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# **INNOVATION IN THE PREVENTION OF ORAL DISEASES**

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# 1. Introduction

*"... the vision is to start talking about health, not about disease."*

(FDI World Dental Federation, 2014)

Unfortunately, according to the World Dental Federation (2015), tooth decay is the most extended chronic disease worldwide and becomes one of the major global health challenge. World Health Organization (2012) provides alarming statistics related to oral health of global population as well. The organization pointed out, that worldwide 60-90% of school children and nearly 100% adults have dental cavities. Globally, about 30% of people aged 65-74 have no natural teeth.

Unhealthy mouth can dramatically impact our physical, psychological wellbeing, and happiness. A healthy and well-functioning mouth is important for essential human functions, such as speaking, smiling, socializing and eating. Teeth give the face its original shape and form. Our oral health and overall health go hand in hand. The relationship between general and oral health is evident. WHO (2012) defines oral health as *'a state of being free from mouth and facial pain, oral and throat cancer, oral infection and sores, periodontal disease, tooth decay, tooth loss, and other diseases and disorders that limit an individual's capacity in biting, chewing, smiling, speaking, and psychosocial wellbeing.'* This definition is widely recognized as an integral element of the right to health, as is established in the UN Universal Declaration of Human Rights (The United Nations, 1945) adopted by all nations.

Nevertheless, oral health seems to be less challenging problem among policy makers, maybe because oral diseases are often hidden and invisible. This is why this area of health is highly underestimated. However, according to WDF (2015), research shows that oral diseases are not inevitable, but can be reduced or prevented through simple and effective methods at both the individual and population levels.

There are many strategies which relates to prevention of tooth decay. Both the WDF (2015) and WHO (2012) argue, that this challenge must be solved by prevention of oral disease and promotion of oral health. They believe that entire population should be involved through communities, policy makers, and individuals. But in general, because tooth decay is caused by sugar consumption, it can be prevented by reducing sugar intake, appropriate fluoride use, and promoting good oral hygiene. For example, school health programmes are ways which lead to better oral health. Furthermore, to include the enforcement of food policies, comprising transparent labelling of foods and restricting the availability of sugar-sweetened beverages in schools.

But, if we have a look on the strategy from the perspective of technology, is there a potential for new approaches to prevention? Nowadays, due to advance in modern technologies, the beginning of the 20<sup>th</sup> century has seen a shift in the relationships between health professionals and patients. According to D. Jane Bower (Tidd and Hull, 2003, p. 212), in all developed countries the technological opportunities are the driver forcing demands for innovation of healthcare. For example, modern hospitals such as Mayo Clinic (2008) deliver care to patients who are thousands of miles away thanks to telemedicine. The brand Babylon (2015) represents the revolution in delivery of prescriptions to customer's door. Furthermore, many hospitals (The Guardian, 2018) tend to improve ways of care by testing robots.

According to Michal E. Porter (1985, p. 22), changes in industry can transform the principles on which generic strategies are built. It is the technological change, Porter pointed out (1985, p. 164 - 165), that is one of the main drivers of competition. The mentioned companies have grown out of technological changes that were able to exploit. But, adopting new technologies is not important just for own sake. Porter stressed out, that it is important to think about the effect on competition and the industry as whole. One must be sure that technological change is strategically beneficial. Porter believes that taking advantage of technological change is the most effective if one wants to change the rules of competition. In this context, talking about competition is not relevant. But, there is an opportunity to make a change in the approach to promotion and prevention oral health by taking advantage in technology. This is the main reason, why a distinctive feature of this work is related to study of information in the context of

innovation in healthcare and prevention. But first of all, it is important to understand the topic from the historical perspective. It is why this research tends to analyse the shift in our understanding of the topic.

## 2. Innovation in the Oral Related Products and Services

### 2.1 Toothbrushes

Many researchers agree, that there is recognized the link between design and meanings. For example, Margolin and Buchanan claims (1995), that "products embody notions of identity, that are socially recognized and thus become tokens in the symbolic exchange of meaning." Other studies by psychologists Csikszentmihalyi and Rochberg-Halton (1981) describe how people use ordinary objects and give them symbolic meaning as expression of their experiences. „Things embody goals, make skills manifest, and shape the identity of their users. His self is to a large extent a reflection of things with which he interacts. Thus, objects also make and use their makers and users.

Concerning toothbrushes, throughout the history there was a great spectrum of designs from ergonomic to environmentally friendly, toothbrushes made from many materials, shapes and sizes, electronic toothbrushes, sonic toothbrushes etc. In 1952, the US Army dental surgeon John Sayre Marshall wrote (*Teeth*, 2018): "The toothbrush is the yard stick by which the degree of civilisation of people and nation may be measured." Toothbrush is the most effective weapon against tooth decay. Innovation from rubber to coloured plastics has come. Brush manufacturers and franchises with an interest in children's market were found a potential in collaboration.

In 1857, the first toothbrush in the western world was patented in the United States. According to American Dental Association (2018), this toothbrush was made of bone (handle) and from the Siberia boar hair bristles. Unfortunately, animal hair was not ideal material because it retained bacteria. From this reason, in addition, handles were made of wood or ivory. According to Bells (2018), in the United States, tooth brushing become routine after World War II, when American soldiers had to clean their teeth daily.

According to Kumar and Jayanth (2011), in the 1990s, celluloid gradually replaced bone handles. Siberia boar hair bristles were also replaced by synthetic fibres such as nylon. In 1938,

the first electronic toothbrush was invented in Switzerland. And according to Sammons (2003), at the beginning of the 21<sup>st</sup> century nylon had come to be widely used for the bristles and handles were usually melded from thermoplastic materials.

