The Environmental Impact and Socioeconomic Differences Within the Global Field of Dentistry

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Introduction

While oral health is not always the first topic that comes into someone's mind when thinking about optimal health of a person, it is in fact one aspect of our body that should be taken care of daily. Oral health should be a top priority because the mouth is the entry point to the digestive and respiratory systems. When there is harmful bacteria in the mouth due to poor dental hygiene and oral care, this harmful bacteria can travel elsewhere in the body such as the digestive or respiratory tracts and cause severe health problems (The Mayo Clinic, 2019). In fact, poor oral health is related to chronic diseases such as diabetes and heart disease (Peterson, Bourgeois, Ogawa, Estupinian-Day, & Ndiaye, 2003). In addition, when someone has poor oral health there is usually pain and uncomfortableness which can affect chewing, eating, smiling, and communication. This ultimately impacts people's daily lives and well being (Peterson et al, 2003). Oral diseases also have a negative impact on attendance at school, and work, and restricts activities at home (Peterson et al., 2003). Examples of these common diseases include tooth decay, also known as dental caries or cavities, gum diseases, and even oral cancers (World Health Organization, 2018).

These diseases affect both advantaged and disadvantaged people in every country, and in fact, in 2016, oral diseases affected nearly half of the world's population, which is approximately 3.58 billion people (World Health Organization, 2018). Clearly, it is a major public health problem worldwide, and for this reason it is important to examine and understand why some countries and populations do not have proper oral care or access to oral health services considering how important this topic is to our body and lives. In addition to understanding why many people do not have proper oral health, it is beneficial to look at the environmental impact of the field of dentistry. Most of the dental products that are used, such as toothbrushes and

toothpaste tubes, are surprisingly non-recyclable. Because of this, a billion toothbrushes and a billion toothpaste tubes will be thrown out each year in the U.S. and end up in landfills or the oceans (Bite., 2019). Dental practices also contribute other environmental waste through the use of X-rays, mercury from silver amalgam fillings, disinfectants, biomedical waste and office disposables (Garla, 2012). The impact that the field of dentistry has on the environment is important to talk about because there is only one Earth, and humans are already pushing this planet to its limit's. It needs to be taken care of so the future of the earth and further generations is not jeopardized.

The Environmental Impact

The magnitude of waste and harm that the products, systems, and procedures in the field of dentistry release onto the planet is vast, although it was not always like this. The history of dental products such as toothbrushes goes back to Ancient Egypt, approximately the 32nd century BC. At this time, what the Egyptians used to clean their teeth were considered "tooth sticks" (Borunda, 2019). A little differently, the Romans used porcupine quill to clean their teeth, and then in the late 1400's a Chinese emperor designed a device quite similar to the modern toothbrush (Borunda, 2019). The device had packed boar bristles cut short from the hog's neck and placed onto a bone or wooden handle (Borunda, 2019). In the 17th and 18th centuries, teeth cleaning essentially was chewing on twigs (Borunda, 2019). In the past, the impact of throwing out what was considered a tooth brush was not harmful to the environment at all because it was all organic material. This soon changed when chemists, specifically an American named John Hyatt, discovered the material called "celluloid" in the year 1870, the plastic our toothbrushes are made out of now, and it has been used ever since (Borunda, 2019; Plastics Halls of Fame, 2019). This celluloid is what is non-recyclable, along with the nylon bristles. Each year, just in

the United States, the amount of toothbrushes that are thrown out can wrap around world four times (Borunda, 2019). An organizer of beach cleanups in Hawaii never used to find toothbrushes during his cleanups, but now during the typical beach cleanup, between 20 and 100 toothbrushes are picked up off the beach (Borunda, 2019). Additionally, toothpaste tubes are another plastic component that people use daily, which add another threat to our copious amount of pollution in landfills and the ocean. According to Bite., a company that makes toothpaste tablets without any plastic packaging, every year the equivalent of 50 empire state buildings is filled with plastic toothpaste tubes that are thrown out worldwide, which ends up in landfills or the ocean (Bite., 2019). This is a major issue, because this plastic will never leave the earth and it impacts the lives of marine life.

