OHSU School of Dentistry
Anthology
VOLUME 4 | ISSUE 1 | WINTER 2026


## Message from the School of Dentistry Anthology Team

Samyia Chaudhry, D.M.D., Christina Truong, D.M.D.

This first issue of 2026 opens the fourth year of contributions to the OHSU School of Dentistry Anthology. The online publication is dedicated to advancing and celebrating the scholarly spirit that defines our academic community. This collection brings together a wide range of voices—first-year students beginning their academic journeys, senior students refining professional perspectives, and faculty and staff contributing insights shaped by years of clinical, educational and research experiences.

Scholarship thrives not only through expertise but through curiosity, rigor and the willingness to ask meaningful questions. The work in this issue varies in complexity and experience, yet shares a unified commitment to learning, discovery and professional growth.

Personal and professional development remain central to cultivating academic excellence and leadership. Programs such as the Executive Leadership in Academic Medicine, or ELAM, and the Bell Leadership Institute Achievers program demonstrate pathways for faculty to strengthen leadership skills, expand scholarly impact and contribute to institutional innovation.

Two faculty members share their experiences, illustrating how structured development supports individual advancement and the evolution of our institution. Students likewise benefit from opportunities such as the American Student Dental Association National Conference and ASDA Diversity and Inclusion events, which foster leadership, networking and engagement with issues shaping the dental profession. Their reflections highlight how national involvement builds informed, confident and socially conscious future dentists.

First-year students' caseCATs showcase early engagement with critical thinking and evidence-based analysis. Topics include Curodont for enamel remineralization, xylitol and caries prevention, the effects of carbohydrate rich sports nutrition on athletes' caries prevalence, the effectiveness of Silver Diamine Fluoride–Modified Atraumatic Restorative Technique, or SMART, compared with traditional drilling, and antioxidant therapies for oral submucous fibrosis. Together, these caseCATs demonstrate the value of introducing scholarly inquiry early in the curriculum and students' growing ability to apply foundational knowledge to clinical reasoning and oral health decision-making.

This issue also features two projects that apply human-centered design to institutional and educational challenges written by School of Dentistry staff. One reimagines financial dashboards, transforming static reports into dynamic tools that align clinical operations with organizational priorities. The other examines empathy-driven design in dental education, exploring strategies to reduce dental anxiety. Alongside these efforts, an Innovation in Dentistry student interest group at OHSU presents practical creations—including an air water syringe holder and a resin composite gun replacement pin—highlighting student driven problem-solving to improve patient care.

Clinically focused scholarship from faculty and students further enrich this issue. A faculty authored article reviews digital dentures and a reference denture technique, emphasizing contemporary workflows and clinical outcomes. A case review written by a student explores Myoaligner therapy for temporomandibular disorders, demonstrating clinical decision-making that is supported by evidence and the integration of emerging technologies with patient-centered care.

This issue also highlights the impact of a student-run free dental clinic dedicated to improving access to oral health care for individuals experiencing homelessness. Through this work, students deliver essential services while gaining meaningful experience in compassionate, patient-centered care for underserved communities.

We extend our heartfelt thanks to the SODA editorial team—Senior Editor Ron Sakaguchi, D.D.S., Ph.D., M.B.A.; Senior Communicator Rhonda Morin, APR, M.L.S.; and Pam Pierce, M.L.S., M.S., of the OHSU Library—for their invaluable contributions and steadfast support in bringing this anthology to life.

Looking ahead, our next issue will feature OHSU Research Day, a signature event reflecting the scholarly vitality of the School of Dentistry. Thank you for your continued engagement and support of the School of Dentistry Anthology.

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## caseCATs



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# The use of Curodont™ Repair self-assembling peptide ($P_{11}$-4) for remineralization of enamel

Britney Muralt '29, Catherine Nordstrom '29, Anh Nguyen '29, Alexis Louie '29
Mentor: Carmem Pfeifer, D.D.S., Ph.D.

**Background/case scenario**

The remineralization of non-cavitated enamel carious lesions remains a primary challenge in minimally invasive dentistry. A new and promising alternative to traditional fluoride treatment is Curodont™ Repair, which contains the self-assembling peptide ($P_{11}$-4) that creates a scaffold within the lesion, facilitating the deposition of hydroxyapatite crystals. This approach is particularly relevant for high-risk populations, including children and patients with special health care needs, where preventing the progression to cavitation is critical. A clinical scenario might involve a pediatric patient presenting with active white spot lesions on primary anterior teeth or an adolescent with post-orthodontic decalcification. Collectively, these studies examine the effectiveness of Curodont™ Repair across varied patient populations, dentitions and lesion types, supporting its use as a minimally invasive approach for the management of early enamel caries.

**Clinical question**

In patients with early tooth decay and white spot lesions, is the use of Curodont Repair Fluoride Plus more effective than standard fluoride varnishes for guided enamel remineralization and the long-term health of the tooth?

## CAT 1

**Article.** Systematic review and meta-analysis on the effect of self-assembling peptide $P_{11}$-4 on arrest, cavitation and progression of initial caries lesions[1]
**Authors.** Keeper J., et al.
**Published.** July 2023
**PubMed ID.** 37245138

**Methods.** Database search identified six clinical studies comparing carious arrest in initial carious lesions with peptide $P_{11}$-4 vs. fluoride varnish vs. no treatment in human permanent teeth in vivo. 227 participants with 319

**POPULATION**
Patients over the age of 3 with early tooth decay and/or white spot lesions

**INTERVENTION**
Curodont Repair Fluroide (self-assembling peptide $P_{11}$-4)

**COMPARISON**
Other topical remineralization agents (e.g., standard fluoride varnish, silver diamine fluoride)

**OUTCOME**
Enhanced enamel remineralization and lesion repression

**Conclusion.** The biological mechanism and consistent clinical benefits suggest that Curodont™ Repair lowers the risk of progression for early interproximal carious lesions. Overall, the evidence supports using Curodont™ as a conservative, minimally invasive option to halt early approximal lesions and reduce the likelihood of future cavitation.

**Keywords.** Curodont™ Repair Fluoride Plus, $P_{11}$-4 peptide, remineralization, white spot lesions

white spot lesions were examined in the studies. End points were assessed for 132 lesions active at baseline treated with Curodont™ Repair compared to the control group.

**Results/conclusion.** This systematic review and meta-analysis provide evidence that Curodont™ Repair is likely effective for arresting initial carious lesions across four studies and for reducing lesion size across two studies. For the effect of Curodont on caries arrest, the relative risk was 1.82 (95% CI, 1.32 – 2.50, p < 0.001). For cavitation progression across 143 lesions, the relative risk was 0.32 (95% CI, 0.15 – 0.69, p = 0.003). In regard to secondary outcomes, specifically the effect of Curodont™ on decreases in merged ICDAS across 109 lesions, there was a relative risk of 3.68 (95% CI, 0.42 – 32.26). The other secondary outcome was the effect of Curodont on lesion size measured by digital photography, which had a mean difference in favor of Curodont™ of 32% across 81 lesions. 73% of all Curodont™ Repair treated caries lesions were anticipated to arrest with 45% of those attributed to Curodont™ only.

**Validity/applicability.** While correlation between Curodont™ Repair and caries arrest was shown, the meta-analysis was based on a limited number of studies because of the novelty of Curodont™ Repair. Larger controlled trials are needed to verify the positive correlation between the use of Curodont™ Repair and caries arrest.

**Level of evidence.** Level 1-Systematic review and meta-analysis of RCTs

## CAT 2

**Article.** Remineralization of white spot lesions in primary teeth using an intensive application protocol of Curodont™ Repair Fluoride Plus, MI Varnish or Duraphat Varnish (randomized controlled clinical trial)[2]
**Authors.** Khairy S., et al.
**Published.** Sept. 2025
**PubMed ID.** 40716822

**Methods.** Sixty-six high caries risk preschoolers with active white spot lesions in their primary anterior teeth were randomly assigned to receive either Curodont™ Repair Fluoride Plus, MI Varnish or Duraphat. The active white spot lesions were assessed using ICDAS-II criteria and DIAGNOdent laser fluorescence at baseline and after three, six, nine and 12 months to evaluate size changes as well as esthetic improvement.

**Evidence search strategy**

PubMed (remineralization) OR (guided enamel remineralization) OR (remineralize*) AND ($P_{11}$-4 peptide) OR (Curodont™)

**Results/conclusion.** Regarding changes in ICDAS-II severity scores, the Curodont Repair Fluoride Plus, or CRFP, group had no statistically significant changes while groups treated with MI Varnish or Duraphat had significant changes with P-values of 0.029 and 0.017. The CRFP group had 4.6% of lesion progression after nine and 12 months while the MI Varnish group had 10.2% lesion progression and Duraphat had 17.7%. Regarding lesion activity, the CRFP group had 95.4% inactive lesions after 12 months compared to MI Varnish, which had 89.8% and Duraphat at 69.4%. For secondary outcome results, CRFP groups had a median lesion size percent reduction of 28.6% while MI was 18% and Duraphat was 10.4% (P-values = < 0.001). Chi squared tests revealed Curodont™ groups had moderate esthetic improvements (58.5% in 12 months) and exceptional improvements (35.4% in 12 months) in VAS scores. MI Varnish groups had moderate improvement (69.5% in 12 months) and Duraphat had mild improvement (37% in 12 months). Adjusted Odds Ratio for CRFP groups was 6.46 (P=0.011) for caries arrests and 19.86 (P=0.003) for decreasing the number of active lesions when compared to Duraphat. All fluoride agents reduced lesion size, but the greatest reduction and esthetic improvement were seen with the CRFP groups.

**Validity/applicability.** This trial provides strong evidence that CRFP yields better remineralization and esthetic improvement than at least one other standard fluoride varnish in preschool children with high caries risk. However, the trial only included primary teeth rather than primary and permanent teeth. Also, other fluoride treatments like gel or toothpaste were not included. But with the results provided, selection bias is reduced due to randomization. There were multiple objective outcomes measured, and a 12 month follow up adds some clinical relevance. So CRFP does show superiority to MI Varnish and Duraphat but in a very specific setting and would need further investigation to guarantee it as a therapeutic option for all teeth.

**Level of evidence.** Level 2-Randomized controlled clinical trial

## CAT 3

Article. Remineralization of post-orthodontic white spot lesions with a fluoride varnish and a self-assembling $P_{11}$-4 peptides: a prospective in-vivo study[3]

**Authors.** Güven E., et al.
**Published.** Aug. 2024
**PubMed ID.** 39096337

**Methods.** Thirty-two subjects, aged 10–18 with 107 post-orthodontic white spot lesions, or WSL, were divided into four groups to receive either nothing (control), tricalcium phosphate containing fluoride varnish, Curodont™ Repair Fluoride Plus or a combined application of the two. Before application, caries risk profile was assessed by evaluating diet, plaque index, gingival bleeding index and salivary flow rate and WSL baselines values were measured with laser fluorescence. After application, remineralization values were obtained using the same laser fluorescence at six weeks, three and six months.

**Results/conclusion.** The fluoride varnish group showed the greatest and most lasting remineralization at six months, with significant improvements in ΔF, ΔQ and lesion area. The $P_{11}$-4 peptide alone produced notable improvement at three months. The combined therapy showed significant progress at three and six months. When comparing treatments, only the fluoride varnish performed significantly better than the others at six months. All groups experienced a decrease in tooth lightness (L*) at six months, while a noticeable color change (ΔE*) was seen only in the control group between three and six months. Overall, fluoride varnish offered the strongest long-term effect, while $P_{11}$-4—whether used alone or with fluoride—provided earlier but less lasting improvements.

**Validity/applicability.** This study shows that the highest remineralization occurred with only the fluoride varnish group at six months; however, it was positively affected after the use of Curodont Repair Fluoride Plus. By combining the two treatments, remineralization occurred earlier but with less lasting improvements. The goal of this study was to determine how fluoride would affect teeth after orthodontic treatment and based on the results both fluoride applications provided remineralization, but fluoride with TCP was longer lasting. This shows that although Curodont™ remineralizes enamel, it is not necessarily long term, and further testing would need to be done to have a definite answer.

**Level of evidence.** Level 3-Prospective in-vivo clinical study

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**1.** Keeper, J. H., Kibbe, L. J., Thakkar-Samtani, M., Heaton, L. J., Desrosiers, C., Vela, K., Amaechi, B. T., Jablonski-Momeni, A., Young, D. A., MacLean, J., Weyant, R. J., Zandona, A. F., Sohn, W., Pitts, N., Frantsve-Hawley, J. Systematic review and meta-analysis on the effect of self-assembling peptide P11-4 on arrest, cavitation, and progression of initial caries lesions. *Journal of the American Dental Association* (1939), 2023;154(7), 580–591.e11. https://doi.org/10.1016/j.adaj.2023.03.014

**2.** Khairy, S. M., Talaat, D. M., Dowidar, K. M. L. Remineralizarion of white spot lesions in primary teeth using an intensive application protocol of Curodont™ Repair Fluoride Plus, MI varnish or Duraphat varnish (Randomized controlled clinical trial). *The Journal of Evidence-based Dental Practice*, 2025;25(3), 102163. https://doi.org/10.1016/j.jebdp.2025.102163

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# Effect of frequent consumption of carbohydrate-rich sports nutrition on dental caries prevalence in elite athletes

Rianne Aboumengel '29, Ellie Anderson '29, Ethan Barber '29, Dallan Bye '29, Maddie Carter '29

### Background/case scenario

Research shows that high endurance athletes have a higher prevalence of dental caries compared to the general population. This is due to their adherence to a sports diet, which entails frequent consumption of foods high in carbohydrates and sugar. It is mainly consumed through sports drinks, energy gels or bars. All of these are high in sugars and acids, which lower oral pH and create the ideal environment for enamel demineralization and the growth of bacteria, which contribute to dental caries. Along with the type of food consumed, the frequency with which athletes consume food also puts them at a higher predisposition for caries, and other oral related diseases. This prolongs the exposure of teeth to sugars and acids, increasing caries rates in athlete populations. Clinicians should consider athletes a higher-risk group for caries, counsel on timing/choices of sports nutrition, emphasize preventive measures and coordinate care with sports nutritionists.