The example of the Mickey Mouse Donald Duck Toothbrush holder shows the Disney's interest in collaboration with manufacturers because of a potential children's market. The holder from 1930 took shape of the famous character Donald Duck (*Teeth*, 2018). Another example of a product for children, Oral-B (2018) came up with an electric toothbrush in design of Star Wars-Blizident's (2018) 3D tooth brush can be considered as one of the current most high-tech products. This toothbrush is tailored to the user's own teeth. For tailoring, it is used a 3D model of the user teeth scanned by his/her dentist. The toothbrush has bristles positioned on every single tooth. Additionally, it has bristles for gum line and interdental bristles between all users' teeth. The technique of tooth brushing is simply biting and grinding for a couple of seconds. According to the company's website, this is called "Modified Bass" -technique and is recommended by dental hygiene experts worldwide. Nevertheless, the experience of cleaning the teeth with this toothbrush seems to be less comfortable compare to traditional toothbrushes. According to a review by Erin Lawrence (2017), the toothbrush is too big and not very flexible and the experience is weird because it fills whole mouth.

The next example is innovative in another way. The electronic toothbrushes by Oral-B (2014) can be considered as an example of a product of the *internet of things*. The term internet of things refers to physical devices, and other items connected with sensors to internet or any other digital network which enables these objects to connect and exchange data (HBS, 2014). The series of smart toothbrushes and the Oral-B app are designed for the best mouth cleaning results. The toothbrush is connected via Bluetooth to a smartphone where the app is running. It provides live time guidance how to clean teeth, take care about the right pressure on gum, provides some content such as weather and news, reminders for tongue cleaning and rinsing. Furthermore, it provides summary of your sessions and insight to your brushing routines which one can easily consult with a dentist.

Another example is a toothbrush Beam (2018) which is innovative in its business plan built around. The product is related to insurance plans. With the Beam's brush the better the user brushes, the lower his premium will go. The smart toothbrush, which you receive at home every six months, tracks your brushing routines and these data are used by the insurers in order to set up your savings. According to Fortune (Higginbotham, 2015), Beams sends notices and encouragement if the user's brushing habits are failing short. The company believes that they are able to reduce cost of premiums by up to 25 percent. It is dealing with data about user's brushing habits and dental visits to encourage users to be proactive about their dental health.

## 2.2 Dental Services

Between May and September 2018, the Welcome Collection gallery provides an exhibition *Teeth* (2018). Visitors can see there a chair borrowed from the British Dental Museum. The chair Oak represents a common design for 19<sup>th</sup> century dental chairs. Nevertheless, pooling-teeth was understood as not serious job for established medical profession. From the middle ages this work was performed by barbers. According to the curators of the exhibition (*Teeth*, 2018), their tool includes these for cutting hair, cutting and wrenching, they took tasks from cutting hair to amputating limbs – and pulling teeth.

The next example is Diamond 2 dental chair. According to the *Teeth* exhibition (2018), this chair was in use in the US in the time period 1925-1935. The chair produced by SS White Dental Manufacturing Company (*Teeth*, 2018), was revolutionary, because it was hydraulically adjusted. The predecessors required the use of hand-crank to alter height or angle. Furthermore, the chair was in tune with hygienic and progressive image that rapidly expand dentistry.

Current seats are much more evolved. For instance, the A-Dec (2018) treatment station includes intraoral scanning data, lights, sink, digital imaging, work surfaces and powered tools.



Nevertheless, the findings above represent treatment handed out approach. These seats are used by patients when the treatment is needed. But, essential for this research is to focus on techniques of prevention. From this reason, other approaches in dentistry are identified.

At the beginning of the 20<sup>th</sup> century, George Cunningham established a clinic in Cambridge which dealt exclusively with children's teeth (Zangwill, 2018). He was inspired by a clinic in Strasbourg, organized by Professor Jessen. The clinic had the primary goal to saving of teeth; no extractions would be carried out there. The waiting room was designed to catch the attention of children. It was a playground full of toys, books, black board and chalks. The purpose was to create a friendly and welcoming environment.

Furthermore, Cunningham organized Punch and Judy shows and magic lantern shows. He wrote a book about dental oral health and benefits of conserving and preserving teeth. In 1930 he produced a film about dental hygiene. It was one of the earliest films on this topic.

According to Zangwill (2018), Cunningham high ideals of preservation and conservation are not applied today. He claims that the major trend in dentistry is an emergency extraction service for relief of pain.

## **2.3 Health Promotion**

One of the tools suitable for the problem solving is mentioned promotion of health and prevention of oral disease. The problem calls for social change - In this sense, social marketing plays important role. Social marketing, according to ISMA (2013), combine different concepts in order to approach to social change and expands traditional marketing concepts towards public health. The ultimate aim is to influence behaviour that contributes to greater social good of individuals and communities.

The exhibition Teeth (2018) in London's Wellcome Collection presents some examples of earliest campaigns. First of all, Our Friend the Dentist was the name of a campaign which took place after World War I in 1926. During the war, nation's teeth became government concern,

because many signing up for the British Army rejected due to poor teeth. The health campaigns start focus on children. The key message of the campaign was visiting the dentist routinely, not only after one has toothache. Curators of the exhibition (*Teeth*, 2018) pointed out: *"preventative maintenance was the most powerful weapon in the fight against decay."*

During the mid-20<sup>th</sup> century, a couple of organisations such as dental associations, ministries of health and ministries of information improved their communication about how the public should take care of their teeth and those of their children. Firstly, the Wellcome Collection gallery houses (*Teeth*, 2018) eight 1-minute television infomercials for television broadcast produced by American Dental Organization in 1958. These short clips ([welcomegallery.org](http://welcomegallery.org), 2108) focus on warning that gum disease rather than tooth decay is a problem, the importance of regular preventive check-ups, health eating etc. Secondly, C.O.I. dental health loop ([welcomegallery.org](http://welcomegallery.org), 2018) produced for the Ministry of Health in 1964. These infomercials were aimed for television broadcast during programme breaks. Thirdly, in 1945 the film *Your Children's Tooth* was produced by Ministry of Information for Departments of Health, in cooperation with Central Council for Health Education (*Teeth*, 2018).

