poised to implement preventive measures and provide curative services as needed.

Food/water insecurity

According to the World Bank Water Overview, water links with nearly all of the UN's Sustainable Development Goals and yet globally 2.2 billion people lack safe drinking water, and 4.2 billion people lack adequate sanitation services. Without potable water, oral hygiene practices may become deprioritised or impossible giving way to higher levels of oral disease and lower levels of oral health quality of life. Furthermore, contaminated water and poor sanitation lead readily to gastrointestinal diseases with subsequent diarrhoea, vomiting and malnutrition.

In many developing economy countries, variable rainfall is not well managed and globally there is depletion of non-renewable groundwater sources. Water scarcity and heat curtail growth of animals and crops and also lower the nutritional value of food,⁹ thereby contributing to food insecurity.

Malnutrition is likely to occur in communities that depend heavily on farming and fishing, that exist outside temperate weather zones, and that lie within developing nations.^{1,4} Malnutrition is associated with NOMA (cancrum oris) and its early signs of onset include gingivitis and ulcerative periodontal lesions.⁵ Malnutrition is also associated with enamel hypoplasia, dental caries and delayed tooth eruption.¹¹

Extreme weather events

Extreme weather events will become more frequent and more intense with global warming.^{4,7} In addition to traumatic injuries, water-borne illnesses due to flooding, limited transportation, and disrupted food supply chains, oral healthcare providers may face infrastructure challenges such as power loss, downed communications, lost or inaccessible patient records (paper-based or electronic), and damaged or demolished dental clinics.

Installing generators in advance may help to mitigate the impacts of downed utilities. Universal health records linking all medical and dental records would support effective patient-provider communication and assure smooth referrals as needed when face-to-face visits are impossible. The use of emerging mHealth technologies would enable remote management of oral pain and other acute dental emergencies until definitive treatment could be delivered.

An adverse weather event would likely disrupt medical supply chains thereby compounding the problematic shortage of personal protective equipment (PPE) occurring now in

the era of COVID-19. Access to laboratory services would also be thwarted.

Multiple factors can potentially cripple the delivery of dental services, leaving patients without access to care and straining the economic security of dental practices and personnel. Evaluating practice preparedness and planning for resiliency in advance of extreme events is critical.

Vector-borne illnesses

As mean SATs rise, vector-borne illnesses will increase and spread to new locations.⁹ Several vector-borne diseases present with oral manifestations. Zika virus may cause intraoral ecchymosis, petechiae, aphthous ulcers or other ulcerative oral mucosal lesions.¹² Early lesions of dengue fever include bleeding gingiva or haemorrhagic mucosal ulcers.¹³ Lyme disease can present as headaches and non-specific orofacial pain resembling temporomandibular joint disorders.¹⁴ Thoughtful review of the patient history and scrupulous clinical examination will enable early diagnosis, earlier treatment, and better outcomes of systemic disease. Oral healthcare providers often see patients more frequently than do physicians and may well be the first provider with an opportunity to detect a case of systemic disease or infection and facilitate referrals for testing and early diagnosis.

Social factors

Weather events, food/water insecurity, and economic impact of lost livelihood will continue to force significant numbers of people to move from rural to urban areas, and ultimately across borders from developing to developed nations.⁴ Migrating populations lack access to healthcare and are at risk for an array of preventable and treatable illnesses and diseases including common oral diseases such as dental caries and periodontal disease.¹⁵ They are also at risk for individual or collective violence⁴ potentially leading to increased traumatic oral injuries.⁹ Migrating persons may also experience dietary changes or nutritional deficiencies that contribute to oral health defects.¹⁵ In addition, nutritional deficiencies, chronic infections and traumatic events have been shown to contribute to mental health disorders.¹⁵

Global migration is underway. In 2008 more than 20 million people were displaced due to climate-related causes and the numbers are growing.⁴ Oral health professionals in urban centres of affected developing nations as well as those in the neighbouring developed nations will face burgeoning immigrant populations needing urgent oral healthcare. This will stress fragile resources and infrastructure. Dental public health solutions are needed to address the challenges arising from climate change-induced migration and urbanisation.

Mental health

Mental health cuts across the six domains just described. Whether the climate burden is an acute event, chronic situation, or existential fear, individuals may suffer stress, anxiety or post-traumatic stress in response.^{4,9} Climate-related displacement and violence contribute to a substantial burden of mental health illness.⁹ Oral health outcomes of mental stress

include orofacial pain, temporomandibular pain, aphthous ulcers, necrotising ulcerative periodontal lesions and ulcerations related to autoimmune diseases.¹⁶ During COVID-19, there has been an increase in domestic violence and abuse which is often associated with increased drug or alcohol use (oral health risk factors) and may show a concomitant rise in orofacial trauma.¹⁷ Psychological risks of loneliness, economic instability, school closures and unemployment are also impacting the mental health of dental patients in the COVID-19 era.¹⁷

COVID-19 considerations

Extreme weather events undermine strategies to contain coronavirus transmission.⁷ For example, social distancing and hand hygiene are nearly impossible for persons who are mass sheltering, experiencing forced migration or seeking care for climate-related illness or injury in hospitals deluged with COVID-19 cases.⁷ Vulnerable populations are at higher health risks from climate exposure pathways, poor air quality, respiratory disease, and severe COVID-19.⁷

Loss of taste is an early symptom of COVID-19 in otherwise asymptomatic persons. Oral health personnel are exceptionally positioned to screen for loss of taste as well as respiratory challenges, findings that may serve to identify undiagnosed COVID-19 cases and facilitate referral for

testing. Early diagnosis will reduce transmission risk and improve outcomes, especially for vulnerable populations. Given the airborne transmission of coronavirus, dental operators worldwide must strive to minimise exposure through aerosol generation and should consider utilising minimally invasive procedures and re-configuring air circulation/ventilation schemes in dental operatories.