### Clinical question

How does adherence to the sports diet, one that is typically high in sugar and carbohydrates, influence an endurance athlete's risk of developing dental caries?

## CAT 1

**Article.** Sports diet and oral health in athletes: A comprehensive review[1]
**Authors.** Schulze A., et al.
**Published.** Feb. 2024
**PubMed ID.** 38399605

**Methods.** Database searching identified 17 studies recording DMF(T) decayed, missing, and filled teeth and/or as the proportion of elite or professional athletes with caries and treatment provided in dental clinics at larger events.

**Results/conclusion.** Reports high ranges of oral disease in elite athletes (dental caries 20–84%; erosion 42–59%; periodontal disease 15-41%),

**POPULATION**
Adult athletes participating in high endurance sports

**INTERVENTION**
The high consumption of foods rich in sugar and carbohydrates

**COMPARISON**
Regular food consumption

**OUTCOME**
Prevalence of dental caries experience and severity in individuals

**Conclusion.** Multiple systematic reviews and meta-analyses indicate a substantially elevated prevalence of dental caries and oral diseases among high endurance athletes, though estimates vary widely by study and sport. Heterogeneity is high due to differing methods, athlete levels, geography and caries definitions. Mechanistically, frequent exposure of teeth to fermentable carbohydrates (gels, chews, carbohydrate drinks) during training/competition increases the time that plaque bacteria have substrate to produce acids—raising cariogenic challenge. Exercise-related hyposalivation (temporary reduced flow) and practical barriers to oral hygiene during events further amplify

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discusses mechanisms (frequent carbohydrate exposure, acidic sports drinks, reduced salivary flow during exercise, suboptimal oral hygiene during events) and recommends integrated mitigation strategies. It concludes that a sports diet is a major determinant of oral health in athletes.

**Validity/applicability.** It's a well-structured narrative review, but its conclusions are limited by the mixed quality and observational nature of the underlying studies. Its insights are broadly useful for understanding how common sports diet practices can affect athletes' oral health, though they're less precise for sport specific or performance specific guidance.

**Level of evidence.** Level 5-Review

## CAT 2

**Article.** Estimated prevalence of dental caries in athletes: An epidemiological systematic review and meta-analysis[2]
**Authors.** Azerado F.N., et al.
**Published.** March 2020
**PubMed ID.** 32436912

**Methods.** Database searching identified five studies that included observational, cross sectional, longitudinal, retrospective and prospective studies that presented the prevalence of dental caries in athletes without intellectual disabilities up to April 2017; pooled estimate across included studies.

**Results/conclusion.** This meta-analysis found a high prevalence of dental caries among athletes. The calculated prevalence was 46.25% (95%CI 28.73-64.27). The study showed that there is also significant variation in caries prevalence across the studies included in the meta-analysis, indicating that some athlete populations experience higher rates of caries than others. The high prevalence of dental caries in athletes may be related to frequent use of sports drinks and diet and reduced salivary flow during prolonged exercise.

**Validity/applicability.** It's a solid systematic review and meta-analysis, but its strength is limited by inconsistent study quality and varied caries assessment methods across athlete groups. The findings apply well to understanding how common dental caries are in athletes, though they're less precise for specific sports or performance related conclusions.

**Level of evidence.** Level 1-Systematic review

*Continued from previous page*

this risk. Therefore, efforts should be made to provide oral health education and promote a lower sugar intake when appropriate. Overall, the current evidence suggests that oral health should be regarded as an important factor in athlete wellness.

**Keywords.** Carbohydrate-rich sports nutrition, dental caries, elite athletes

**Evidence search strategy**

PubMed ("athlete" OR "athletes" OR "sport" OR "sports" OR "endurance") AND ("dental caries" OR "caries" OR "tooth decay" OR "DMFT" OR "ICDAS") AND ("sports drink" OR "sports nutrition" OR "energy gel" OR "carbohydrate")

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## CAT 3

**Article Title.** Oral health of elite athletes and association with performance: A systematic review[2]
**Authors.** Ashley P., et al.
**Published.** Nov. 2014
**PubMed ID.** 25388551

**Methods.** Literature search resulted in 34 studies on elite or professional athletes worldwide. It combined data to determine the oral health of athletes.

**Results/conclusion.** The systematic review found that elite athletes commonly have poor oral health. The data shows that athletes have high rates of dental caries (15-75%), periodontal disease (15%) and dental erosion (36–85%). A key contributing factor identified was the frequent consumption of sports drinks and a carbohydrate-rich diet. This article concluded that athletes have poor oral health.

**Validity/applicability.** The review is broadly reliable but limited by weak, inconsistent primary studies. Its findings apply well to elite athletes, showing poor oral health is common and may hinder performance, though evidence for direct performance effects is still tentative.

**Level of evidence.** Level 1-Systematic review

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**3.** Ashley, P., Di Iorio, A., Cole, E., Tanday, A., Needleman, I. Oral health of elite athletes and association with performance: a systematic review. *British Journal of Sports Medicine*, 2015;49(1), 14–19. https://doi.org/10.1136/bjsports-2014-093617

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# How much xylitol to make an impact on caries?

Cole Buller '29, Josh Allen '29, Colin Wong '29, Jason Zhao '29, Maria Ayad '29
Mentor: Lyndie Foster Page, B.D.S., Ph.D., DIPClinDent, MComDent

### Background/case scenario

Xylitol is a buzzword in the dental world. Allegedly, xylitol can reduce the risk of caries. The American Dental Association endorses the benefits of xylitol; however, how much xylitol is necessary to make a measurable impact on caries risk for the general patient population? By answering this question, we can help patients navigate if they should be ingesting xylitol daily.

### Clinical question

For the general patient population, what is the minimal amount of xylitol intake necessary to make a clinically significant risk reduction in caries formation?

## CAT 1

**Article.** Xylitol-containing products for preventing dental caries in children and adults[1]
**Authors.** Riley P., et al.
**Published.** March 2015
**PubMed ID.** 25809586

**Methods.** This study was a systematic review and meta-analysis of randomized controlled trials and other intervention studies focusing on items containing xylitol for prevention of dental caries in all ages, specifically children and adults. Overall, this included 10 studies analyzing 5,903 participants.

**Results/conclusion.** Some key results from this were that first, children who used fluoride toothpaste containing 10% xylitol over the course of 2.5 years had a 13% reduction in caries. In other xylitol items such as syrup, lozenges, tablets and wipes, the evidence wasn't as supportive and was sometimes unclear. There were benefits and non-reactive parts to the study. There were some beneficial numbers that showed 8 grams of xylitol syrup per day had a 58% reduction in caries for 94 infants over the course of a year. On the other hand, there weren't many studies that listed adverse

**POPULATION**
General patient population

**INTERVENTION**
Daily xylitol ingestion

**COMPARISON**
No xylitol ingestion

**OUTCOME**
Reduction in caries risk

**Conclusion/reflection.** Xylitol does reduce the risk for caries. However, xylitol should not be recommended by itself. Daily oral hygiene along with regular visits to the dentist makes a more significant impact than using xylitol by itself. Adding xylitol will further help reduce the risk for caries.

**Keywords.** xylitol, *Streptococcus mutans*, caries, DMFS/DMFT, sugar-free gum, caries reduction

### Evidence search strategy

PubMed search keywords:

- Xylitol, g/day
- *Streptococcus mutans*
- Caries
- DMFS/DMFT
- Percent reduction

effects, but a few that were reported included mouth sores, cramps, bloating, flatulence and loose stool.

According to the author, there was low-quality evidence that the toothpaste with xylitol is more effective than without it in preventing caries. However, the evidence is not on a large enough scale to definitively prove a reduction in caries.

**Validity/applicability.** The overall study used a large total sample size, discussed its biases and used systematic methodology for its research. Still, there were limitations and shortcomings. Seven out of the 10 studies showed a high risk of bias as well as heterogeneity in the types of items or products with xylitol used in the studies.

**Level of evidence.** Level 1-Meta-analyses and systematic reviews

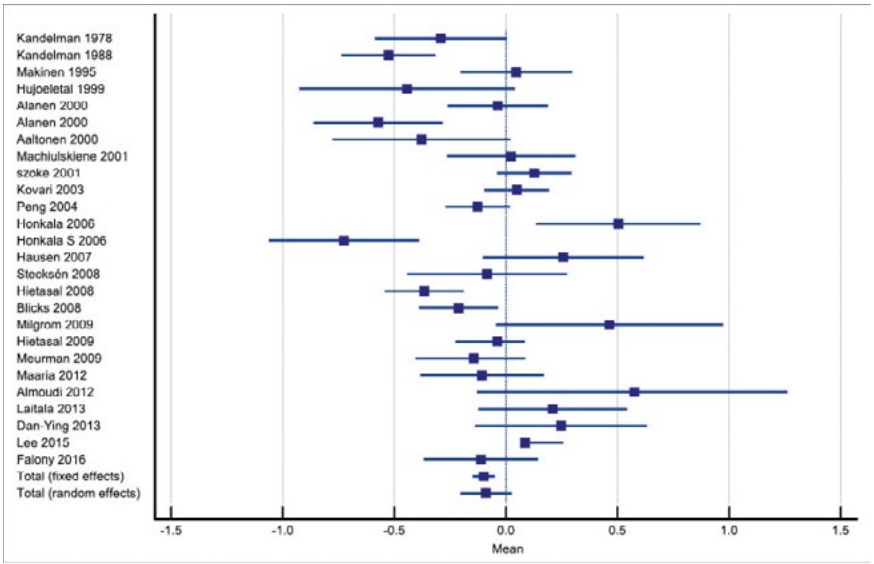


**Image 1.** Forest plot of xylitol studies included in the meta-analysis, showing that most studies favor xylitol for caries prevention and the pooled effect is modest but statistically significant.[2]

## CAT 2

**Article.** Meta-analysis on the effectiveness of xylitol in caries prevention[2]
**Authors.** AlHumaid J., et al.
**Published.** April 2022
**PubMed ID.** 35462747

**Methods.** Evidence-based systematic review and meta-analysis selected after search utilizing Medline, PubMed Central, Scopus, Web of Science, OpenGrey, Cochrane Library (1966 –March 2020), for human studies in English only. Randomized control trials, case–control and cohort studies with ≥1-year follow-up that reported mean DMFT/DMFS/dfs (and SD/95% CI) for xylitol-containing products versus non-xylitol controls included. Primary outcome was mean DMFS/DMFT/dfs (caries experience)—not bacterial counts. Thirty clinical studies (19 trials, seven case–control, four cohorts) on xylitol gum, candies, lozenges, pacifier tablets, foods and oral hygiene products included a follow-up period of one to five years. Fixed and random-effects models; heterogeneity tested (Q, $I^2$), publication bias checked with funnel plot, Egger test and Kendall correlation were used for analysis.

**Results/conclusion.** Overall effect was that xylitol products significantly reduced caries compared with controls. Standardized mean difference was approximately ≈ −0.09 to − 0.10, indicating lower DMFS/DMFT in xylitol groups. Overall prevented fraction was ~17% (caries reduction) across studies. For products and dosages, most tested forms were chewing gum (19 studies), candies, lozenges, foods, pacifier tablets, toothpaste and mouthrinse. Most effective regimen was 100% xylitol gum or

candies, used three to five times per day after meals, total dose 5–10 g/day. Frequencies <3 times/day (≈ <3.4 g/day) showed no caries preventive benefit. Doses up to ~15.6 g/day did not show extra benefit beyond ~11–12 g/day. Comparison with other agents showed in some trials, xylitol products performed similarly to fluoride varnish or sealants, suggesting they can be considered as co-adjuncts in preventive programs. Xylitol is generally found safe; gastrointestinal side effects occur mainly at very high doses (well above recommended 5– 10 g/day).

**Validity/applicability.** Strengths included broad multi-database search over >50 years, with clear inclusion criteria and focus on true caries outcomes (DMFS/DMFT), included a wide range of xylitol products and populations (children, adolescents, adults), increasing generalizability. It used formal meta-analytic methods, plus funnel plot and statistical tests to check for publication bias (none detected). Limitations included high heterogeneity (initial $I^2 \approx 95\%$), even after removing four outlier studies (reduced to ~79%); mix of study designs (trials + observational); variable xylitol doses, frequencies, and background fluoride/preventive care and many products were combined with routine fluoride and other measures, so xylitol is rarely tested as a pure stand-alone intervention. Applicability to PICO: It strongly supports that for general patients, xylitol can provide an additional, modest caries reduction when used correctly, reinforces a practical minimum effective regimen: about 5–10 g/day of xylitol (ideally 100% xylitol gum/candies), three to five times daily—very consistent with the other CATs. Helps justify recommending xylitol as a dose and frequency dependent adjunct, not a replacement for fluoride, sealants or standard prevention.