Afterwards, a good example of combining different concepts in order to make a social change, are modern prevention programs. The word "program" in the business context is defined in the Cambridge Dictionary (Dictionary, 2018) as "an officially organised system of services, activities, or opportunities that help people achieve something - in this context of healthy behaviours.

Nowadays, one of the most visible prevention programs is Brush Day & Night. This program is based in partnership between FDI, Unilever and National Dental Associations (FDI World Dental Federation, 2018). The aim of the program is to encourage one of the most important behaviours for good oral health: tooth brushing twice a day with fluoride toothpaste.

The program is divided into four phases. The first phase's activities took place in the time period between the 2005 and 2009. The aim was promoting of oral health and tooth brushing in schools and communities. FDI claims (2018), during the programs there were reached 1 million children. The second phase took place between the years 2010 and 2013. The purpose of the campaign was the same but there were reached over 1million children. The phase four

took place between the years 2014 and 2016 and there were reached 136 million children. The aim of this phase was to teach children in schools and helping them to become advocates for oral health.

The fourth phase includes two main projects in 12 countries organising over the time period between 2017 and 2019. The first project, according to the FDI (2018) are the 21-day oral health school programmes which deliver the key message to children and educate them the importance of dental hygiene by tooth brushing twice a day with a fluoride toothpaste. The children are becoming the advocate of oral health. The school programme aims based on the supervision teaching them the technique of brushing teeth and develop the habit of regular tooth brushing. The impact of the school programme is measured by observing the habits of a focus group before the programme and after the 21-day long programme.

The second project includes the World Oral Health Day activities. The World Oral Health Day is celebrated annually on 20 March. The company aims, that in 2017 there were activities around 12 countries related to education of youth about dental hygiene.

Nevertheless, the purpose of the partnership between FDI and Unilever has its business side. In the Unilever's website is pointed out (2018), that approximately 3 billion people do not brush their teeth twice a day and 1 billion or maybe more do not use fluoride toothpaste at all. That is a potential market for products sold by Unilever's brands such as Signal. Globally, the company (Unilever, 2018) reached about 78 million people in 2017 which means 4% growth of their Sustainable Living brand. The company's target is of 50 million people by 2020.

The business aim is highly obvious in the example of their activities in Sri Lanka. Unilever claims (2018), that about 1.5 million people are living in regions which are focusing on supply of tea business and they have limited access to a dentist or even a store to buy essential products of dental hygiene. The company organised dental summer camps by the end of 2017. The camps focused on children between 5-15 years old. The children now get an annual check-up and treatment from a dentist. The company organised courses in schools as well dedicated to dental hygiene. Furthermore, new stores were open so the families have better access to the essential products. These stores create new markets for Unilever's brands such as Signal and Lifebuoy.

Other Unilever's campaign which should be mentioned is the Little Brush Big Brush. The campaign designed by R/GA London (Farey-Jones, 2016) employed Facebook chatbot to educate youth to brush their teeth twice a day. Little Brush, Big Brush is designed for the chatbot and aims to target children and parents. There are 21 stories represented by animal characters. The aim of the games is to find way home. The family must complete regular brushing challenges in order to finish the games.

Anuj Rustag, global brand director of Signal said for Campaign magazine (Farey- Jones, 2016): "We are really proud of this fantastic piece of personalized communication. Research has shown that we can help to drive behavioral change with 21 episodes of Little Brush, Big Brush evening challenges, and that is something really meaningful."

### 3. The Role of the Dentist in Innovation

Health care organizations and purchases, public and private, and also clinical professionals play important role in approving the products, services and delivery models of healthcare interventions. Nevertheless, according to Bower (1996), the general public and particular groups interested in healthcare are able to make an indirect influence over prioritization and funding and adopting of specific innovations. However, according to Bower, in all developed countries there are free major (sometimes conflicting) forces, which currently drive powerful demands for innovation in every aspect of healthcare.

- I. Technology opportunity – the vast capability to develop novel methods of diagnosing, treating and monitoring patients.
- II. Growth in demand – past success in producing "medical miracles" has boosted demand.
- III. Growth in costs – has put pressure on public purses and also private insurers.

In order to understand how these forces are influencing the European dentistry, this research demanded to interview two professionals in this field. The first is Roman Šmucler MD, CSc, a president of the Czech Dental Chamber, and Doctor Samuel Elhadad, who works for an Israel-American company Dentsim, which is developing innovative products for dental markets in the Europe and the US.

According to Šmucler (Appendix 6.3), all the mentioned forces are present in dentistry. Nevertheless, there is one more important force which forces the demand for innovation – the need of dentists to excel. He says that dentistry is very competitive, because only in the Czech Republic is approximately 500 dental clinics. He claims that it is not only about money, but about the feeling from a job well done.

The health care system in Czech Republic (Health Care System in Transition, 1999) is based on a compulsory insurance model, with a number of insurers financing health care providers on the

basis of contracts. These providers are government hospitals and private providers of dental services such as small and medium enterprises and entrepreneurs. According to the Czech Dental Chamber (2018), in 2003 about 90% of dental care was delivered by private dentist. In 2007 about 87% of all practices were private.

Elhadad pointed out (Appendix 6.2), that the medical field is different from dental field because of two factors. First of all, it is very surprising, that basically the dental healthcare in the Europe is socialised. That means, to take care in the EU is easier than in the United States. Even though, because it is accessible, it seems that dental health of the average European is lower than in the US. Elhadad believes, that it is all about education and prevention and the education of oral health in the European sector is not well done yet.

The second factor, according to Elhadad, is the fact that dentistry (in average) is not the legal issue so that the technology meets the dental market much later than the medical market. But he agrees, that there are some specific health markets with basically match these three mentioned forces above.

Nevertheless, Šmucler do not agree with this claim. He believes that the willingness for innovation in dentistry is huge. He claims, that dentist attend many expensive trainings and the competition between them creates pressure and the willingness is much higher than the doctors from hospitals have. He says that dentists are probably farthest in adopting new technologies – for example 3D printers and CAD-CAM are becoming standard. CAD-CAM is a technology suitable for creation of dental restraints such as dental prostheses, including crowns, crown lays, veneers, inlays etc. (Rekow, 1987). Furthermore, the dentistry is getting ready for full robotization. He says that orthopaedics is not so far.

