PhD thesis summary
Sustainability in dentistry

PhD candidate: drd. Veress Szidonia-Krisztina
Doctoral supervisor: Prof. Dr. Székely Melinda

Climate change is one of the biggest issues of our time, to which healthcare is a significant contributor. Dental care is energy and resource intensive and is unsustainable in its current form. The World Dental Federation is calling on dentists to become more environmentally aware in their dental practices.

The first study aimed to assess the degree of openness of dentists to the idea of environmental awareness and knowledge on this topic. To this end, an online questionnaire consisting of 50 questions was compiled and completed by 98 dentists. The majority of respondents worked in urban practices (79.41%) and commuted to work by car (64.28%). 55.10% of respondents knew that travel significantly contributes to the carbon footprint of a dental practice. When choosing materials, quality is the main consideration, with environmental awareness being less important, but products with larger packaging are preferred in most cases over single-doses. 74.49% of respondents were open to the idea of environmental awareness, and 98.97% would do something to make their practice more environmentally friendly. Those who would like a more environmentally conscious practice are statistically significantly more likely to live in an environmentally conscious way in their households, to use environmentally friendly disinfectants, to create a "green wall" in the practice and to collect waste selectively. Based on the results, we can state that the responding dentists are fundamentally open to the idea of environmental awareness in the practice.

The second study determined the carbon footprint of the 10 most common dento-alveolar surgical procedures performed at the Faculty of Dental Medicine of the "George Emil Palade" University of Medicine, Pharmacy, Science and Technology in Târgu Mureș, while examining the ease of applying the carbon footprint as an indicator of environmental awareness. Dentists who want to achieve a more environmentally conscious practice need a simple, easy-to-use indicator that can both assess the environmental impact of their activities and monitor the positive effects of changes. For each of the 10 most common dento-alveolar procedures, 3 scenarios (best case, average case, worst case) were considered. The stages of the procedures were observed, as well as the materials and instruments used during them, and their mass and composition were determined. Based on these, the carbon footprint was determined using Defra conversion factors or, where not available, monetary conversion factors. The carbon footprints ranged from 338,825 to 3075,441 g CO_2eq. The carbon footprint of temporary tooth extraction and simple extraction with elevator or forceps was the lowest, while odontectomy of intraosseous impacted teeth had the highest value. Disposable materials contributed the most to the carbon footprint (on average 83%), especially in the worst

case scenario. There was a statistically significant difference ($p<0.00001$) between the results of the 3 scenarios. Energy consumption and disinfectant use also contributed significantly to the carbon footprint. Based on these results, the carbon footprint, although not the most accurate, is a simple tool for measuring environmental awareness. To reduce the environmental impact of dentoalveolar surgical procedures, it would be necessary to reduce the use of single-use materials.

The third study performed a life cycle assessment of the production of bone augmentation materials from allografts. Femoral heads removed during orthopedic surgeries can be reused, in accordance with the principles of the circular economy, to produce bone augmentation materials, making cancellous or corticospongiosa bone blocks or bone granules. Long bones taken from donor cadavers can also be used to produce bone augmentation material granules containing BMP proteins. Life cycle assessment is the standard method for assessing the environmental impact of processes or products. To do this, the production stages of allografts were monitored, determining the materials, instruments and energy consumption required. The data were evaluated in OpenLCA software, according to the ReCiPe 2016 Midpoint (H) and Endpoint (H) impact categories. During a production process, 500 g of bone granules or blocks are produced using femoral heads or 300 g of bone granules from long bones from cadavers. The carbon footprint of the production of bone blocks is 88,972 kg CO_2eq, while for the granules produced from femoral heads is 100.33 kg CO_2eq, and for granules produced from long bones it is 66,759 kg CO_2eq. In the case of impact categories, in addition to climate change impact, material resources (metals/minerals) and terrestrial ecotoxicity contributed most to the environmental impact. In most impact categories, chemicals and electricity contributed most to the results. Recycling femoral heads for the production of allografts could be an opportunity to make the production of bone augmentation materials and dental implantology more environmentally friendly. To optimize the production process, it would be necessary to use energy from green sources and to apply chemicals that are equally effective in degreasing and deantigenizing bones, but less harmful to the environment.

The fourth study examined the effectiveness of conventional and environmentally friendly disinfectants, as well as an environmentally friendly cleaning agent. The conventional disinfectants Gigasept and Zeta 1 Ultra, the eco-friendly disinfectants BossKlein IDActiv and Sekusept Aktiv and the eco-friendly cleaning agent Gigazyme were tested. The efficacy was assessed by determining the minimum inhibitory and bactericidal concentrations, and the cleaning efficacy was determined using the Bradford test for disinfection after controlled contamination or after use of instruments in the dental office. All tested disinfectants were able to exert a bactericidal effect at the concentration specified by the manufacturer and complied with the ISO 15883-5:2005 protocol for protein removal. In bacteriological tests, Sekusept Aktiv was the most effective disinfectant. Eco-friendly disinfectants can be an effective alternative for the disinfection of dental instruments and are less harmful to the environment than conventional ones.