**Level of evidence.** Level 1–Meta-analysis of clinical trials and observational studies

## CAT 3

**Article.** A systematic review and meta-analysis of the role of sugar-free chewing gum on *Streptococcus mutans*[3]
**Authors.** Nasseripour M., et al.
**Published.** April 2021
**PubMed ID.** 33926448

**Methods.** This study is an evidence-based systematic review and meta-analysis of 13 studies evaluating the effect of sugar-free gum (xylitol gum) on *Streptococcus mutans* levels in adults and children. Structured literature research was conducted using 12 major databases (Medline, Embase, PsycINFO, Web of Science, Scopus, Central, Open Grey, Prospero), focusing on controlled trial studies (randomized control trials, crossover, pre–post trials). Chewing gum was the primary intervention stated in these studies, and the *S. mutans* count are percentage change (decline) used as measurable indicators of effectiveness. The studies are analyzed using random-effects meta-analysis in STRATA, and the risk of bias is evaluated using Cochrane RoB 2 with effect sizes calculated in standardized mean differences.

**Results/conclusion.** Sugar-free mostly xylitol-based gum significantly reduced *Streptococcus mutans* compared to controls (Effect size: −0.42 (95% confidence interval: −0.60 to −0.25)). Xylitol-only gum trials showed stronger reductions in *S. mutans* (Effect size: −0.46 (95% confidence interval: −0.64 to −0.28)). Moderate heterogeneity ($I^2$ = 44–43%). No adverse events were reported. A few studies showed wide confidence intervals due to small sample sizes.

**Validity.** The risk of bias was found to be low in the studies that were included in this systematic review and meta-analysis. Additionally, the process the researchers used to come to this conclusion appears to be thorough and accurate. The studies were reviewed by three independent researchers and assessed for bias across six different areas: Randomization, allocation concealment, masking of participants, masking of outcome, incomplete reporting, selective reporting and other biases. Studies that were found to have low risk of bias were included in the systematic review and meta-analysis. These above points increase our confidence in the outcomes of the research.

Many of the studies included were randomized controlled trials, which are quality sources of evidence, and used proper Chi-squared and p-value analysis techniques to assess whether the change in *Streptococcus mutans* between the experimental group who chewed xylitol gum and the control group was significant or due to random chance. The results found that the decrease of *Streptococcus mutans* in the oral cavity in the experimental group was significant and not due to random chance.

**Applicability.** This article explores the effect of xylitol gum on *Streptococcus mutans*. Since *Streptococcus mutans* are the cause of carious lesions in the oral cavity, removing *Streptococcus mutans* would decrease the number of carious lesions in the mouth, helping us to directly answer our clinical questions of whether chewing xylitol gum significantly decreases the number of caries in the oral cavity in the general population. This study shows that xylitol gum significantly decreases the level of *Streptococcus mutans* in the oral cavity, and thus it can be inferred that chewing xylitol gum influences the number of carious lesions in the oral cavity in the general population, making it related to our PICO.

**Level of evidence.** Level 1-Systematic review and meta-analysis

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# A comparison of the effectiveness of SMART vs. traditional drilling methods

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### Background/case scenario

SMART, or silver-modified atraumatic restorative technique, is a form of treatment that both halts dental decay via silver diamine fluoride, or SDF, application and seals the tooth with a glass ionomer cement. This method is highly attractive because it is minimally invasive in nature—it does not require drilling the natural tooth structure or the use of anesthetics. If successful clinically, this method could be a valuable alternative for more traditional drill-and-fill techniques or atraumatic restorative techniques, or ART, methods, especially for pediatric, developmentally or physically disabled or anxious patients.

### Clinical question

In patients with caries lesions, how does SMART compare to conventional drill-and-fill or ART methods in its ability to arrest or limit caries progression based on clinical success outcomes?

## CAT 1

**Article.** Clinical outcome success of silver-modified atraumatic restorative Treatment (SMART) in Treating children with dental caries in primary teeth: A systematic review[1]
**Authors.** Mohapatra S., et al.
**Published.** July 2024
**DOI.** 10.1055/s-0044-1788659

**Methods.** Two hundred and four records were taken through database searching and 2,620 additional records were identified through other sources. Four randomized controlled trials were selected for qualitative analysis, including participants aged 3 to 13 years old and tooth sample size ranging from 60-562. Comparisons were made between intervention group (SMART) and conventional treatment group (drill-and-fill with GIC or ART). Outcomes were assessed over three-month intervals until 12 or 24 months of post-treatment.

**POPULATION**
Children or adults with carious lesions

**INTERVENTION**
Silver diamine fluoride-modified atraumatic restorative technique, or SMART

**COMPARISON**
Traditional drill and fill restorative techniques or atraumatic restorative techniques, or ART

**OUTCOME**
Reduced progression of caries, improved patient acceptance of treatment

**Conclusion/reflection.** Silver-modified atraumatic restorative therapy, or SMART, is an effective, minimally invasive strategy for managing caries lesions in children. SMART involves the placement of glass ionomer cement, or GIC, after applying silver diamine fluoride, or SDF, to arrest caries and mask discoloration. This combined approach provides strong antibacterial action and caries arrest while avoiding drilling, anesthesia and the aesthetic concerns typically associated with SDF alone. Current evidence shows that SMART achieves comparable and possibly superior clinical outcomes to

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**Results/conclusion.** Three of the studies found noninferiority of SMART when compared to conventional drill-and-fill or ART methods in the success rate of treating children's carious teeth (arresting caries development).

Moreover, the fourth study found the use of SMART led to a higher treatment success rate than the conventional ART. It has also been found that SMART is more cost-effective and less time-consuming than ART (7.8 minutes versus 15 minutes). SMART is reported to be more acceptable in children when compared to the conventional drill-and-fill method.

**Validity/applicability.** This systematic review provides level 2 evidence supporting the effectiveness of SMART in terms of treatment success rates, cost-effectiveness and patient experience. Although certain outcomes such as long-term economic impact remain uncertain due to relatively short follow-up periods in most included studies, and variations in clinical outcome measures across trials may limit generalizability across different populations, the overall findings are consistent. Collectively, the evidence indicates that SMART performs comparably to conventional drill-and-fill and ART approaches, supporting its applicability as a viable alternative for managing carious lesions in children.

**Level of evidence.** Level 2–Systematic review

## CAT 2

**Article.** Silver diamine fluoride modified atraumatic restorative treatment compared to conventional restorative technique on carious primary molars: A randomized controlled trial[2]
**Authors.** Kalpana B., et al.
**Published.** Sept. 2018
**PubMed ID.** 37704105

**Methods.** 226 children (SMART group, 112 and conventional, 114) were included with 280 and 282 GIC restorations placed by the SMART and the conventional method respectively. At 24 months, 459 (81.6%) primary molars were available for evaluation.

**Results/conclusion.** In this two-arm RCT of 226 children with cavitated primary molars, no significant difference was found in the 24-month restoration success between SMART and conventional drill-and-fill using GIC. Per protocol, at 24 months success was 38.4% for SMART (84/219 teeth) versus 45.8% for conventional (110/240), not statistically different (p=0.105; adjusted OR for failure 1.28, 95% CI 0.87–1.86). The

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conventional drill-and-fill techniques and other minimally invasive approaches such as atraumatic restorative treatment, or ART. Moreover, SMART is generally better accepted by young patents than traditional restorative methods, namely the drill-and-fill.

**Keywords.** SMART, silver diamine fluoride, ART technique, traditional drilling, atraumatic restorative technique, children, glass ionomer cement, primary molars, silver diamine fluoride

**Evidence search strategy**

MeSH Terms:

- Silver modified atraumatic restoration technique (SMART)
- Silver diamine fluoride (SDF)
- Dental atraumatic restorative treatment and methods
- Dental caries
- Child
- Glass ionomer cements/ therapeutic use

intention-to-treat analysis showed the same pattern (38.8% vs. 45.9%; p=0.119; adjusted OR for failure 1.25, 95% CI 0.86–1.81). Across time points there was no difference at 12 months (54.6% vs. 64.0%; p=0.128) or 18 months (50.0% vs. 55.9%; p=0.437), with a slight conventional advantage at six months (79.3% vs. 68.2%; p=0.017). Minor and major failure rates were similar between groups at each recall. No pulp exposures occurred in either arm. Children accepted SMART better: 79% were rated "comfortable" on the SEM scale compared with 56% in the conventional group (p=0.002). Self-reported pain was also lower with SMART, with 96% scoring 0–2 on the Facial Image Scale versus 84% in the conventional arm (p=0.003). Because the SMART arm started with more multi-surface lesions, the authors adjusted for lesion type in logistic models. After adjustment, there was still no significant difference in success. This supports clinical comparability with better acceptance for SMART in this study.

**Validity/applicability.** This randomized controlled trial provides reasonably strong evidence of the effectiveness of the SMART technique compared to conventional treatment methods on primary molars. The use of random allocation, standardized treatment protocols, blinded outcome assessment and statistical analyses supports the validity of the study. The study is limited in its applicability to other age groups as the study population was pediatric. Overall, the study offers clinically relevant evidence with credible validity for use of SMART in pediatric populations.

**Level of evidence.** Level 2–Randomized controlled trial

## CAT 3

**Article.** Can S.M.A.R.T. technique substitute conventional restorative procedure for permanent teeth[3]
**Author.** AL-Hashimi A.
**Published.** Feb. 2025
DOI. 10.48047/n2e05y83

**Methods.** This study was a comparative analysis approach, analyzing 35 research papers, most of which are randomized controlled trials and systematic reviews. The criteria for choosing studies included articles that use the S.M.A.R.T. technique and studies that assess the effectiveness in permanent teeth.

**Results/conclusion.** Through the analysis of extensive research, the authors found that S.M.A.R.T. could be an effective alternative to traditional restorative techniques in cases where preserving the tooth structure is the highest priority. Using the S.M.A.R.T. technique to arrest caries and maintain tooth structure is a valid alternative to traditional restorations, especially when factoring in patient comfort. However, traditional restorative treatment may still be necessary in cases that require more extensive treatment of caries and the underlying tooth. Therefore, it depends on the individual patient case whether S.M.A.R.T. should be used alternatively to a traditional restoration.

**Validity/applicability.** In terms of validity, the evidence level of this article is secondary, although it pulls from many articles with high levels of evidence. When looking at the applicability of S.M.A.R.T. in clinical practice, the paper states that S.M.A.R.T. is a great alternative for traditional restorative methods prioritizing the retention of the tooth structure and patient comfort. Additionally, the study mentions that S.M.A.R.T. methods are heavily impacted by the oral hygiene of the patient, meaning that bad oral hygiene could reduce efficacy.

**Level of evidence.** Level 2–Systematic review

### References:

**1.** Mohapatra, Subhashree, Mohandas, Rahul. Clinical outcome success of silver-modified atraumatic restorative treatment (SMART) in treating children with dental caries in primary teeth: A systematic review. *Journal of Health and Allied Sciences* NU. 2024;15. 10.1055/s-0044-1788659

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# Oral submucous fibrosis: Antioxidant vs. conventional therapy

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### Background/Case scenario

Oral submucous fibrosis, or OSMF, is a chronic, progressive fibrotic disorder of the oral submucosa. The etiology of OSMF is multifactorial, but the habits of areca nut chewing and tobacco use are most strongly associated with the overproduction and fibrosis of collagen leading to OSMF development. Clinically, patients present with the symptoms of reduced mouth opening, burning pain and decreased cheek flexibility. While current conventional treatments involve the use of corticosteroids, antioxidant therapies are now being explored as alternative or adjunctive options.

### Clinical question

In patients with oral submucous fibrosis, are antioxidant therapies (topical or systemic modalities) more effective than conventional treatments (corticosteroids, hyaluronidase or physiotherapy) for improving the burning sensation, interincisal distance and cheek flexibility that compromise oral function?

## CAT 1

**Article.** Comparative efficacy of interventions for the management of oral submucous fibrosis: A systematic review and network meta-analysis [1]
**Authors.** Gopinath D., et al.
**Published.** Aug. 2022
**PubMed ID.** 36013221

**Methods.** A systematic review of 32 randomized control trials comprising 2,062 patients aged 15 to 70 was conducted to determine the efficacy of interventions regarding OSMF symptoms. Clinical parameters assessed were mouth opening, burning sensation, ulceration reduction, relief of fibrous bands, tongue protrusion, cheek flexibility, pain, speech and swallowing difficulty. Tested interventions were hyaluronidase, corticosteroid, lycopene, allicin, aloe vera, curcumin, spirulina, Oxitard, vitamin E, piperine and a placebo.

**POPULATION**
Patients with oral submucous fibrosis, or OSMF

**INTERVENTION**
Antioxidant therapy

**COMPARISON**
Conventional treatments

**OUTCOME**
Improvements of clinical symptoms associated with OSMF

**Conclusion/reflection.** In patients with OSMF, antioxidant therapy improves symptoms, specifically burning sensation and improved mouth opening. A meta-analysis study done by Gopinath et al., 2022, ranked aloe vera (topical antioxidant) the highest for burning sensation relief and Oxitard (antioxidant) the highest for mouth opening. Combination treatments which include corticosteroid, hyaluronidase and antioxidant are highly ranked. Confidence is reduced by variability between studies and potential bias.