But, Elhadad argues, that dentists are more conservative than medical doctors. His argument is built upon two points. The first is that the European dentists are basically entrepreneurs. They have to manage the cost effectiveness of their offices. They have to focus on return of investment of each product. They rather avoid techniques or products which increase the cost.

As an example, Elhadad mentioned CAD-CAM as well. He says that CAD-CAM is becoming a standard in the US, but it is not becoming the standard of care in the Europe. Elhadad argues

that it is because the European dentists are completely under control of government. By the nature of dentists would maybe possible wants to adopt new technologies but not without return on investment and it is based on what the public and government will allow to reimburse. The patient will always choose the product or service which is paid by government. This is the bad cycle of the current dentistry.

The second point is that the dentists are very isolated and alone. The dynamic is different compare to the medical markets. Usually, hospitals have the ability to pay for the technology because it is the standard of the care. Furthermore, this ecosystem allows to talk to each other and to share information. But, in the case of dentist, the only way they can do that is to be proactive and learn by them-self about new technologies. These two factors cause that the dentist are not able to exchange the information what technologies are as easy as being part of a hospital team.

According to Elhadad, the innovation already exists in the European market, but the way how dentists adopt new technologies is limited. The reason is, according to Elhadad, the health system policy. Elhadad explain the system on the following example: in the Czech Republic, most of the treatment is covered by government. If a patient with a missing tooth is asked to choose between a bridge that will cost 200\$ or an implant with the same cost. In the second case the insurer will pay back 75% of the cost. The patient will take the bridge for sure. This system, Elhadad says, does not allow covering the cost to set up new technology in the dentist's office.

The participants were asked on how innovation technologies affect the cost of dental services. Šmucler pointed out, that the nature of cost of innovative technologies is the same as everywhere. At the outset, the cost of the technologies is higher, but later on, the competition tends to decrease the cost.

Once the technology is applied, Elhadad claims, the quality of dental services increase. On the other hand, it also makes the patient spend more money. Elhadad thinks that it will be more out of patients' pockets than from insurers.

To finish this part, Elhadad argues, that in the forces mentioned by Bower at the beginning of this chapter is missing public health sector (in the context of dentistry). The public health sector in the Europe is very complex and does not allow private sector of dentistry to be bold to adopt more technologies.

The second part of the interviews related to prevention in the field of oral health. As is mentioned in the introduction of this research, WHO (2012) and WDF (2015) claim, that tooth decay is the most extended chronic disease and becomes one of the major global health challenge. WHO argues, that this challenge must be solved by prevention of oral disease and promotion of oral health. Furthermore, patients are motivated to become pro-active in their own care. Thanks to this there are expected increasing quality of healthcare services and facilitation of healthcare at all.

Šmucler pointed out, that most of the countries plan to eradicate tooth decay until the 2029. He does not believe that the Czech Republic would achieve it. Even though, the state of tooth decay and missing teeth are declining. Unfortunately, the epidemiological data about the Czech Republic are missing. In the Czech Republic, surveys on tooth status and treatment have not been conducted since 2006. The last oral health analysis of the Czech population was published in 2003. Nevertheless, it is expected increase in the dental caries experience among children and young adults in areas in which prevention and education have been neglected or removed (Glass, 1982). From the long-term perspective, according to the First International Conference on the Declining Prevalence of Dental Caries (Glass, 1982), the dental caries experience was decreasing until the 1982. The prevalence of dental caries may increase as urbanization increases, especially in developing countries.

According to a study carried out by the Czech Dental Research Institute (Horálková, 2012), the state of teeth in the Czech Republic is below the European standard. Statistics provided by the OECD (2018) describe the data related to dental health status of the Czech population. The data are available only for the years between 1987 and 2006. In 2006, the DMFT index of the Czech Republic was 2.6. Compare to Denmark and the United Kingdom which scored 0.8 DMFT. DMFT index is commonly used to measure the prevalence and severity of dental caries



in a defined population. The index refers to decay, missing or filled teeth in 12-years-old age group.

The data available in Datahub (2018) provides clear insights of the national oral health status. In the Czech Republic, between 40 – 59% of 12-years-old children in average have caries. To compare, in Denmark and the United Kingdom it is between 20 – 40% in the 12-years-age-group children.

The question is: What must be done in order to achieve zero of dental pain experience until 2029? Elhadad argues that it is the health care system which must become aware of the cost-effectiveness of public health promotion. The system is controlling what is acceptable and what is unacceptable on the cost-effective treatment.

Elhadad pointed out, that some countries have very low number of cavities such as Norway, Sweden or Denmark. What drives the dentist to apply new technique is how much money they can charge. It is all about that, he claims. In the Scandinavian countries for example, they are awarded by providing and developing oral health education and oral health prevention technology. But many other countries such as Italy and Spain are not very well educated in this field. The preventive approach will be dominant, Elhadad says, that only if in the future it will be promoted by public healthcare service. Once, they will understand that in long-run they can reduce the cost of that sector, they will change the way how they allocating the reimbursement of the different services.

Elhadad does not trust the system. He says that the system is completely necrosis. It is basically waiting for disease to appear and fix. The statistics according to Elhadad shows the rate of reimbursement for prevention examinations or tooth cleaning is less reimbursed than the cavity, than the crown and the cavity canal. The same opinion has Šmucler. He claims, that the health care system in the Czech Republic is based on treatment of cavities rather than on prevention.

Nevertheless, Šmucler believes that we are entering gold era of dentistry. Dentist are working on the total eradication of tooth decay, there is huge revolution due to the use of artificial

intelligence and robotics. According to Šmucler, the patients will see a completely different world.