Not only are simple products such as toothbrushes and toothpaste tubes being used and disposed of carelessly, but dental practices are also emitting mercury waste into the environment. This is done by not properly separating out the mercury that is retrieved from old cavity fillings from the septic systems of the office (American Dental Association, 2019). Older cavities and dental decay fillings used to be made out of a material called amalgam. Amalgam is a mixture of different metals consisting of liquid mercury, silver, tin, and copper (U.S. Food and Drug Administration, 2017). If a dentist does not dispose of this metal properly when he or she is fixing or removing a filling, then this mercury can be leaked into the environment through water ways (American Dental Association, 2019). Mercury is a toxic chemical that can accumulate in the marine life humans eat, because once it is in the environment, bacteria can use it to convert it to a more toxic chemical (Garla, 2012). This chemical is a neurotoxin, a poison that affects the nervous system, and is very harmful to vulnerable populations (Garla, 2012). This mercury waste is produced by many dental practices around the world, and is a great environmental hazard.

Simple products used daily in the office also harm the environment. Hundreds of disposable latex gloves, head rest covers, patient bibs, plastic suction tips, etc., are thrown away each day and cannot be recycled (Garla, 2012). Some of the disinfectants used are hazardous and poured down drains which go into waterways, and there is a large number of biomedical waste materials such as blood soaked materials, broken glass etc. that pose challenges to the environment (Garla, 2012). To note, it is not just the United States that produces large amounts of dental waste. In fact, in Gorgan, Iran, the total amount of dental waste produced just from public practices was 12,015.1 kilograms out of 5 practices in a year (Nabizadeh, Faraji, & Mohammadi, 2014). Looking at the big picture, there are many harmful contributions that the field of dentistry contribute to our environment. Considering that toothbrushes and toothpaste tubes are the first thing most people touch in the morning, and considering that there are about 200,000 practicing dentists just in the U.S. alone, it is necessary that the impact the field has on the environment is recognized and suggestions to help fix this problem are implemented (Borunda, 2019; American Dental Association, 2019).

Implementing Change

There are many ways in which change in the dental field can be implemented. One creative, organic way to reduce the numbers of plastic toothbrushes is to buy from and support companies that make bamboo toothbrushes. There are many companies all over the world that produce bamboo toothbrushes, such as Green Root and Mother's Vault. These toothbrushes are eco-friendly and biodegradable, so if they end up in the ocean or landfill they are not harmful to the environment (Borunda, 2019).

There are also ways in which the plastic toothpaste tubes can be removed from the cycle of human waste. A creative way to decrease the number of these non-recyclable plastic tubes was

invented by a small company called Bite. This company creates toothpaste tablets, with all natural materials, that you bite down on in order to start brushing. These tablets have no harsh chemicals, no plastic packaging, and less carbon emissions from shipping. They come in a refillable, reusable glass bottle, and the products are not tested on animals. It is an all-around eco-friendly company founded on the love for the planet, which reduces waste, saves animals, and does not contribute to polluting our oceans or landfills (Bite., 2019). The impact that these two interventions could have on a dental practice would be significant. For example, instead of giving each hygiene patient a new plastic toothbrush for their visit, practices could give them bamboo toothbrushes instead, ultimately making more people aware that there are alternatives to our daily products. To be specific, if one dental practice that sees about 12 patients a day, provided their patients with bamboo toothbrushes instead of plastic toothbrushes, this could save about 2,800 plastic toothbrushes from entering the environment per year (Accounting Financial Tax Consultants, 2019).

In addition to these changes, dental practices also need to limit or ultimately end their work with mercury in amalgam. They can do this by substituting old, metal amalgam fillings with newer, less harmful materials. Most of the time, this material is called a resin composite filling that is made out of a ceramic compound (Delta Dental, 2018). Many practices, such as North Seattle Dental in Washington and Forrester Dental in Connecticut, do not use the metal amalgam anymore, but because of the switch from the metal amalgam to the ceramic material, dentists are now commonly doing a removal procedure of the old amalgam and replacing it with the newer material (North Seattle Dental, 2017). Because of this, it is important that dental practices install an amalgam separator which catches and separates out the amalgam that is put down the practice's drains, before it goes into the environment, especially the oceans (American

Dental Association, 2019). The Environmental Protection Agency has actually mandated compliance regarding all practices having an amalgam separator by July 14th, 2020 (American Dental Association, 2019). In general, there are many different avenues in the field of dentistry where significant change can take place, so it is important that professionals all around the globe take into consideration the creative, yet effective ways they can lower their impact on the environment.