Perez-Leal et al., 2024, a systematic review study focused on antioxidants that improve burning sensation, mouth opening, tongue protrusion and cheek flexibility and are effective when compared to conventional treatments (e.g. corticosteroids). Aloe vera (topical or systemic) and spirulina treatment

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**Results/conclusion.** Of the 32 studies, 29 focused on relief from the burning sensation of OSMF. Results showed that aloe vera proved to be most effective in relieving the burning sensation, followed by a combination therapy of corticosteroid and antioxidants. The lowest ranked was the combination treatment of curcumin and piperine. For relieving mouth opening pain caused by OSMF, Oxitard was shown to be the most effective followed by a combination therapy of lycopene, hyaluronidase and corticosteroids. In relieving pain from mouth opening, corticosteroids proved only slightly more effective than antioxidants. Cheek flexibility and tongue protrusion also showed positive outcomes when patients were treated with antioxidants like aloe vera and lycopene. Regarding treatment of other OSMF symptoms, an overall positive outcome was shown, but additional studies are required for results to bear statistical significance.

**Validity/applicability.** Literature search for this review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, or PRISMA, guidelines. Out of the 142 unique studies initially identified, 63 met the inclusion criteria, and 32 of these ultimately met the eligibility criteria determined by this analysis. Risk assessment was then performed according to Cochrane guidelines. Statistically significant improvement in interincisal distance was demonstrated in 25 of the 32 randomized control trials; the minimal incidence of side effects in these trials suggests applicability of antioxidant treatment to long-term OSMF management. Despite this, many included trials were small, single-centered and had methodological limitations (unclear randomization, limited blinding, short follow-up and heterogeneity of protocols). Further studies are recommended to confirm the advantage of antioxidant therapy in OSMF treatment and formulate definite clinical guidelines for its management.

**Level of evidence.** Level 2– Systematic review and network meta-analysis

## CAT 2

**Article.** Antioxidant treatments in patients with oral submucous fibrosis: A systematic review[2]
**Authors.** Pérez-Leal M., et al.
**Published.** Jan. 2024
**PubMed ID.** 38155549

**Methods.** The treatment of 1,721 OSMF patients, (male and female, 15 to 70 years old), was examined across 19 articles. Systemic antioxidants were Oxitard, lycopene, curcumin, SM Fibro, spirulina, aloe vera, Dr.

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alone showed the most efficacy. Curcumin seemed to perform less than aloe vera or hydrocortisone. Overall, the performance of antioxidant treatments is quite comparable to conventional treatments. The authors recommend development of a standardized protocol for future studies.

Perumal et al., 2024, study showed that astaxanthin (antioxidant) showed greater improvement in mouth opening and reduced burning assessed by visual analog scale, or VAS, compared to placebo over 12 weeks. It is a promising preliminary randomized controlled trial study for the efficacy of OSMF treatment with antioxidant therapies

**Keywords.** oral submucous fibrosis, antioxidant therapy, aloe vera, spirulina, astaxanthin, corticosteroids, hyaluronidase

**Evidence search strategy**

MeSH Terms:

- Oral submucous fibrosis
- OSMF
- Antioxidant or aloe vera or spirulina or astaxanthin
- Conventional treatment or corticosteroid or hyaluronidase or physiotherapy
- Clinical symptom or mouth opening or burning sensation

Reddy's Antoxid, pentoxifylline and piperine. Topical antioxidants were aloe vera gel and curcumin gel. Conventional treatments were hyaluronidase, corticosteriods (hydrocortisone, dexamethasone, triamcinolone) and physiotherapy. Treatment efficacy was evaluated when used alone, in combination with treatments of the same or different classification, and/or against a placebo control treatment.

**Results/conclusion.** All examined antioxidant treatments demonstrated potential for improving the burning sensation, interincisal distance, tongue protrusion and cheek flexibility symptoms associated with OSMF. Patients treated with aloe vera (systemic or topical) showed improvement across all parameters, yielding better results than other antioxidant treatments; spirulina was the only antioxidant showing more clinical improvement than aloe vera. Spirulina treatment alone, or in combination with physiotherapy, showed significant improvement in all OSMF-associated clinical symptoms. Curcumin treatment showed improvement across all OSMF parameters when studied alone or in combination with other antioxidants but demonstrated less improvement in comparison to aloe vera or hydrocortisone. Lycopene treatment showed efficacy in burning sensation reduction in two of 19 examined articles and demonstrated synergistic effects in combination with other antioxidants. The systematic review concludes that antioxidant treatments obtain beneficial results when compared to conventional treatments, despite being less favored and widely undervalued. However, further clinical studies are needed to determine the ideal antioxidant or antioxidant combination for OSMF treatment. An official standardized protocol for this treatment must be established for its clinical application to be most effective.

**Validity/applicability.** In the initial literature search (following PRISMA guidelines), 97 articles were obtained, and through preliminary screening 23 were determined to have potential eligibility. Comprehensive evaluation resulted in the identification of 19 total articles fulfilling predetermined inclusion criteria, which were then evaluated for risk of bias according to Cochrane guidelines. Within this review, all antioxidant treatments analyzed demonstrated potential for effectiveness in clinical OSMF symptom improvement. However, this review is limited by the lack of standardization between the included studies, specifically in terms of clinical protocol, pharmaceutical treatment forms used and follow-up period length. To determine the most advantageous antioxidant therapy for long-term OSMF management, standardized studies with larger sample sizes and longer follow-up periods are needed.

**Level of evidence.** Level 2–Systematic review

## CAT 3

**Article.** Efficacy and safety of astaxanthin in the management of oral submucous fibrosis: A preliminary randomized controlled trial[3]
**Authors.** Perumal E., et al.
**Published.** Feb. 2022
**PubMed ID.** 38524025

**Methods.** Sixty-eight adults (18 to 60 years old) clinically diagnosed with OSMF. Experimental group was administered astaxanthin, HealthVit tablet 4 mg (2 tablets BID after food) for the entirety of the 12-week intervention period. Control group received placebo capsules, indistinguishable from the astaxanthin capsules, twice daily for the same 12-week duration.

**Results/conclusion.** In 68 patients with OSMF, astaxanthin (4 mg, two tablets twice daily) and a placebo were administered for 12 weeks. The astaxanthin group showed a significant improvement in mouth opening compared with placebo ($p < 0.001$) and a significant reduction in burning sensation as measured by VAS ($p < 0.001$). Adverse events were mild and comparable between groups, with no serious events reported. These results indicate that astaxanthin was superior to placebo in improving both objective (mouth opening) and subjective (burning sensation) clinical symptoms, with its therapeutic effects observed without compromising safety. Although this double-blind study provided strong evidence for the use of astaxanthin as a standard treatment protocol, more high-quality randomized controlled trails are needed to identify further treatments for OSMF.

**Validity/applicability.** The impact of systemic astaxanthin administration on patients' OSMF symptoms was comprehensively evaluated via the thorough design and systematic execution of this clinical trial. The specific inclusion/exclusion criteria used to determine patient eligibility eliminated the possibility of confounding variables (such as pregnancy/lactation, allergy to astaxanthin, other conditions/illnesses and concurrent clinical trial participation). Computer-generated sequences were used to randomize participant assignments. Blinding methodology was reinforced by the identical appearance of astaxanthin and placebo capsules, which were both administered twice daily for a 12-week duration. Although the experimental group demonstrated marked improvement in interincisal distance and burning sensation, indicating the anti-fibrotic potential of astaxanthin, the limited sample size of 68 participants and relatively short intervention duration pose limitations to the generalizability of these findings. To further validate the applicability of astaxanthin treatment to long-term OSMF management, studies including larger population sizes and extended follow-up periods should be conducted.

**Level of evidence.** Level 2–Randomized, double-blind, placebo-controlled clinical trial

### References:

**1.** Gopinath, D., Hui, L. M., Veettil, S. K., Balakrishnan Nair, A., Maharajan, M. K. Comparative efficacy of interventions for the management of oral submucous fibrosis: A systematic review and network meta-analysis. *Journal of Personalized Medicine*, 2022;12(8), 1272. https://doi.org/10.3390/jpm12081272

**2.** Pérez-Leal, M., Lanciano, F., Flacco, N., Estornut, C., Carceller, M. C. Antioxidant treatments in patients with oral submucous fibrosis: A systematic review. *Journal of Oral Pathology & Medicine: Official Publication of the International Association of Oral Pathologists and the American Academy of Oral Pathology*, 2024;53(1), 31–41. https://doi.org/10.1111/jop.13503

**3.** Perumal, E., Patil, S., Karobari, M. I. Efficacy and safety of astaxanthin in the management of oral submucous fibrosis: A preliminary randomized controlled trial. *Cureus*, 2024;16(2), e54667. https://doi.org/10.7759/cureus.54667

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# Retrospective descriptive analysis of a student-led dental clinic for individuals experiencing housing instability in downtown Portland, Oregon

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**Abstract**

**Objective.** To assess trends in student participation, clinical productivity and patient demographics at the Bridges Collaborative Care Clinic, or BCCC, the first student-run dental clinic serving individuals experiencing homelessness in the metropolitan area of Portland, Oregon.

**Methods.** A retrospective descriptive review of BCCC utilization, production and demographic data from fall 2022 through fall 2025 was conducted. Student participation was measured as the average student hours per clinic session. Productivity was measured as total quarterly production using standard Oregon Health & Science University fee schedules. Patient race and ethnicity were self-reported and summarized descriptively, then compared with U.S. Census Bureau QuickFacts estimates for the city of Portland.

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## Introduction

Individuals experiencing homelessness face substantial barriers to accessing oral health care, including financial constraints, lack of insurance, transportation challenges and competing priorities related to housing and basic needs. Consequently, this population bears a disproportionate burden of oral disease and unmet dental needs. Student-run clinics play a critical role in addressing these disparities, particularly in urban settings where homelessness is highly prevalent.

Student-run dental clinics have emerged as an important component of the oral health safety net. In addition to expanding access to care, these clinics provide experiential learning opportunities that enhance students' clinical skills, understanding of social determinants of health and commitment to serving underserved populations. Despite their growing role, limited data exist describing longitudinal trends in student participation, clinic productivity and patient demographics within student-run dental clinics serving individuals experiencing homelessness.

BCCC is a student-run dental clinic in Portland, Oregon, designed to provide oral health services to individuals experiencing homelessness while supporting interprofessional education. The purpose of this study was to evaluate trends in student participation, clinical productivity and patient demographics at the Bridges Clinic over a multi-year period and to contextualize patient demographics relative to the general Portland population.

## Methods

### Study design

This study was a retrospective, descriptive review of clinic utilization, productivity and patient demographic data collected from BCCC over a multi-year period.

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### Clinical setting

BCCC is a student-run dental clinic located in Portland, Oregon, that provides oral health services to individuals experiencing homelessness. Care is delivered by dental students under faculty and preceptor supervision within an interdisciplinary safety-net care model. The clinic operates in scheduled sessions with a limited number of operatories available per session.

### Data collection

**Student participation and clinic productivity.** Student participation was measured as the average number of student hours per clinic session by academic quarter from fall 2022 through fall 2025. Clinic productivity was measured as total quarterly production, reflecting completed clinical procedures aggregated across all clinic sessions.

From May through December 2025, clinic operations were affected by facility flooding, resulting in reduced operatory availability. This period was documented and noted in analyses; data from this interval were not adjusted or excluded.

**Patient demographics.** Patient demographic information was obtained from clinic records and was self-reported at the time of care. Collected variables included race and ethnicity, age and sex. Race and ethnicity were categorized as White/Caucasian, Black/African American, Hispanic/Latino, American Indian/Alaska Native and Asian/Pacific Islander. Patients who declined to report race or ethnicity or selected other or unknown categories were classified as undeclared. Age was recorded in years. Sex was categorized as male, female or other. Demographic data were available for a subset of clinic sessions and did not include the most recent sessions. Estimates for the general Portland population were obtained from the U.S. Census Bureau QuickFacts database, which summarizes American Community Survey data.[1]

### Results

Average student clinic hours per session demonstrated an overall upward trend from fall 2022 through fall 2025 (Figure 1A). Student hours increased steadily over time, with the highest average observed in spring 2025. Despite a temporary reduction in operatory availability due to facility flooding from December 2024 through December 2025, student participation was sustained during this period.

**Results.** From 2022 to 2025, average student hours per session and total clinic production increased overall, with $112,255 in cumulative production. Despite extended periods of operational constraints due to facility flooding (December 2024–December 2025), student participation and productivity were maintained. BCCC served a racially and ethnically diverse population, including higher proportions of Black/African American and American Indian/Alaska Native patients compared with the general Portland population.

**Conclusions.** BCCC demonstrated sustained growth in student engagement and productivity while providing care to a diverse and historically underserved population. These findings underscore the value of student-run clinics in expanding access to care while enhancing dental education.

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Total clinic production also increased over time (Figure 1B). Although quarterly production fluctuated across the study period, including during the period of reduced clinical capacity, cumulative clinic production totaled $112,255. When stratified by procedure type (Figure 2), extractions accounted for the largest share of total production (35.2%), followed by dental prophylaxis (18.0%), restorative procedures (13.8%), limited examinations (12.4%), and radiographs (11.0%). Debridement (5.1%) and fluoride treatments (4.6%) comprised smaller proportions of total production.

Self-reported demographic data were available for 341 patients and are summarized in Table 1. The largest proportion of patients identified as White/Caucasian (36.4%), followed by Hispanic/Latino (17.6%), Black/African American (14.4%) and American Indian/Alaska Native (6.5%). A substantial proportion of patients (22.3%) declined to report race or ethnicity or selected other or unknown categories.

Compared with the general Portland population based on U.S. Census Bureau QuickFacts data,[1] BCCC patients included higher proportions of individuals identifying as Black/African American and American Indian/Alaska Native and lower proportions identifying as White and Asian (Figure 3). Patients who declined to report race or ethnicity were included in Table 1, but excluded from the comparative analysis. Patient age data were available for 212 individuals, with a mean age of 44.3 years (range: 18–80 years); most patients were between 31 and 60 years old (Figure 4). Sex data were available for 212 patients; the majority identified as male (71.1%), followed by female (25.1%), with a small proportion identifying as other or unknown (Table 1).