But, Elhadad is not so optimistic in the way how technology might help to solve the problem of global decay epidemic. He believes that prevention is not about technology at all. It can help the patients who are already educated about how important the toothbrush is. The problem according to Elhadad is, that the patients do not know about it. It does not make sense to offer a smart toothbrush which is doing the job for him. Because these patients do not understand the value and do not want to pay for it.

Elhadad claims, that first of all it is important to educate patients in order to understand why he has to brush. It is very simple. All is about education. Doctors have to start with children and then family. It depends on the education level of the parents and the way the dentist has to influence them to be better.

Built upon the literature review, the last part if the interviews focused on businesses involved in prevention. Šmucler says that thanks to many commercial companies involved, the Czech Dental Chamber was able to organize 650 dental prevention events just in one week. Furthermore, he claims that even government and insurance companies are becoming interested are starting to participate. Elhadad agrees. He thinks that private companies participate in the cost of the public health dept. It is mutual relationship which is beneficial for both the public sector and the private sector. Elhadad believes that it is not unethical to sell a toothbrush which looks like a children's super hero, if the children is using it right. But, he says, the relationship between private companies and public health institutions should be more in tune and in control.

## 4. Conclusion

From the beginning of the 20<sup>th</sup> century, the dental caries experience is decreasing (Glass, 1982). In these days it was recognized, that toothbrush is the most effective weapon against tooth decay. As the US Army dental surgeon John Sayre Marshall wrote (*Teeth*, 2018): "The toothbrush is the yard stick by which the degree of civilisation of people and nation may be measured." During the World War I. in 1926, the national oral health became the British government concern, because many soldiers rejected due to poor oral health (*Teeth*, 2008). Prevention was considered as the most powerful weapon in the fight against tooth decay. The health campaigns started focused on children as well. The key message was the importance of visiting the dentist routinely, not only after one has toothache.

During the mid-20<sup>th</sup> century, a couple of organisations such as dental associations, ministries of health and ministries of information improved their communication about how the public should take care of their teeth and those of their children (*Teeth*, 2018). The health campaigns focused mainly on children. The key messages were the importance of cleaning teeth twice a day, visiting check-ups regularly, and healthy eating and so on. Today marketing campaigns are much more complex and sophisticated. One of the most visible prevention program is Brush Day & Night (FDI World Dental Federation, 2018). This program is based on cooperation between Unilever and FDI. The aim is to teach people to brush their teeth twice a day with fluoride toothpaste. Unilever's objective (2018) is to increase markets of its brands such as Signal. Furthermore, the most advance preventive program mentioned in this research was the Little Brush, Big Brush (Farey-Jones, 2018). This campaign was designed for Facebook' chat-bots and it is based on a theory which says that people can develop certain habits after 21 days of practicing. The campaign was promoting not only health but the brand Signal as well. Šmucler (2018) said for the interview, that even the Czech Dental Chamber has organized a number of preventive programs thanks to business partners. Elhadad (2018) agreed that the relationship between private companies and public health institutions is good for both the business and the public health as well. But, he believes, that this relationship should be more under control.

From the 19<sup>th</sup> century, pooling teeth was understood as not serious job for established medical profession. This work was for barbers (*Teeth*, 2018). In 1925, SS White Dental Manufacturing Company (*Teeth*, 2018) came with a new dental chair which expands dentistry. This chair was innovative, because compare to its predecessors, it was hydraulically adjusted, the chair was in tune with hygienic and progressive image. Nevertheless, current seats such as A-Dec (2018) treatment station are much more sophisticated. The station is not only a chair anymore. It includes intraoral scanning data, lights, sink, digital imagining etc.

There was a significant change in manufacturing of toothbrushes as well. After World War II tooth brushing become routine when American soldiers had to clean their teeth daily (Bells, 2018). For the manufacturers the market was growing and it was the force of innovation of toothbrushes. From animal hair, bones and ivory (Kumar, Jayanth, 2011) to synthetic fibres and thermoplastic materials (Sammons, 2003). Innovation from rubber to coloured plastic was opportunity for manufacturers and franchises with an interest in children's market to cooperate. The example is the Mickey Mouse Donald Duck toothbrush holder from the 1930 (*Teeth*, 2018).

Earlier, toothbrushes were simply meant to provide an automatic cleaning, which kept on by modifying of offering new features in the products. Modern toothbrushes became much more complicated from the technological perspective and even from the way how the work with healthcare system. One of the most advanced products is Blizident (2018). This toothbrush is produced after scanning of the consumer's teeth and printed on a 3D printer. Other advanced products are Oral-B's (2014) smart series of toothbrushes. These toothbrushes are connected via Bluetooth to the user's smartphone. It provides daily insights to the user's cleaning routines, summary of sessions, reminders of preventive check-ups etc. The last example of innovative products is Beam (2018). This is the example of how products are becoming services. The toothbrush is tracking your daily cleaning habits and based on one's results the user is getting lower premium. It is an innovative product crossing the borders to insurers' business.

The second part of this research focused on the near future of dentistry. Nowadays, this research considers six factors which force the innovation in dentistry and oral health (Šmucler, 2018, Elhadad, 2018, Bower 2016).

- I. Technology opportunity
- II. Growth in demand
- III. Growth in cost
- IV. Need to excel
- V. Competition
- VI. Government

The opportunity in technology is present in dentistry, but the ability to adapt is highly influenced by the other factors. Growth in demand is speculative. The growth in demand for dental care services means worst oral health of population. The statistics, according to Elhadad (2018), shows the rate of reimbursement for prevention examination or tooth cleaning is less reimbursed than the cavity, that the crown and the root canal. Growth in cost might be influenced by adopting new technologies. But in the European market it is limited by public health policy. There is something like the need to excel among dentists (Šmucler, 2018).

The dentists are entrepreneurs and they are forced by competition. They have to manage cost and expenses effectively. In the case they want to apply a new technology they always consider return on investment (Elhadad, 2018). They rather avoid these products which increase the cost of their services. But, the willingness for innovation is there from the nature of dentistry (Šmucler, 2018; Elhadad, 2018).