Socioeconomic Differences Of Oral Care

Although it may seem like many countries in the world have availability and access to oral health services this is not always the case. In fact, "the greatest burden of oral diseases [both in developing and developed countries] is on the disadvantaged and poor population groups" (Peterson et al., 2003, p. 7), and this is because there is limited availability and accessibility of oral health services in some areas (Peterson et al., 2003, p. 7). Poor access to services is a major risk factor for poor oral hygiene (Peterson et al., 2003). One reason why poor populations in developing countries experience a burden of oral diseases is because oral health services are mostly only offered at regional and central hospitals of the large, urban cities (Peterson et al., 2003). If these dental services are accessible to people, they focus very little on preventative and restorative dental care, which are both very important to sustain proper oral health throughout a lifetime (Peterson et al., 2003).

This concentration of oral health services in the cities of some countries is a large problem, because in many developing countries, the disadvantaged or poor populations do not live near urban centers so this is leaving them without any access to health services (Khan, 2001). For example, 63 percent of worldwide poverty is rural poverty, and in certain countries such as Bangladesh, 90 percent of their poverty is concentrated in rural areas (Khan, 2001). This

leaves the disadvantaged, poor populations outside of the cities with insufficient access and unequal distribution of services, ultimately leading to higher rates of oral diseases because they cannot afford or physically get to the proper care they need. For example, oropharyngeal cancer, a type of head and neck cancer, "is more common in developing countries than developed countries" (Peterson et al., 2003), because the majority of disadvantaged or poor people such as in Bangladesh where 90 percent of their poverty sits outside the cities, cannot afford or get to the services they need (Khan, 2001). In fact, oropharyngeal cancer is one of the top three most common types of cancers in South Central Asia, where many developing countries lie (Peterson et al., 2003).

Moreover, there is a socioeconomic difference in oral health because of the lack of health personnel that are present in many communities and countries. Many countries in Africa, Asia and Latin America have a large shortage of oral health professionals, and the system that they are a part of generally just focuses on pain relief and emergency (Peterson et al., 2003). Therefore, by the time patients come into the office their oral health is already substandard (Peterson et al., 2003). This shortage of personnel causing scarce access to services is particularly shown in Africa. In Africa, the dentist to population ratio is about one dentist per 150,000 people, whereas the ratio in most industrialized countries is one to 2,000 people (Peterson et al., 2003). In addition, investment by the government and health care systems on oral health services in developing countries is low, because resources are usually allocated to emergency care and relief (Peterson et al., 2003). Not only this, but also because treating dental diseases are some of the most expensive diseases to treat (Zosseo Overland Support, 2017). Therefore, there is not enough money being circulated and pushed into the developing countries health system to support the oral health services needed to keep populations healthy. In industrialized countries, treating oral

diseases constitutes about 10% of their healthcare budget (Zosseo Overland Support, 2017). If developing countries, like Bangladesh for example, allocated this same 10% of their budget for treating oral diseases, it "would exceed the entire financial resources available for child health care" alone (Zosseo Overland Support, 2017). Because of this, there is poor access to oral health services due to the lack of proper financial allocation and availability in health care systems of developing countries. The lack of health personnel in certain communities and countries, along with poor investment in oral health care are two socioeconomic barriers that impacts people's oral health. As indicated above, access to oral care is a major determinant as to why certain people may have more suitable oral health than others.

Although access to care is a common determinant of oral health, it is not the only agent that contributes to oral health. Dietary and cultural beliefs, and infrastructure also play a role. Comparing Chinese beliefs and culture to Westerners is a perfect example. Manhui Liu, a practicing dentist in Malden, Massachusetts, has worked on many Chinese patients and draws analogies between Eastern ideas and practices versus Western ideas about oral health (Ruggles Media, 2016). He found that in China, very few people gargle or floss daily, and he found that Chinese parents and even dentists do not recommend people to get their teeth cleaned professionally because they believe it will cause damage to the teeth and gums (Ruggles Media, 2016). This is very different than Western habits and culture where teeth disease prevention, such as examination and care, is actively sought after (Ruggles Media, 2016). Additionally, Dr. Liu noted that many Chinese people see Western medicine as aggressive and used too often, and therefore many parents prefer traditional Chinese medicine (Ruggles Media, 2016). In the case of treating oral diseases, traditional Chinese medicine can consist of acupuncture. The practice of certain acupuncture procedures targeted at specific oral diseases takes a different approach for