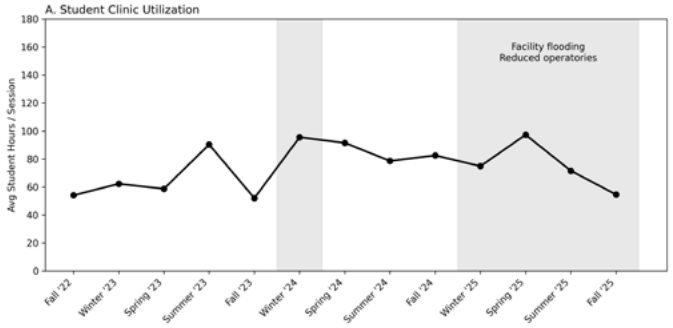


**Figure 1A.** Longitudinal trends in student clinic utilization and clinic production. Total clinic production by quarter over the same period. Shaded regions denote a period of reduced clinical capacity due to facility flooding.

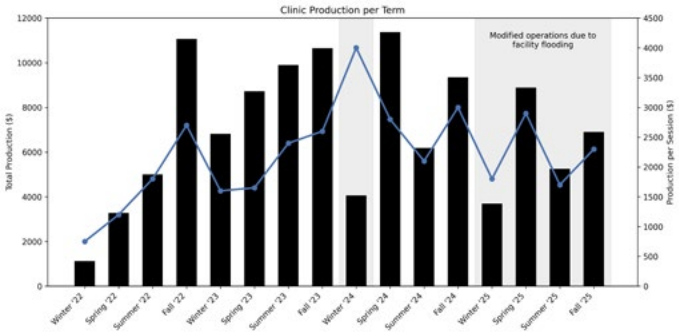


**Figure 1B.** Total clinic production by quarter over the same period. Shaded regions denote a period of reduced clinical capacity due to facility flooding.

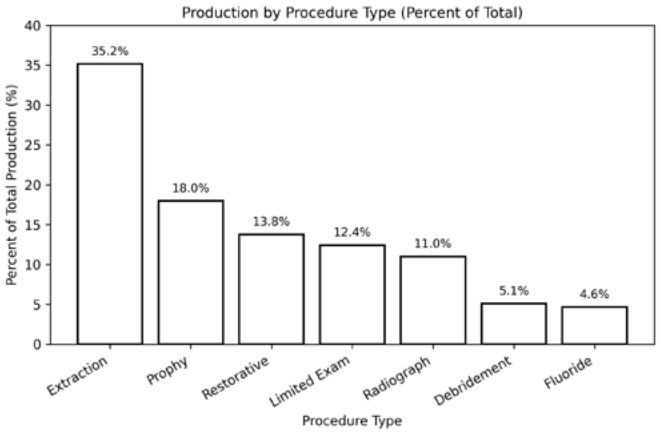


**Figure 2.** Production by procedure type (percent of total production). Bars indicate the distribution of total production across procedure categories for the included sessions.

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## Discussion

This study demonstrates sustained growth in student participation and clinic productivity at a student-run dental clinic serving individuals experiencing homelessness. Despite operational challenges related to facility flooding, the clinic maintained student engagement and clinical output, underscoring the resilience of the student-run care model.

The demographic profile of Bridges Collaborative Care Clinic patients differed from that of the general Portland population, with higher representation of Black/African American and American Indian/Alaska Native patients. These findings are consistent with broader patterns of racial and ethnic disparities among individuals experiencing homelessness and highlight the clinic's role in serving historically underserved communities. The procedure mix was weighted toward extractions and diagnostic services, reflecting the high prevalence of urgent and unmet oral health needs in this population.

In addition to its service mission, the Bridges Clinic provides meaningful educational experiences for dental students. Sustained student participation suggests strong engagement with community-based care and supports the value of student-run clinics as educational and service-oriented models. These findings further indicate that student-run clinics can maintain educational quality and service capacity even during periods of operational disruption.

### Limitations

This study has several limitations. The data were retrospective and descriptive, and patient demographic information was self-reported and incomplete for some clinic sessions. Additionally, the analysis reflects a single clinic site and may not be generalizable to other settings. Future studies incorporating more comprehensive data and additional outcome measures are warranted.

### Future directions

Ongoing data collection will allow for continued evaluation of clinic utilization, patient outcomes and educational impact. Future research should include surveys of returning patients to investigate barriers to follow-up care and continuity of treatment.

| **Race/Ethnicity** | **n (%)** |
|---|---|
| White/Caucasian | 124 (36.4%) |
| Black/African American | 49 (14.4%) |
| Hispanic/Latino | 60 (17.6%) |
| American Indian/ Alaska Native | 22 (6.5%) |
| Asian/Pacific Islander | 10 (2.9%) |
| Undeclared† | 76 (22.3%) |
| Total | 341 (100%) |
| **Sex** | **n (%)** |
| Male | 150 (71.1%) |
| Female | 53 (25.1%) |
| Other | 9 (4.3%) |
| Total | 212 (100%) |

**Table 1.** Patient demographics (self-reported)
Race/ethnicity and sex were self-reported by patients. Percentages are calculated using available responses for each demographic category; patients reporting unknown or undeclared information were included in total counts but excluded from percentage calculations where applicable. *Undeclared † includes patients reporting "Other" or "Unknown."*

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## Conclusion

The Bridges Collaborative Care Clinic demonstrated sustained increases in student participation and clinical productivity while serving a diverse and historically underserved patient population. These findings highlight the capacity of student-run dental clinics to expand access to care for individuals experiencing homelessness while providing valuable educational experiences for dental students.

## Acknowledgements

The authors would like to acknowledge the students who established the clinic in 2018, as well as the student leaders from 2018 to 2025 whose ongoing efforts have contributed to the clinic's success. We also thank A-dec for their generous donation of equipment and the faculty and preceptors whose continued support has been essential to the operation of the Bridges Collaborative Care Clinic.

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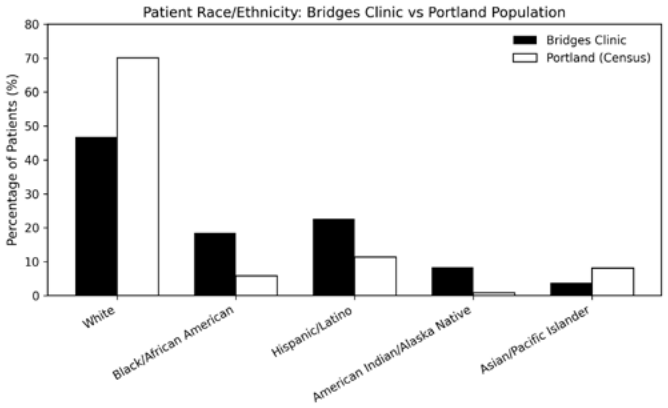


**Figure 3.** Comparison of patient race and ethnicity between Bridges Clinic and the general Portland population. Bars represent the percentage of patients by race/ethnicity among Bridges Clinic patients (self-reported identified n = 265) and the general Portland population based on U.S. Census Bureau QuickFacts data.[1] Patients who declined to report on race or ethnicity are included in Table 1 but are not shown in this comparison.

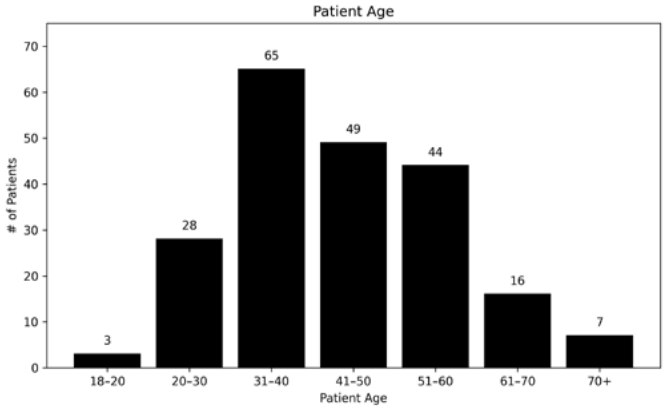


**Figure 4.** Distribution of patient age at the Bridges Collaborative Care Clinic. Age data were available for 212 patients. Most patients were between 31–60 years of age, with the highest representation in the 31–40 years age group. The mean patient age was 44.3 years (range: 18–80 years).

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# The role of diversity-focused events in dental education

Khalil Tams, '28, Samyia Chaudhry, D.M.D.

Dental education extends beyond technical training to shape how future clinicians understand patients, communities and their role in promoting health. As the populations served by dental professionals become increasingly diverse, recognizing differences in background, lived experience and career pathways is more important than ever. Diversity-focused events are essential to student learning, equipping future clinicians to care for diverse populations while contributing to the reduction of health disparities.

Exposure to diverse perspectives strengthens students' critical thinking, cultural awareness and communication with patients. A diverse student body and workforce also help build trust and improve access to care, particularly for historically underserved communities. Research in health professions education consistently demonstrates that diversity within training environments strengthens problem-solving abilities and promotes patient-centered care. These lessons are most impactful when diversity is experienced beyond textbooks—through lived experiences and shared stories. Diverse perspectives truly matter.

At the OHSU School of Dentistry, an American Student Dental Association (ASDA) Diversity Event provided a meaningful opportunity for dialogue, reflection and storytelling. The event, held in October 2025, enriched students' education by highlighting experiences and perspectives that traditional curricula may overlook, fostering a deeper understanding of the human dimensions of dental practice.

**Fostering inclusive education**

ASDA organized an OHSU event at the southwest waterfront campus in Portland with the goal of amplifying voices and experiences that are often underrepresented in conversations about success in dentistry. Sara, ASDA's DEI chair and a first-generation college student, emphasized that representation was a central motivation for the event. She explained that when students see individuals with similar backgrounds or challenges in leadership and professional roles, they feel validated and become more confident in their own paths.

From the organizer's perspective, the event was designed not only to support students but also to educate the broader student body. Sara described ASDA's role as both an advocate and a platform—one that promotes empathy, awareness and cultural humility. These qualities are essential for providing equitable care to all patients and for creating an educational environment where meaningful conversations about diversity are encouraged rather than avoided.

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### A nontraditional path in dentistry

At the center of the diversity event was Laura Fortes, D.D.S., whose presentation resonated deeply with students because of its honesty and relatability. Initially trained in Spain, Fortes discovered her interest in dentistry through her own experience receiving orthodontic care as a teenager. She described that moment as transformative, sparking a desire to help others feel confident and cared for. Without family members in the profession or a traditional roadmap, she pursued dentistry guided by compassion and a commitment to service.

Fortes's challenges extended beyond clinical training. After practicing dentistry in Spain for 10 years, she made the difficult decision to move to the United States. Arriving without speaking English, she began her journey again as a dental assistant. She faced cultural adjustments, professional barriers and moments of self-doubt.

Fortes candidly shared that there were times she considered returning to Spain, but she chose to persevere for herself and her family.

Students connected strongly with Fortes' reflections on humility, resilience and adaptability. She emphasized that dentistry is not defined solely by technical skill, but also by empathy, integrity and a commitment to lifelong growth. Her experiences across health care systems shaped her understanding of patient care and education, ultimately leading her to discover a passion for teaching at OHSU.

Through education, outreach and mentorship, Fortes found purpose in helping students navigate their own non-linear journeys.

### Student engagement and lasting impact

The impact of the event extended well beyond the presentation itself. Sara observed high levels of student engagement, with many attendees staying afterward to ask questions and personally thank her. Post-event feedback revealed that students felt inspired and reassured, particularly those who had been uncertain about their own paths in dentistry.

Events like this help students recognize that patients and providers bring personal values, lived experiences and systemic barriers into the clinical setting. Listening to stories like Fortes's encourage students to approach patient care with empathy and to consider the broader social determinants

**Figure 1.** Left to right, Sara Garci, Laura Fortes, D.M.D. and April Sierra during a diversity event at OHSU.

**Figure 2.** Laura Fortes, D.M.D., says dentistry is not defined solely by technical skill, but also by empathy, integrity and a commitment to lifelong growth.

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of health. Several attendees shared that they felt more comfortable seeking mentorship from faculty and more motivated to learn about the diverse backgrounds of those guiding their education.

**Why these moments matter**

From both student and organizer perspectives, the ASDA Diversity Event reinforced the importance of representation and storytelling in dental education. These conversations help bridge the gap between technical training and real-world human experience, preparing students to become skilled, compassionate and culturally competent dentists.

As dentistry continues to evolve, diversity-focused gatherings play a vital role in shaping a workforce capable of addressing oral health disparities and effectively serving diverse communities. Gatherings remind students why they chose a profession rooted in service—and why fostering inclusive spaces within dental education is essential to fulfilling that mission.

**Figure 3.** Dental students gather after the ASDA event held at the OHSU Robertson Life Sciences Building in Portland.

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Anthology
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# Myoaligner® as a diagnostic, therapeutic and reversible decision-making tool in the management of temporomandibular disorders: A case review

Diyar Dezay, '28, Maryam Motlagh, D.M.D., Samyia Chaudhry, D.M.D.

## Introduction

Temporomandibular disorders, or TMD, encompass a wide range of conditions affecting the temporomandibular joints, or TMJs, and masticatory muscles. These multifactorial disorders are commonly associated with malocclusion, neuromuscular dysfunction and psychosocial factors, which may contribute to postural abnormalities, headaches and migraines.