The healthcare system in the Europe is based on compulsory insurance model. The system is socialized. Elhadad (2018) claims, that this is the reason why in the Europe the access to care is easier compare to the US. But, he pointed out, that the oral health of average European is lower than of Americans. Elhadad believes that it is because the oral health education is less

developed in the Europe. Furthermore, this model, according to Elhadad (2018) creates less effective environment for innovation. Patients will always go for those services and products which are covered by insurers. They do not want to pay.

In the future, dentistry will be different in the Europe and the US. According to Elhadad (2018), the US dentistry will be more innovative. Šmucler claims (2018), that dentistry will be fully robotized, artificial intelligence will be commonly applied, 3D printers and CAD-CAM will be standard of care. It will be fundamentally different world.

The product of dental hygiene will be much more sophisticated than it seen today. But, these products will be less interested for those who are not educated in oral health. The education will be mentored by public institutions in cooperation with business. This world will split in the eyes of consumers. The patients will have to become consumers of various products of dental hygiene which will be promoted as need for oral health. Products, services and promotion will be one.

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## 6. Appendices

### 6.1 Participant Information Sheet

#### Participant Information Sheet

**Study Title: Innovation in the Prevention of Oral Diseases**

**Researcher: Radim Pekarek**

#### **Background of the study**

A healthy and well-functioning mouth is important for essential human functions, such as speaking, smiling, socializing and eating. Our oral health and overall health go hand in hand. Unhealthy mouth can dramatically impact our physical, psychological wellbeing, and happiness.

Nevertheless, according to the World Dental Federation, tooth decay is the most extended chronic disease worldwide and becomes one of the major global health challenge. Oral health seems to be less challenging problem among policy makers.

Nowadays, due to advance in modern technologies, there is seen a shift in the relationships between health professionals and patients. According to D. Jane Bower, in all developed countries the technological opportunities are the driver forcing demands for innovation of healthcare. The questions are: how the near future will look and how emerging technologies change the way how we approach this major global health challenge?

#### **Purpose of the study**

The purpose of the study is to provide overall insights to the context of emerging technologies employed in modern dentistry with the focus on prevention and to analyse current trends in order to construct a most likely to happen future scenario.

#### **Why have I been chosen?**

The participant is considered as professional in the focus area. He has high reputation not only as professional dentist, but entrepreneur and expert in new technologies as well.

#### **Who is responsible for the study?**

Radim Pekarek under the supervision of Royal College of Art

#### **What will happen to me if I take part?**

The participant will be asked on questions related to his opinion about emerging technologies and its impact on dental services, changes forcing the future of dentistry and the future of prevention of dental diseases and promotion of oral health.

**Are there any disadvantages in taking part in this study?**

There are no disadvantages in taking part in this study.

**What are the possible risks of taking part?**

There are no risks involved.

**What are the possible benefits of taking part?**

It is hoped that the study will help to identify current trends in preventive dentistry in the way to provide essential insights for the future designers, managers and medical professionals which aims to develop cutting-edge services.

**Confidentiality - who will know I am taking part in the study?**

All information which is collected about the participant will be presented publicly in the research.

**Who has approved the study?**

Royal College of Art has approved this study.

**Researcher contact details:**

Radim Pekárek,  
(+420) 734 158 033,  
radim.pekarek@network.rca.ac.uk

## 6.2 Semi-Structured Interview

### SEMI-STRUCTURED INTERVIEW, SAMUEL ELHADAD 15 JUNE 2018

Dear doctor,

The following questions relate to innovation in stomatology. D.

Jane Bower claims in the book *Service Innovation*: "...However, in all developed countries at the present time three forces currently drive powerful, often conflicting demands for innovation in every aspect of Healthcare:

- I. *Technology opportunity – the vast capability to develop novel methods of diagnosing, treating and monitoring patients.*
- II. *Growth in demand – past success in producing "medical miracles" has boosted demand.*
- III. *Growth in costs – has put pressure on public purses and also private insurers.*

My first question is:

**1. Are these factors dominant in the EU stomatology as well, or do you see any other factors which stimulate innovation of dental services?**

*This is more medical field and it is different from dental field because there are two factors involved in it: 1) there is not legal issue if you do not take care of your teeth. Especially in the EU market, it is very surprising, that basically that dental healthcare in the Europe is socialised. So, to take care is easier than in the United States. Even though, because it is accessible, it seems that dental health of the average European is lower than in the US. I think it is all about education and prevention. And the education of oral health in the European sector is not well done yet. 2) The second factor is the fact that dentistry is not the legal issues so that the technology meets the dental market much later than the medical market. I am talking about average patient in the Europe. You still have high dentistry for a specific patient health that will basically match these three factors what you have mentioned.*

*But the fact that there is the new technology what you can apply in dental field makes the quality of care better but also it makes the patient spend more money. I am not sure that insurers in the Europe will tip in. It will be more out of the pocket from the*

*patients that from the insurers. So, I do not agree with the statement that growth in cost has put pressure on public purses and private insurers.*

*Concerning private insurers, some of them will maybe tip in but most of the time they do not tip in. An example, implant treatments. The fact is that there are some markets in the Europe where the government is subsidising their dental care. They want to be imbursed if the patient is going to place an implant whereas it will refund part of the treatment if you go lower and less standard of care treatment like dentier.*

*So, the part what you are missing here is public health. The public health sector in the Europe is very complex and does not allow private sector of dentistry to be bold to adopt more technologies.*

**1.1 So, if I understand it well, you are saying that in the European dental market is less innovative because the insurers do not want to pay for it?**

*Innovation exists, and it is on the market. But how many of the dentist in the Europe could adopt the technology is limited because of the cost of the technology and not reimbursement of the health system.*

*Think yourself, if you come to the Czech - there is everything payed by government, almost. If you come to my office and I tell you, you are missing a tooth and I can give you a bridge that will cost you 2000\$, I can put you an implant which cost the same cost, but in this case, you will not see a dollar from your insurer. On your bridge you will get back 75% of the cost. So, the patient will take the bridge. It does not allow recovering the cost to set up new technology in his office.*