treating a problem, than Western teeth examination and care. For example, traditional Chinese medicine sees periodontal disease, or gum disease, caused by bacteria in the digestive system due to heat accumulation (Lam, 2006). This heat accumulation can be targeted by an acupuncture point in the webs of the feet, so pressing this point daily is believed keep a balance in our digestive system and ultimately lower the risk of periodontal disease (Lam, 2006). Although this acupuncture procedure for gum disease does release natural painkillers in the nervous system and changes the way the nervous system processes pain signals, it does not mean that it actually cures and treats the periodontal disease (Naik, et al., 2014). It just suppresses the pain and discomfort associated with the disease, it does not remove the cause of the pain (Naik, et al., 2014). Because many Chinese residents do not believe in visiting the dentist for preventative and examination care, and many focus on traditional medicine such as acupuncture, some of the rates of non-communicable diseases such as periodontal disease is rather high (Naik, et al., 2014). In an epidemiological investigation released in 2005, it was found that over 50% of the adult population studied in China were affected by periodontal disease (Zhang, et al., 2017). Western practices would treat this disease differently, targeting the cause directly, not just the pain. Most Western dentists would do non-surgical practices such as scaling and root planning, or surgical procedures where they clean under the gum tissue (The Mayo Clinic, 2018). This difference between Western and Eastern oral practices and culture between China and the U.S, is important to note because it is not always access to health services that cause poor oral health. In some cases it is cultural beliefs and traditions that restrict people's ability to obtain optimal oral health.

Another barrier issue that sparks a difference in oral health around the globe is dietary customs. In the America's, children that are 12 years old have about three decayed, missing, or filled permanent teeth, whereas this number is much lower in most African countries. The

average number of decayed, missing, or filled permanent teeth that 12 year old children in Africa have is about 1.7 (Peterson et al., 2003). This is because of the high levels of sugars that are being consumed in foods in the America's, and inadequate exposure to fluorides which help prevent cavities (Peterson et al., 2003). Therefore it is clear that countries that do not have processed, sugary foods like the United States, are less likely to have higher rates of cavities in children. This underscores the idea that diet can impact oral health.

Part of a community's infrastructure, such as water and sewage systems, in some countries can also affect oral health. For example, in some parts of India and Thailand, there are high levels of fluoride in the drinking water because it is natural groundwater (Peterson et al., 2003). If there is more than 1.5 parts per million of fluoride in drinking water, it can cause fluorosis, or the discoloration and damage to tooth enamel due to too much fluoride during teeth formation (Peterson et al., 2003). This greatly affects the oral health of the citizens of these countries, especially the younger generation considering their teeth are still forming. This indicates that poor access to health services in the area is not the only aspect that impacts oral health. Oral health still can be substandard due to poor infrastructure such as insufficient water systems.

Solving The Socioeconomic Differences

Although not all health issues can be solved globally, there a few steps that can be taken to enact change for the socioeconomic differences of oral care and services globally, especially pertaining to access. One way this can be done is to promote community water fluoridation in areas where they do not have sufficient access to preventive oral health services. This is important to make sure that people have some type of access to fluoride, a mineral that helps prevent and stop tooth decay, while also making sure that the fluoride concentration in the water

is not too high so dental fluorosis can be avoided (Colgate-Palmolive, 2019; Office of Disease Prevention and Health Promotion, 2019). This can be a very effective step, as "studies show that [community water fluoridation] prevents tooth decay by 18% to 40%," so if this is implemented to a greater extent globally, it is possible that tooth decay rates will decrease (Office of Disease Prevention and Health Promotion, 2019).

School sealant programs are also another initiative that can be implemented. Sealants are a material that is placed on the chewing molars where cavities are more common, in order to prevent tooth decay (Office of Disease Prevention and Health Promotion, 2019). This is important because many low income families cannot afford sealants for their children, and only "1 in 3 children aged 6-8 has a dental sealant" (Office of Disease Prevention and Health Promotion, 2019). Tooth decay can be prevented by 80% with the presence of dental sealants, so it is important that as many children as possible have access to this service in order to prevent high rates of dental caries or tooth decay in the future (Office of Disease Prevention and Health Promotion, 2019). Schools are a great access point in order to reach children.