A contemporary physiologic dental approach proposes that the optimal mandibular position should be determined primarily by physiologic muscle balance, rather than relying solely on tooth-guided occlusion and condylar position, which were emphasized in traditional approaches. With the use of bioelectronic instrumentation such as ultra–low frequency transcutaneous electrical neural stimulation, or ULF-TENS, clinicians can identify a muscle-compatible jaw position, providing a biologic framework for the management of TMD.

This case review evaluates a published case study by Maryam Motlagh, D.M.D., examining the use of the Myoaligner® system in a patient with complex TMD, malocclusion and airway concerns.[1] Myoaligner, an FDA-cleared device for the treatment of migraine headaches and temporomandibular joint disorders, was employed as the initial phase of care to establish a physiologic mandibular position prior to definitive treatment. Beyond its therapeutic role, this review highlights the Myoaligner as a reversible diagnostic and clinical decision-making tool, enabling assessment of mandibular function, physiologic tolerance and functional response before irreversible dental or orthodontic interventions. This approach may reduce clinical risk and improve treatment predictability in complex cases.

## Abstract

**Background.** Temporomandibular disorders, or TMD, involve complex interactions between occlusion, neuromuscular function and airway dynamics. Identifying a physiologic mandibular position prior to irreversible dental intervention remains challenging in patients with severe malocclusion.

**Purpose.** This review evaluates a published case study examining the Myoaligner system as a reversible diagnostic and therapeutic approach for managing complex TMD, malocclusion and airway compromise.

**Methods.** The reviewed case involved an adult female with facial asymmetry and painful TMD who declined surgical treatment. Ultra–low frequency transcutaneous electrical neural stimulation, or ULF-TENS, was used for neuromuscular deprogramming, followed by fabrication of a segmented Myoaligner orthotic at a physiologic functional bite position.

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## Case Summary

**Patient presentation.** According to the author, patient Michele is an adult female in her 30s who presented with facial asymmetry, a unilateral posterior crossbite, a canted smile and symptoms consistent with painful temporomandibular dysfunction (Figure 1). Prior to consultation with Motlagh, Michele had been advised that orthognathic surgery was her primary treatment option. The patient declined surgical intervention and sought a nonsurgical alternative.

**Key clinical findings.** The patient exhibited severe malocclusion and a distorted maxillomandibular relationship, accompanied by cranio-cervical misalignment and airway compromise (Figure 1). Imaging and clinical examination reportedly revealed compromised temporomandibular joint positioning, neuromuscular imbalance and functional occlusal discrepancies.

**Diagnostic approach.** The author reports that initial treatment involved the use of ULF-TENS to stimulate the facial and trigeminal nerves, thereby reducing hyperactivity in the masticatory and facial musculature (Figure 2).
Following neuromuscular deprogramming, the patient's physiologic functional bite position (Myobite) was recorded slightly above the mandibular rest position to preserve approximately 2 mm of freeway space.

Unlike conventional TMD splints fabricated at the physiologic rest position, the Myoaligner is designed to be fabricated at the Myobite position, allowing for mastication and functional loading along a physiologic mandibular trajectory. This recorded position served as the basis for fabrication of the milled PMMA Myoaligner® orthotic.

**Results.** The patient reported symptom improvement within 90 days, with objective gains in electromyographic balance, mandibular function and airway dimensions prior to irreversible intervention.

**Conclusion.** This case highlights the value of a reversible, muscle-guided approach in diagnostic decision-making for complex TMD cases. Further controlled studies are needed to validate this treatment strategy.

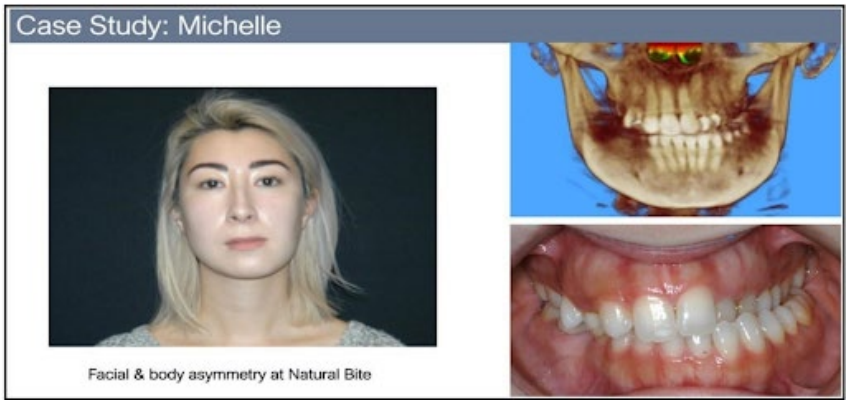


**Figure 1.** Extra-oral and intra-oral clinical images, along with CBCT views, illustrating facial imbalance, posterior occlusal asymmetry, smile canting and altered cranio-cervical orientation.

**Figure 2.** Recording Myobite after stimulation of cranial nerves V and VII by ULF-TENS.

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### Treatment phases

The case highlights multiple phases of treatment:

**Phase I**
Use of a lower-arch segmented Myoaligner worn day and night for three months to stabilize the mandible in a physiologically balanced Myobite position.

**Phase II**
Concurrent orthodontic expansion of the palate using an FDA-cleared upper DNA appliance and orthodontic repositioning of maxillary teeth, while maintaining the mandible in a physiologic trajectory during continuous wear.

**Phase III**
Introduction of a maxillary segmented Myoaligner for transitional use to address esthetic concerns and stabilize space created at the right maxillary canine site following exfoliation of retained primary teeth in a previously narrow maxillary arch. The appliance maintained the corrected arch form and occlusal relationships, providing stability for subsequent restorative planning (Figure 3).

**Phase IV**
Although not detailed in the original case report, this phase consisted of definitive restorative treatment aimed at optimizing occlusion and esthetics. Fixed prosthodontic bridges were placed to restore function and form, with implant therapy intentionally avoided.

**Outcomes.** According to the author, the patient experienced subjective relief of TMD symptoms within 90 days, along with improved facial symmetry and enhanced head and neck posture. Objectively, improvements were reported in electromyographic activity, jaw tracking and airway dimensions. These outcomes were documented at the conclusion of Phase I, prior to initiation of irreversible orthodontic or restorative procedures. During Phase II, sufficient maxillary expansion allowed exfoliation of retained primary teeth and subsequent eruption of an impacted canine (Figure 4).

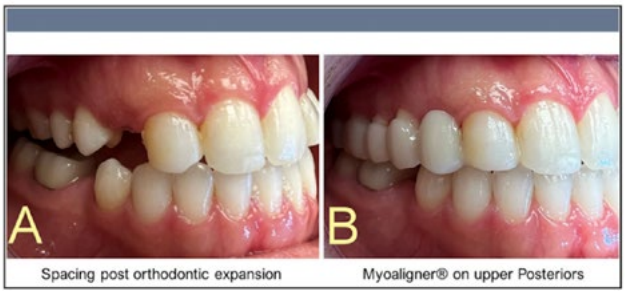


**Figure 3.** Maxillary segmented Myoaligner appliance placed to support esthetic correction and maintain space in the right maxillary canine region.

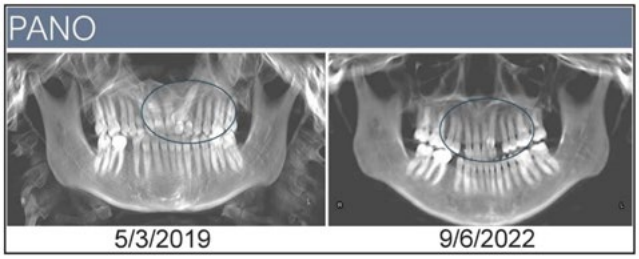


**Figure 4.** Panoramic radiograph demonstrates sufficient maxillary expansion to facilitate exfoliation of retained primary teeth and subsequent eruption of a previously impacted canine before initiation of Phase IV treatment.

## Clinical rationale

**Use of ULF-TENS.** While devices such as Aqualizers, leaf gauges and flat-plane occlusal appliances are commonly used to disengage posterior occlusal contacts and facilitate mandibular positioning, the author favors ULF-TENS for its speed and efficiency. By relaxing the postural muscles of the mandible, an optimal maxillomandibular relationship may be achieved in as little as 40 minutes.[2]

ULF-TENS was employed to relax hypertonic musculature innervated by the trigeminal and facial nerves, allowing the mandible to assume a physiologic rest position guided by muscular activity—including the lateral and medial pterygoids—rather than habitual occlusion. This physiologic position was used diagnostically to determine a muscle-compatible mandibular posture from which treatment could proceed.

**Rationale for segmented orthotics.** This case highlights the proprietary segmented design of the Myoaligner, distinguishing it from conventional full-arch orthotics. The segmented architecture is intended to accommodate physiologic mandibular flexion and reduce appliance rigidity; factors associated with decreased muscular compensation and improved functional tolerance during mastication. By avoiding a monolithic full-arch design, the appliance may also increase lingual space, supporting airway-focused treatment objectives by reducing tongue restriction during function. Additionally, segmented configuration permits staged occlusal modification during later phases of treatment. With two to three segments per arch, diagnostic and therapeutic adjustments can be performed incrementally, allowing controlled, stepwise occlusal changes without disrupting the entire occlusal scheme or introducing abrupt irreversible alterations.

**Distinction from traditional splints.** Flat-plane stabilization splints are typically intended for nocturnal use. In contrast, the Myoaligner is described as suitable for continuous wear, as it may be temporarily cemented to nonprepared teeth during the initial phase of therapy. This facilitates uninterrupted neuromuscular reprogramming, potentially accelerated temporomandibular joint remodeling[3,4] and allows for sustained evaluation of the proposed mandibular position during daily function.

## Critical analysis

**Strengths of the case.** Supported by clinical expertise and referenced research, the case includes comprehensive documentation of both subjective symptom improvement and objective data, including electromyography, jaw tracking, CBCT imaging and photographic records.

**Limitations.** As a single-patient case study, the findings cannot be generalized. Additionally, disclosure that the author is the inventor of the Myoaligner introduces potential bias.

**Objective versus subjective data.** Objective findings—such as improved EMG symmetry, mandibular range of motion and airway volume—strengthen the report beyond subjective symptom reporting. However, interpretation of these outcomes must be contextualized within the broader evidence base

for TMD, a heterogeneous and multifactorial group of conditions encompassing musculoskeletal, neurologic and functional components. This heterogeneity complicates standardization of diagnostic criteria, outcome measures and treatment protocols.

The absence of a universally accepted gold-standard therapy, combined with ethical constraints surrounding placebo or no-treatment controls in symptomatic patients, limits the feasibility of traditional randomized controlled trials. While the objective measures in this case suggest physiologic improvement, the lack of a control group restricts attribution of outcomes solely to the Myoaligner intervention. Patient-reported improvements in pain and function are clinically relevant but remain subjective, as they were not assessed using standardized pain scales or validated quality-of-life instruments.[5]

**Clinical relevance.** This case illustrates the Myoaligner as a viable nonsurgical option for a patient seeking relief from TMD symptoms and improvement in facial asymmetry. The reversible nature of the appliance was central to its clinical value, emphasizing the importance of reversibility in diagnostic decision-making for TMD management—particularly in cases with complex or uncertain mandibular positioning.

As demonstrated, reversible appliances such as the Myoaligner can serve both therapeutic and diagnostic roles, allowing clinicians to assess patient tolerance, symptom response and functional sustainability of a proposed mandibular position before proceeding with irreversible interventions. Monitoring function during Phase I may reduce the risk of iatrogenic complications associated with premature occlusal equilibration, orthodontic movement or extensive restorative procedures when mandibular positioning remains uncertain. This conservative, stepwise approach aligns with ethical principles prioritizing patient safety and minimizing unnecessary permanent alterations.[6]

Furthermore, compared with traditional single-phase stabilization splints, the segmented design of the Myoaligner may offer greater clinical flexibility. The phased protocol allows selective removal of appliance segments while pursuing restorative treatment, maintaining mandibular support throughout different stages of care. In contrast, transitioning from a single-phase splint to full-mouth restorative treatment often requires rapid fabrication of a new appliance, with no guarantee that the patient will maintain the desired mandibular position. The adaptability of the Myoaligner may therefore be advantageous in phased orthodontic or restorative treatment planning where preservation of a stable maxillomandibular relationship is critical.

In less complex cases, patients may elect to remain in Phase I after completing three months of continuous wear, transitioning to nighttime use for symptom maintenance and stabilization. This approach also preserves future options for esthetic or restorative enhancement without compromising mandibular position.

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**Conclusion.** This case review reframes the Myoaligner system not as an immediate pathway to definitive treatment, but as a reversible diagnostic trial appliance that supports informed clinical decision-making. According to Motlagh, the device enabled assessment of physiologic mandibular positioning, symptom response and functional stability prior to irreversible dental procedures. While the reported outcomes are promising, further controlled studies are required to validate the diagnostic role of segmented neuromuscular orthotics and establish standardized clinical guidelines for their use.

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# Shaping the future of dental leadership: Highlights from the American Student Dental Association National Leadership Conference

Diyar Dezay '28, Taylor Carpenter '28, Samyia Chaudhry, D.M.D.

Each November, the American Student Dental Association, or ASDA, holds a national leadership conference in Chicago. The conference brings together dental students from across the nation to build leadership, business and professional skills that extend beyond the traditional dental curriculum. This year, the ASDA chapter at Oregon Health & Science University was represented by 17 students who attended the conference on behalf of the university.