**2.  
How effective and efficient are the European dentists in adopting new innovative technologies? Are they rather conservative or are they willing to experiment and test new approaches?**

*I would say dentist are more conservative than medical doctors. Also, I see there two main factors. 1) The dentists are entrepreneurs; they have to manage the cost effectiveness of their offices. The way to do that keep it is to adapt certain habits. Knowing the products, knowing*

*that that it works, it avoids you to have remakes or it teaches you something new (new techniques) that will maybe increase the cost of that technology. We do not have any ROI, so that is one of the factors – the economic factor.*

*The second factor is the fact that the dentists want to own their own practice. You are not exposed, you are very isolated and alone. It is little bit different from the dynamics of public healthcare. Because the medical market usually, the hospitals have the ability to pay for the technology because it is the standard of the care. And the second think is that it allows doctors to talk to each other and share information. But in the case of dentist, the only way how they can do that is to be proactive and learn by them-self about new technology. We have some continuing education that allows you to know what is on the market but it does not make the dentist to change his habit that he sees something that looks amazing.*

*So, these two factors 1) the economical and 2) that the dentists are more isolated – and not able to exchange the information what the technologies are as easy and fast as being part of a hospital team. And the third on 3) because of that way of working it makes the dentist less eager to change his habits. Once you have a technique which works you do not have change to change it. I would say it is a little bit small minded way of going with.*

**2.1 For me, it is surprising, that even though the dentists are entrepreneurs, you are saying that they are less willing to take a risk.**

*They are entrepreneurs and they have to balance their sheets. They have to manage the money. If you are in a business you have to be effective in costs. Let's take an example of CAD-CAM. It is becoming a standard in the US, but it is not becoming the standard of care in Europe. You are completely control by government how much money you can take by government. Maybe I am completely wrong but that is what I know from my past experience but I think it still works like that. So, I think that by nature of dentistry would maybe possible wants to adopt new technologies but not without ROI. And ROI is based on what the public and government will aloud to reimbursed. And the patient will not choose a prestige that will be reimbursed by government. That is the bad cycle we have in dentistry.*

**The second part of this interview relates to prevention in the field of oral health. WHO and WDF claim, that tooth decay is the most extended chronic disease and becomes one of the major global health challenge.**

**WHO argues, that this challenge must be solved by prevention of oral disease and promotion of oral health.**

**Nowadays, patients are motivated to become pro-active in their own care. Thanks to this there are expected increasing quality of healthcare services and facilitation of healthcare at all. The discussion is about patient-oriented approach.**

**4. Do you think, that this approach will be dominant in the future? Or there will be dominant the emergency approach as we see today.**

*The European market is driven by one factor that is very important. There is a bus that is basically controlling what is acceptable and what is unacceptable on the cost-effective treatment.*

*If they understand that basically they will reduce the cost of reimbursement to patient better about the risk of having bad oral health, like for example having cardiac infection for some people, having some diabetes problems...there is some risks. If you keep some bacteria in your mouth that you can develop some heard issues or diabetes issues and obese Issues. So, obviously it will be driven what public health service is asking form the dentists.*

*It is very different form each part of the Europe. The lowest number of the cavities in the world is, I think Scandinavia, but you should research it. If you take Norway, Sweeden or Denmark, those countries are on very low rate. I am talking about locals, because I do not know what can happen with all these immigrants and how it will change dynamics in these countries.*

*What drives the dentist to apply new technique is how much money they can charge. It is all about that. For example, in the Scandinavian countries they are awarded by providing and developing oral health education, oral health prevention technology. But, many of other countries such as Italy, Spain are not well educated. It is the factor which is variable. To answer you r question, this preventive approach ca be dominant in the future if it will be promoted by public healthcare service.*

**4.1 It makes sense that healthier population is cost less the healthcare. So why the European governments are less interested in promotion of oral health and prevention of**



**oral diseases?**

*This is interesting because they do not understand that. If you take the rate of reimbursement for prevention examination or tooth cleaning it is less reimbursed than the cavity, than the crown, than the cavity anal. So, the public health system did not realise what they should push. The problem what they do not understand is that if you have not the presage done, and involved in the treatment, it means that you did not work very hard. And it is why they do not value the service money vice. Once they will understand that in the long-run they will reduce the costs of that sector, they will change the way they are allocating the reimbursement of the different services.*

**4.2 Do you think it is right or it is just how it is?**

*It is not right at all. The system is completely necrosis. It's basically waiting for disease to appear and fix it. And again, the dental decay, it's very simple. It is about education. It is all about education. You start teaching kids and then family. It depends of the education level of the parents and the way the dentists have to influence them to be better in the category. It is what I see.*

**5. Do you think, that technology together with prevention might be crucial in solving this global health challenge? Do you think we are entering the better era?**

*I think that prevention is not about technology. It will help the patients which are already educated about how important it is to brush, to have more effective way of doing it. But, the patient that does not know about it, why would he go and buy a toothbrush which is doing the job for him. Because for him it is waste of money. It is not valuable to spend money on that. That is my humble opinion, I am maybe wrong. From working with patients that is what I see.*

*These who are motivated, will obviously embrace technology advanced treatment or technology for prevention. Whereas, those who are not motivated won't understand anyway what it is for. First of all it is important to educate patient in order for him to understand why he has to toothbrush. I can tell him, I have here a new technology toothbrush which clean your teeth in one minute instead of three, which is bias, you know the brush is doing the job for you. But you know what, that is basically a good market for a company, but again, on the worldwide it is good. When you see big companies such as Oral or Colgate, they make tons of money. So, they are really selling, but they are selling the most cost-effective dentistry. That is where it is more important for the patients than prevention. And it is why they*

*are making the money. It is more and more toothpastes are coming such as whitening, these and that. This is maybe the way how to educate the patients by using of the factor of aesthetic.*