Lastly, a way in which oral health services can be reached to the disadvantaged and poor populations that do not have adequate access, could be through the operation and implementation of coalitions or non-profit organizations. Different alliances and NPO's around the globe such as the Global Dental Relief Program and the Alliance for a Cavity- Free Future work every day to better the field of dentistry and the oral health of people all over the globe. The Global Dental Relief Program tries to bring free dental care to children around the world, particularly in Kenya, Guatemala, Nepal, India, and Cambodia where dental care is needed the most. The program consists of a team of volunteers that delivers treatment and preventative care year round to children in schools, orphanages, and rural villages that are impoverished (Global Dental Relief,

2019). Since it started in 2001, over 170,000 children have been served, and if more dental professionals, allied health professionals, and general volunteers come together from all over the world and contribute to this organization, the gap between the oral health of the disadvantaged and advantaged populations will start to decrease (Global Dental Relief, 2019). Quality of lives will continue to increase, and people who would never had access to oral health services are now getting the care they need through the efforts and services provided by the volunteers that travel to these countries every year through the Global Dental Relief Program.

The Alliance for a Cavity-Free Future is another avenue that hundreds of professionals worldwide can partake in to make change. This international non-profit organization fights against the initiation and progression of dental caries by working with partners to promote comprehensive prevention management systems and collaborating with a wide-range of organizations to reduce inequality (Alliance For a Cavity-Free Future, 2019). Their overarching goal is to have every child born in 2026 to stay cavity- free throughout their lifetime (Alliance For a Cavity-Free Future, 2019). This focus on the future of oral health and preventative care is necessary in order to combat the high rates of oral diseases worldwide, and lessen the burden of potential chronic diseases associated with oral health. This is why it is important to have as many professionals and volunteers engaged in alliances and programs such as the Global Dental Relief program and the Alliance For a Cavity-Free Future, in order to solve as many of the socioeconomic differences within oral health as possible.

Conclusion

The mouth is one of the most important parts of the body, as it allows us to smile, communicate, eat, drink, and ultimately is the entry point for anything going into our digestive and respiratory systems (The Mayo Clinic, 2019). Because of this, toothbrushes are usually the

first thing that people touch in the morning, and with their popular use, most people go through about 300 toothbrushes in their lifetime (Borunda, 2019). Considering how widely used and disposed of these products are, it is important to recognize the large environmental impact that plastic toothbrushes and toothpaste tubes have on the environment. If change is not made and consumers do not resort to other options such as bamboo toothbrushes or toothpaste tablets like the ones Bite. produces, thousands of plastic toothbrushes and toothpaste tubes will be picked up off of some of the most beautiful beaches in the world as time evolves and the waste accumulates (Borunda, 2019). This impacts humans, marine life, and ecosystems in which they are disposed. Consumers are not the only agent in this environmental waste issue. Dental practices are also culprits of producing massive amounts of waste throughout the year. This waste consists of biomedical waste, mercury waste, sterilization agents, and of course toothbrushes and toothpaste tubes, which all effect our health in the long run (Garla, 2012). For example, the mercury waste that is being released into water ways, is now being found in the fish we eat (Garla, 2012). Thus, the interventions proposed are not just efforts to reduce dental practice waste and "go-green". They are efforts to promote a more eco-friendly approach to the dentistry field in order to save the wellbeing of the environment, but also to promote and sustain the general health of the public in the long-run. With the impact that dentistry has on the environment, it is clear that change needs to be made especially from the health professionals. It is also necessary for these health professionals to recognize the socioeconomic differences in oral care between different countries and cultures, because poor oral health does not directly mean the population has poor access to services. Poor oral health is also contributed by dietary and cultural barriers, along with poor infrastructure such as water systems. Therefore, if health professionals want to combat poor oral health, they must take an inclusive, intellectual approach that embodies the different components

and causes of oral health, not just accessibility to services and care. In entirety, dentistry in the global scene needs to take a more eco-friendly approach, while simultaneously recognizing the socioeconomic differences of oral health and being mindful of the dietary, cultural, and infrastructural barriers that impact it.

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