The weekend officially kicked off on Thursday evening, Nov. 20, as students representing more than 70 ASDA chapters arrived at the Hyatt Regency McCormick Place. The conference began early Friday morning with a powerful keynote from Juan Bendana, an author and motivational speaker, who shared his journey of perseverance after being told by an English teacher that he was not capable of writing his own book. His message challenged attendees to view obstacles as catalysts for personal and professional growth.

Throughout the weekend, participants attended breakout sessions focused on leadership development, business acumen and clinical competencies. Those interested in practice ownership explored topics such as workplace dynamics, effective team leadership and pathways to buy a dental practice. Students considering specialization in oral surgery, periodontics or orthodontics attended sessions outlining the steps and realities of postgraduate training.

Other sessions covered corporate dentistry, student loan repayment, policy development, pharmacotherapeutics and financial planning for future dentists. One standout session was a presentation on facial injectables by Erin Fraundorf, D.M.D., M.S.D., an orthodontist who broadened her practice by expanding her clinical skill set and scope of care. Even for students not planning to incorporate injectables into their future practices, the session offered valuable perspective on the evolving scope of dentistry and the importance of adapting to a changing profession.

One of the weekend's most anticipated social events was the ASDA NLC Boat Cruise. The event provided a relaxed setting for networking and connection with sweeping views of Chicago's skyline.

On Saturday, students explored emerging innovations at the Tech Expo, where companies demonstrated advances such as 3D printing, AI-assisted radiographic analysis and new implant systems.

The day culminated in another highly anticipated event, the Old Hollywood Glam Party. Sponsored by Aspen Dental, Haleon, Heartland Dental and PDS Health, the event blended networking,

entertainment and collaboration, serving as a fitting conclusion to the conference ahead of the final closing session on Sunday.

Overall, the 2025 ASDA National Leadership Conference helped participants expand their professional networks, gain renewed enthusiasm for leadership opportunities within dentistry and earn continuing education credits.

Students from OHSU described the experience as inspiring and empowering, noting that the conference strengthened their confidence, clarified career goals and fostered meaningful connections with peers and mentors from across the country.

Looking ahead, OHSU's ASDA chapter is eager to continue the experience with plans to return next year with more students and a sustained enthusiasm for professional development and leadership growth.

OHSU dental students, representing multiple class years, gather at the national leadership conference in Chicago in November 2025. Photo by OHSU

A FIGS booth had customizable tote bags at a vendor fair during the American Student Dental Association National Leadership Conference. Photo by OHSU

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# Innovation in Dentistry student interest group explores new ideas and practical solutions

Peter Nguyen ’27, Preston Phan ’27, Christopher Yoon ’26, Hector Martinez Sanchez ’27

### Who we are

Innovation in Dentistry is a registered Oregon Health & Science University student interest group, or SIG, within the School of Dentistry offering technical and logistical project support, as well as practical and informational workshops.

The group is dedicated to fostering a culture of creativity, collaboration and forward-thinking within the dental community.

We create a culture where students feel empowered to share their passion for innovation, exchange ideas and develop practical solutions to advance the field of dentistry and improve patient care. The group encourages involvement across many disciplines, including biological sciences, engineering, computer science and design and business, to leverage diverse expertise in creating groundbreaking advancements.

### What we do

Project management is a core function. We use the online platform Discord to exchange ideas between peers, request design feedback and coordinate 3D printing prototypes. Once projects are developed, members are referred to the OHSU Intellectual Property Management team to register patents and communicate with external businesses.

### Our prototypes

The simulator unit typically has an air-water syringe, or AWS, attached to the left arm of the unit. Right-handed clinicians typically hold the AWS in their right hand. This means the provider reaches over the patient’s face to grasp the AWS. By adding a holder on the right side, the provider can store the AWS on the right side where it is more convenient.


An air-water syringe, or AWS, holder is attached to an A-dec simulator unit.

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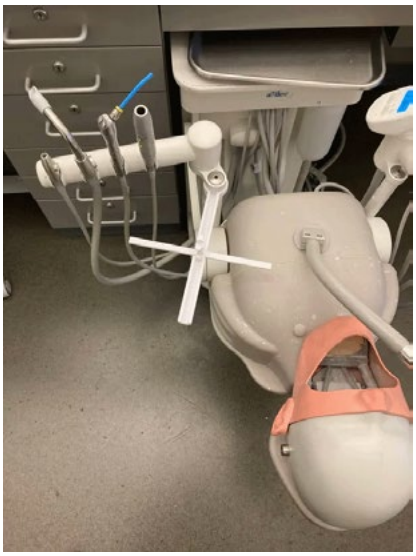
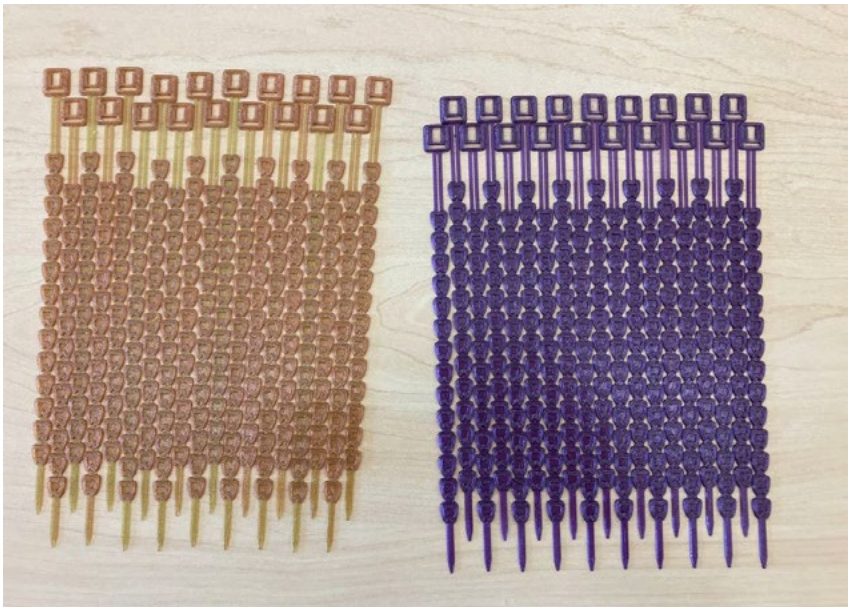



An instrument tray mount is attached to an A-dec simulator unit.

In the clinics, the instrument trays are near the 12 o'clock cabinetry's countertop. In the simulation clinic, the instrument trays are out of reach on the simulator unit or even further away on the nearby countertop. To remedy this, a mount for the simulator unit allows right-handed providers to have their instrument tray adjacent to their left. The mount is designed to fold up allowing students to store it in their desk drawers when it's not in use.



Dental-themed cable ties.

This project was a demonstration of rapid prototyping with 3D printing. After eight iterations, the final cable ties were printed in flexible thermoplastic polyurethane and distributed as gifts at OHSU events.

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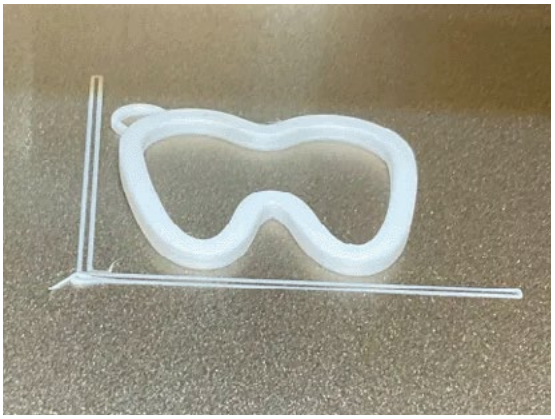
A resin composite gun replacement pin.

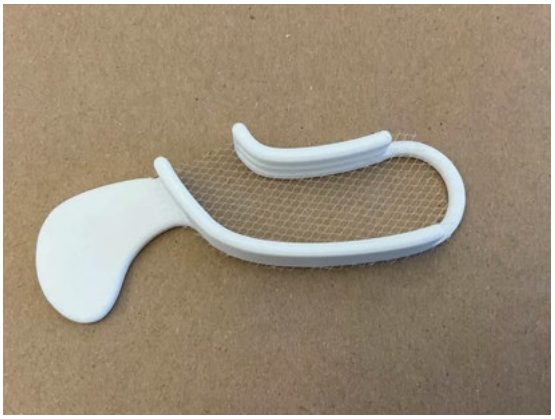
The black part of this composite dispenser often breaks in the two spots marked. The manufacturer does not sell individual parts, only entirely new dispensers. To prolong the life of the tool and save money, a replacement part was designed and printed.



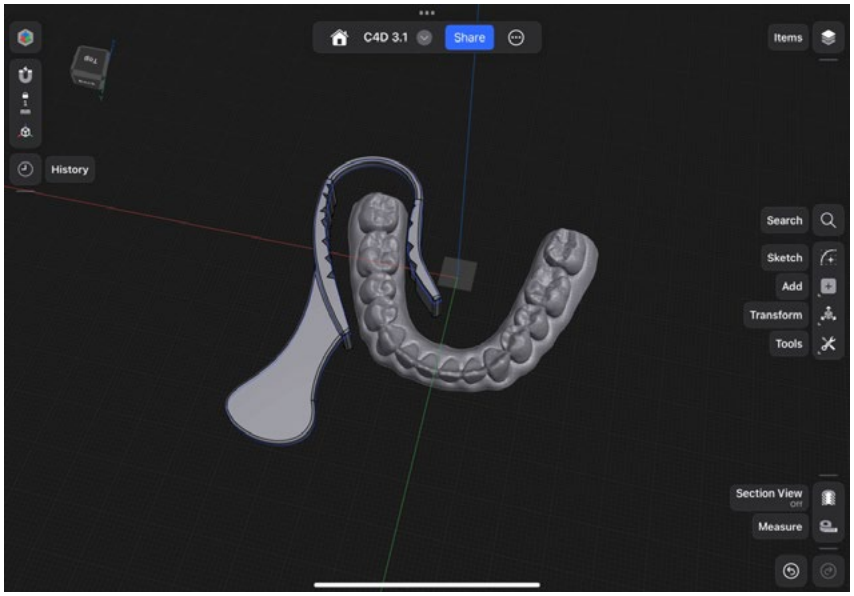
A simple keychain model taught students how to sketch basic models in 2D and then extrude it to make the model 3D.

### Workshops

Workshops increase CAD skills, such as how to use Shapr3D, a CAD program available on iPads. We aim to teach a few basic CAD concepts that students can apply to their projects. As the workshop is often during lunchtime, a box lunch is offered and sometimes a printed version of the day's project is included.



A custom triple impression tray modeled to fit an example mandibular arch. The mesh is made of tulle, which was added during printing.




### Printing service

With the goal of facilitating rapid prototyping and allowing students to explore 3D printing, the Innovation in Dentistry SIG offers 3D printing services. Students can request 3D prints and receive training on how to use the 3D printers. Prints for individuals are free, thanks to reimbursements from OHSU. Prints for non-OHSU student interest groups are charged for materials.

### The future

The Innovation in Dentistry SIG collaborates with other dental schools nationwide to share workshop information and discuss ideas. There are plans to hold pop-up events at the OHSU School of Dentistry to showcase prototypes and create awareness of our pioneering advances in dentistry.

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# Bell Leadership Institute Achievers™ program. Why do we behave as we do? How can we be better leaders?

Lyndie Foster Page, B.D.S., Ph.D., DIPClinDent, MComDent

Gerald Bell, M.S., Ph.D., founder and CEO of the Bell Leadership Institute, believes there are certain qualities that make great leaders, and great leaders build great organizations.

The institute, which he established in 1972 and today is based in North Carolina, builds on its ability to use "time-tested solutions" drawing from more than 50 years of research and consultation with generations of CEOs and senior leaders. The program continually evolves to understand the behaviors of the most effective leaders who have created the most positive results.

**Supporting future leaders**

While considering my academic leadership growth with the dean of the OHSU School of Dentistry, I came across an American Dental Education Association advertisement for the Bell Leadership Institute Achievers™ program. Rick Workman, D.M.D., and his wife were offering 10 scholarships to support full-time dental academics to take part in the Achievers program. The goal for Workman, the executive chair of Heartland Dental, a dental support organization, is to prepare senior dental faculty at academic institutions who are midway into their careers for future positions as associate deans or deans.

The Achievers program appeared to benefit my development as a leader. To be nominated by the OHSU dean, I had to earn the title of assistant or associate dean or department chair and have held a leadership role for at least two years. Then I could apply with my current CV, a letter of endorsement from the dean and my reasons for applying.

**Assessing my personality**

In late 2024, I was selected and set about organizing my three-day in-person meeting at the University of North Carolina, Chapel Hill campus. First, I participated in a pre-coaching session with a facilitator to clarify what I wanted to gain from the program.

A Bell Personality Profile™ was next. Fifteen colleagues whom I work with participated in the profile process, giving vital feedback about me. The profile provides an assessment of my personality and leadership style across eight dimensions of leadership. These are goal setting, delegation, communication, listening, response to mistakes, response to stress, style of humor, general styles and motivation. Each element captures personal insights that uncover clues to a leader's effectiveness.

The Achievers experience was transformational for me in looking at leadership from a different perspective. The course gave me a deeper knowledge of myself, a deeper connection to my beliefs and behaviors, and how I can adjust my behaviors to be a better leader. Each day we were invited to think about why we behave as we do and what competencies are required to be a great leader.

The framework Bell uses is based on the personality patterns and behaviors of the world's best and worst leaders. Founded on 50 years of research, the model identifies effective and ineffective leadership approaches by understanding the underlying motivations and the impacts that result from those intentions.