**Turning to prevention is related to the evolution of patients to consumers. I'll explain what I mean. Prevention is often associated with dental hygiene and it is necessary to change the mentality of patients to regular users of the products of dental hygiene. An example may be the cooperation of the international company Unilever and FDI. In the last 10 years, they have been organizing preventive programs around the world.**

**7. In the context of prevention, will we see more cooperation between public institutions and commercial brands over the next ten years?**

*I think the private companies participate into the cost of the public health dept. Obviously, it is already in place. It is mutual relationship which is beneficial for both the public sector – who is in charge of developing some prevention education and method of prevention and adopting maybe some marketing points they could not provide to the customer.*

*There is no problem with using a toothbrush, if the kid is using it right, which looks like your super hero. If the campaign is only about promoting and selling the brush in the cover of some hero it is not enough (33:57). The relationship between private companies and public health institutions should be more in tune and in control.*

**8. Is there anything else what is coming to your mind in the context of the future of dentistry in the next 10 years?**

*I see that technology is integrated more and more. And at least in the US, it makes dentistry much fun to work with. It makes the treatment planning and the treatment process much easier for the patient. It is very good for the professionals and for the patient. Part of it is about technology. So, in some parts of the world dentists adopt these technologies to benefit not only them but patients as well. It is in not a mainstream in the world. Amazing products of prevention are coming from Germany.*

*Definitely dentistry is very embarrassing technology because of facilitating treatments, making the treatment easier for the patient. But there must be ROI. And it is the limitation in the EU, not in the US because here we have no one to control the pricing.*

*I have just compared these two systems, the US and the EU. In the US the system motivates the dentist. But in the EU not, because of the cost and the rate of reimbursement in these countries.*

## 6.3 Questionnaire

### QUESTIONNAIRE, 8 JUNE 2018, ROMAN ŠMUCLER MD, CSc- THE PRESIDENT OF THE CZECH DENTAL CHAMBER (ČSK)

Dear doctor Šmucler,

The following questions relate to innovation in stomatology. D.

Jane Bower claims in the book *Service Innovation*: "...However, in all developed countries at the present time three forces currently drive powerful, often conflicting demands for innovation in every aspect of Healthcare:

- I. *Technology opportunity – the vast capability to develop novel methods of diagnosing, treating and monitoring patients.*
- II. *Growth in demand – past success in producing "medical miracles" has boosted demand.*
- III. *Growth in costs – has put pressure on public purses and also private insurers.*

My first question is:

**1) Are these factors dominant in the EU stomatology as well, or do you see any other factors which stimulate innovation of dental services?**

*This is true. Furthermore, the need of individuals to excel in stomatology plays important role. The field of stomatology is full of competition, in the Czech Republic, we have approximately 500 dental clinics. It is not only about money, but the feeling from a job well done.*

**2) How effective and efficient are the European (or Czech) dentists in adopting new innovative technologies?**

**Are they rather conservative or are they willing to experiment and test new approaches?**

*In stomatology, the willingness is huge – they attend many expensive trainings. The competition creates pressure and the willingness is much higher than the doctors from hospitals have.*

**3) How innovation technologies affect costs of dental services?  
Are they increasing or decreasing the costs?**

*It is the same everywhere. At the outset, the cost of some technologies is higher, but later on the competition tend to decrease the cost. It is the difference compare to oligopoly and monopoly from "big healthcare".*

**The second part of this interview relates to prevention in the field of oral health. WHO and WDF claim, that tooth decay is the most extended chronic disease and becomes one of the major global health challenge.**

**WHO argues, that this challenge must be solved by prevention of oral disease and promotion of oral health.**

**Nowadays, patients are motivated to become pro-active in their own care. Thanks to this there are expected increasing quality of healthcare services and facilitation of healthcare at all. The discussion is about patient-oriented approach.**

**4) Do you think, that this approach will be dominant in the future? Or there will be dominant the emergency approach as we see today.**

*Most of the countries plan to eradicate tooth decay until the 2029. We cannot achieve it but even in the Czech Republic the amount of tooth decay and missing teeth are declining.*

**5) Nowadays, we can see many innovations in healthcare related to technology such as tele-medicine, patient monitoring (smartwatch, wearables etc.), smart toothbrushes, e-clients (online records), social media, AI, etc.  
In the context of stomatology, where do you see the potential in adopting these technologies?**

*We are probably farthest – very common are 3D-printers and CAD-CAM, compare to orthopaedics, they are not so far. We are getting ready for full robotization in stomatology.*

**6) Do you think, that technology together with prevention might be crucial in solving this global health challenge? Do you think we are entering better era?**

*No doubt about that. We are working on total eradication of tooth decay.*

**Turning to prevention is related to the evolution of patients to consumers. I'll explain what I mean. Prevention is often associated with dental hygiene and it is necessary to change the mentality of patients to regular users of the products of dental hygiene. An example may be the cooperation of the international company Unilever and FDI. In the last 10 years, they have been organizing preventive programs around the world.**

**7) In the context of prevention, will we see more cooperation between public institutions and commercial brands over the next ten years?**

*Thanks to its commercial partners, the Czech Dental Chamber organized 650 dental prevention events just in one week. It seems that the government and insurance companies, who have not been interested in it yet, are starting to participate.*

**8) Will we see Signal Dental Clinic in the coming years? Will such companies be more committed to our health? Do you see similarly unique results of the connection between public and business interests somewhere?**

*We strive to learn the perfect hygiene 100% of children, and we believe that commercial partners will help us and they will dramatically increase their markets.*

**9) Where do you see the ethical boundaries of this cooperation? What do you think about ethics of this example: children's camps in Sri Lanka, where children learn dental hygiene under the Unilever's brands? Furthermore, Unilever has also opened its stores there.**

*We are doing this already.*

**10) Is there anything else what is coming to your mind in the context of the future of dentistry in the next 10 years?**

*We are in a huge revolution with the use of artificial intelligence and robotics. We will see a completely different world and I personally work very hard on it.*