Discussion

Familiarisation with scholarly articles documenting climate impact on health should inspire formulation of next steps that may include:

- Planning for extended power outages, office destruction/closure, loss of patient records, downed communications, disrupted medical supply chains
- Developing strategic plans utilising teledentistry for managing patients with oral pain or acute emergencies when offices are closed
- Establishing strategies for personal and professional financial security
- Considering in-office medication storage
- Avoiding antibiotic over usage

Table 1 – Consideration of climate exposure pathways, health risks and potential areas for oral health surveillance and research.

Exposure pathway	Health risks	Potential oral health associations to be researched
Heat stress	Diabetes Antibiotic resistance Dehydration	Periodontal diseases, poor wound healing Difficult to manage odontogenic infections Dry mouth sequelae (caries and soft tissue inflammation)
Poor air quality	Increasing rates of asthma and chronic pulmonary disease	Asthma and caries, altered oral microbiome, hypomineralised second primary molars, delayed eruption, periodontal disease
Food/water insecurity	Ozone depletion Little/no potable water	Cancer of the lip, face, neck, ears; oral clefts Lack of oral hygiene practices and impact on oral health status and oral health quality of life
Extreme weather events	Less food/less nutrition in food; water microbes; diarrhoea and dehydration (malnutrition) Trauma Power outage Infrastructure	NOMA; oro-skeletal changes (osteoporosis); congenital disorders; tooth dysplasia Orofacial trauma Orofacial trauma due to violence; disruption/delay of treatment with poorer oral health outcomes Closures due to lack of power; supply chain disruptions; loss of medical records
Vector-borne illnesses	Zika Dengue Fever Lyme	Oral manifestations; ulcerations Oral manifestations; haemorrhagic lesions Orofacial and temporomandibular joint pain
Social factors	Migration and community violence	Orofacial trauma; no access to care with poor health outcomes; mental health; malnutrition
Mental health	Climate anxiety, stress Domestic violence Drugs, alcohol and tobacco use	Aphthous ulcers; acute necrotising periodontal diseases; increased oral presentation of autoimmune diseases; track events in cementum Orofacial trauma 'Meth Mouth' (caries and periodontal diseases); oral cancers; orofacial trauma
COVID-19	Loss of taste Aerosols	Oral health team as front-line personnel to identify COVID-19, facilitate testing Effective prevention of coronavirus transmission in the dental office

- Including climate-risk screening questions in the standard medical history; understanding possible renal, respiratory and cardiovascular implications
- Being cognisant of oral manifestations related to risk factors from climate change exposure pathways.

As clinic managers and global citizens, oral health professionals have an opportunity to model behaviours that mitigate climate change by conducting office energy and waste audits and adjusting their practices accordingly. While following WHO, CDC and state guidelines on handling medical waste are of paramount importance especially in the era of COVID-19, PPE should be disposed of using environmentally sound waste management protocols. In the broader scheme, it is time to reimagine the use of environmentally harmful oral health related materials (plastic toothbrushes and toothpaste, floss and mouthwash packaging, patient 'goody' bags with take-home samples, and single use plastics where alternatives exist) as these contribute to environmental degradation, worsened health, health disparity, and climate change.

Within dental education programs, it is possible to integrate a climate lens into the existing dental curriculum particularly as it relates to practice preparedness, waste management and models of service delivery. Within institutions, multi-stakeholder sustainability committees must endeavour to reduce fossil fuels, maximise energy efficiency, and improve waste management. This paper seeks to invite oral health researchers to investigate climate effects on oral health and contribute to the body of scientific literature on climate change and health (Table 1). Oral health indicators have the potential to form early warning systems for systemic disease surveillance. By bringing dental discipline expertise to the table, oral health professionals will collaborate with medical, nursing and public health colleagues to tackle these unprecedented challenges and reinforce the status of oral health as part of overall health. The interconnectedness of global climate disruption and COVID-19 elucidates some of the health-outcome consequences of racial injustice. Oral healthcare systems should be reimaged to address the inequitable susceptibility of vulnerable populations to adverse oral health impacts. In forcing the reduction of aerosol generation, COVID-19 is pushing providers toward delivering minimally invasive, indeed preventive, oral health services that target delivery of care to the base of the primary healthcare pyramid⁵ where high-frequency, low-cost integrated care incorporates common risk factor approaches and benefits communities at large.

Climate change affects health, including oral health. Provider awareness is essential for recognition and management of climate impacts on individuals and communities. Practice preparedness is critical for securing health system resiliency and navigating adverse climate events to ensure positive health outcomes. Oral health care delivery systems can be retooled to ensure equitable access and integrated delivery of service to the most vulnerable populations.

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