**Exceptional leaders**

Over the first few days, we considered the basic elements of human existence, genetics, needs, likes, preferences, fears and dislikes and the impact these have on our beliefs and behaviors. We contemplated how the behaviors are programmed by the facets of our life: family, people we interact with and roles we have held.

We learned about the characteristics of the six core competencies of an exceptional leader: the entrepreneur, competitor, producer, stabilizer, team builder and creator. We learned about the six extreme personality patterns that limit an effective leader. These are the performers, attackers, commanders, avoiders, pleasers, and drifters. In each session, we broke up into small groups and enjoyed a highly engaging peer sharing experience, then received take-home assignments to reinforce the concepts. Occasional one-on-one facilitation and coaching filled the course.

**Feedback**

On the final day, each of us were given our Bell Personality Profile 360-degree assessment results. Everyone is slightly anxious leading up to this moment, but also reflective, of what's in the profiles. We worked together in small and large groups to interpret the findings and put our minds at ease.

Each participant sees a breakdown of their achiever's core scores and gaps, extreme scores and gaps, and overall rankings of their personality. We get qualitative feedback from each of the associates who filled in their profiles. This is a large amount of information and requires dissecting and reflecting all the data.

Reviewing my strengths and weaknesses, although difficult, was useful in highlighting many areas I could work on. Some of the areas I knew about, but others I did not.

**Reflections**

I believe in Gerald Bell's framing of the four laws of leadership:

1. Great leaders build great organizations
2. Build yourself first
3. Build your people so they can build your organization
4. Lead first, manage second and do last

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I must build myself to be a better person so I can be a better leader. This will not happen overnight. I learned that personality patterns are the drivers of how we lead. Understanding our personality is integral to being a better leader. Our behavior is patterned and persistent over time, but we can change it if we work at it. The program suggests I take up to three areas causing me to be an ineffective leader and work on them for a year. Each day I remind myself of these areas and reflect on whether I was able to achieve change.

Many leadership programs focus solely on how leaders behave; the Achievers program gave me a thorough understanding of why I behave as I do, delivering the self-awareness that drives long-term, positive change. I am thankful for the opportunity to grow as a leader and use new tools to enhance my leadership skills. My goal is to build a team that will support building a great School of Dentistry.

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# The Executive Leadership in Academic Medicine® program from a School of Dentistry perspective

Carmem Pfeifer, D.D.S., Ph.D.

The Hedwig van Ameringen Executive Leadership in Academic Medicine®, or ELAM®, program is a year-long fellowship for faculty in schools of medicine, dentistry, public health and pharmacy. The program was established in 1995 as a prestigious national leadership fellowship to address a gap in the number of women leaders in the health sciences and ultimately unlock and sustain their impact in the field. Its mission is to "develop and connect successful professionals so they can confidently lead academic health care into the future."

I was extremely fortunate to have been part of the 30th year cohort in 2025 and join the more than 1,600 alumni, many of whom hold high-level leadership positions (provosts, deans, chief officers, chairs) at 300 health institutions around the country as well as internationally.

The program consists of three separate weeks of in-person sessions held in Philadelphia, plus sessions held online throughout the year. The curriculum keeps the fellows engaged throughout the year by building community through intensive project-based interactions. Fellows are grouped into small learning communities, which meet twice monthly, to work on projects and engage in peer-mentorship and coaching.

ELAM is not the only leadership program available to dental professionals, and it is similar to others such as the American Dental Education Association  Leadership Institute (also a cohort-, project-based, year-long program). What makes ELAM unique that it is tailored to address specific needs of women leaders (through 2025) and it combines perspectives from other health sciences to offer a global, campus-wide perspective.

Given its success and strong track record, the program expanded to include Executive Leadership in Healthcare, and Executive Leadership in Academic Technology, Engineering and Science, focusing on hospital and STEM management, respectively. As of 2026, all programs will welcome all genders.

**Learning communities**

Learning Communities, or LCs, are intentionally structured to serve as the core peer-based environment through which leadership development is deepened and sustained. These small, longitudinal groups create a trusted space where reflection, challenge and mutual support are integrated with the broader curricular experience of the fellowship.

Each Learning Community is composed of a diverse cohort of fellows drawn from different institutions, disciplines and career stages, with facilitation provided by experienced ELAM faculty coaches. I was the least senior peer in my group, at the division head level at the time the program started. My peers

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were associate deans for research, academic affairs and faculty affairs, and one was a board-certified emergency medicine physician who directed the firearm injury prevention and suicide prevention program for the state of Colorado. I was the only dentist in my group, and one of six dentists in the 150-fellow cohort in 2025.

Groups are formed early in the program and are maintained throughout the fellowship year, with regular meetings scheduled during in-person sessions and are sustained through virtual engagement across the year. Most of the active learning experiences and workshops developed during the in-person sessions happen within the LC. Through this structure, a stable forum is established in which experiences are shared, leadership dilemmas are examined and growth is tracked over time. Through facilitated dialogue, participants are invited to explore challenges related to authority, conflict, identity and influence, and to test new ways of thinking and acting as leaders. In this way, leadership development is shifted from purely cognitive learning to deeper reflective and adaptive work.

Concepts introduced through the ELAM curriculum (such as emotional intelligence, negotiation, power dynamics, systems thinking and change leadership) are brought into the LCs to be applied to real-time institutional contexts. Case examples drawn from fellows' own experiences are analyzed, and feedback is exchanged in a structured yet supportive manner, with mutual accountability and collective growth. Over time, as trust and familiarity increases, the dialogue tends to deepen, allowing more complex issues to be addressed, including navigating politics, exercising authority and leading through ambiguity. This sense of connection reduces isolation often experienced in senior roles and reinforces shared commitment to values such as integrity, inclusion and service.

The value of the Learning Communities extends well beyond the formal duration of the ELAM program. Relationships formed within these groups are frequently sustained as enduring peer networks that provide consultation, mentorship and collaboration across institutions and career transitions, which has been the case in my experience. As leadership challenges evolve over time, I have often relied on these trusted peers as sounding boards and allies. In this way, the LCs are not viewed merely as a programmatic feature but as a foundation for lifelong professional support and influence.


Ron Sakaguchi, D.D.S., Ph.D., M.B.A., School of Dentistry dean, Jack Ferracane, Ph.D. and Carmem Pfeifer, D.D.S., Ph.D., stand next to Executive Leadership in Academic Medicine signage in Philadelphia in May 2025.

The largest graduating class in the history of Drexel University's Executive Leadership in Academic Medicine and Executive Leadership in Health care programs was in 2025. OHSU's graduating cohort was the largest representation by any health science university in the nation. An OHSU group gathered during the May graduation in Philadelphia. From left to right, David Robinson, Ph.D., Constance Tucker, M.A., Ph.D., Sarah Diamond, M.D., Maria Rodriguez, M.D., M.P.H., Amy Hermesch, M.D., Ph.D., Nathan Selden, M.D., Ph.D., Carmem Pfeifer, D.D.S., Ph.D., and Ron Sakaguchi, D.D.S., Ph.D., M.B.A.

While LCs are the main base of peer mentorship in the program, it is by no means the only one. In my case, I could rely on the dental fellows (six of the 150 fellows), the OHSU fellows (five total) and the ELAM alumni at OHSU and across the country. This program has truly expanded my professional network exponentially, with meaningful connections—the "pick up the phone and ask an impromptu question" type connection.

**Yearly projects**

The cornerstone of the ELAM experience is the Institutional Action Project, or IAP, a year-long initiative that addresses a strategic priority at the fellow's home institution through systematic needs assessment, stakeholder engagement and data-informed planning. There is an expectation for close collaboration with senior leadership to identify barriers to productivity and morale and to propose actionable solutions. The project is meant to be aligned with the fellow's own strengths and interests and to produce a tangible, actionable plan to advance an area of interest, such as infrastructure to support interdisciplinary collaboration and enhance pathways for mentoring and career advancement.

Emphasis is placed on getting familiar with organizational dynamics, building partnerships and social/political capital across departments, strengthening the fellow's skills in strategic analysis, negotiation and change management. In summary, the goal of the IAP project is to develop competencies essential for senior leadership roles in academic medicine and dentistry, while producing results that also benefit the institution.

My project focused on establishing a formal faculty development program at the OHSU School of Dentistry, spanning a wide breath of the academic pathway, from the D.M.D. program through mid-career. I tapped into my project management experience as a researcher and my deep interest in faculty development to address the leaky pipeline of personnel in academia and to ultimately train and retain the next generation of dental educators and researchers.

According to the American Dental Education Association, there are 300-400 faculty vacancies in the United States currently, a shortage that affects clinical and education/research positions. Compounded by a shortage of dentists in underserved areas, this represents a threat to not only the education of dental students, but also to the standards of care provided to patients nationwide.

I used the concept of found pilots, building from existing resources to develop a formal business plan, in consultation with the dean of the OHSU School of Dentistry and the executive vice provost at the time, focusing on the value proposition for the institution. Specifically, the project aimed to address a lack of mentoring leading to a lack of awareness of alternative career paths in dentistry. My vision is to ultimately empower trainees and junior faculty to pursue careers in academia, especially at the time of career transitions, when they are most vulnerable. The ongoing, lofty goal is to address all career stages, from dental student to resident and post-doc, to junior and mid-career faculty, and inculcate in them the life-long learning mindset.

The Leaders Forum presentation is as an opportunity to synthesize these experiences and to articulate a leadership narrative before peers and an invited audience that includes the ELAM and Executive Leadership in Healthcare fellows and leaders from their institutions. This event also provides more networking opportunities. Preparation for and delivery of this presentation required a clear articulation of the rationale, process and anticipated impact of the Institutional Action Project, as well as reflection on leadership development. The session also offered feedback and dialogue, which were instrumental in refining not only the project, but the tools and resources available at the institution and nationwide to realize it.

While in the IAP, fellows were expected to work and articulate within their local communities. We did this through a project for the Anne Preston Health Sciences University, or APHSU. We were assigned to groups different from our learning communities to work on a hypothetical case study for a health sciences center in financial trouble, on the verge of a large hospital merger, with local and regional implications.

The assignment included a deep dive into financial records, which were used as a tool for strategic budget planning education, as well as simulated political negotiations at the institutional and state level. Each person in the group was assigned a high-level role at the university or hospital system and asked to negotiate and contribute to the strategic plan from their assigned perspective. This highlighted the pressures each role faces and provided clear training on effective advocacy and influencing outcomes, with emphasis on systems thinking and the responsibility of academic leaders to address upstream determinants of health through education, research and community engagement.

In other words, leadership was reframed through this work, shifting focus from management within organizations to influence across systems. The importance of aligning academic missions with community needs, leveraging partnerships and preparing future leaders equipped to address complex public health challenges was reinforced.

The deliverable of this exercise was a formal written proposal to bring this imperiled university back on track, which allowed me to draw from our own experience. The final task was to deliver a presentation to defend our project to a simulated board of directors. This mock board included people who serve as board members in their real lives. They did not hold back on their comments. This was an invaluable experience for me.

In summary, the IAP grounds leadership in practical, institution-focused action, while the APHSU project expands system-level perspective on academic health. Both enhanced my awareness and ability to navigate complexity and build coalitions that ultimately drive meaningful change.

**In-person sessions and lessons learned**

The in-person sessions require a great deal of pre-work and preparation to be fully taken advantage of. The faculty in the program are truly exceptional. Many are alumni who have gone on to be chancellors, university presidents, provosts, deans and executive leaders in hospitals and academic medicine. But other speakers were invited who have professional knowledge on certain topics, some of whom are

best-selling authors. The sessions were structured in a workshop style, with a truly active learning lens. This forced the fellows to show up prepared, with accountability coming from within the LC. Many times, we were asked to play C-suite roles in simulated scenarios, and those were tremendously helpful to consolidate the concepts from the mini-lectures. While the themes of the more than 90 sessions delivered throughout the program are too numerous to list, the themes are as follows:

**Personal effectiveness, conflict management and negotiation tactics.** This was a focus on the three in-person sessions. The program uses a few tools for individual traits evaluation, such as the Med360® (from peers, direct reports, and supervisors—a brutally honest way to learn how the world sees you) and the Myer-Briggs® test (light version of Myer-Briggs), the latter a commonly used tool that confirmed I am an introvert. Working with a coach to understand the results was helpful (details are below). A few keywords and links to briefly describe themes: developing your executive style, time management (Pomodoro® technique), active listening, using communication skills to influence decisions (see a short video on the Science of Persuasion), techniques such as the STAR conversation method, assuming positive intent, and negotiation tactics and finding your "best alternative to a negotiated agreement" (Sara Laschever is truly great). Finally, there were sessions on job interviewing and negotiating for an offer letter led by a recruiting company, with practical advice, ending with a panel of representatives from the five largest recruiting companies in the U.S., which gave us a glimpse of how mid- to high-level position searches happen.

**Financial literacy.** As part of the APHSU project, we developed a budget strategy to address a complex, multi-layered financial crisis. There were several mini-workshops on financial basics with smaller, focused problem-based sessions, for real-time applications. This was extremely helpful and immediately applicable to the work I was doing at a university-wide committee at the time. Learning continues to be beneficial in the financially constrained environment we are currently in (situational leadership).

**Coaching, mentoring and sponsorship.** Even though conceptually these three were different, I often see the terms being used interchangeably. A coach helps you do things better (skills/execution), a mentor shares wisdom for broader growth, while a sponsor uses their influence to advocate for you, using their reputation to create opportunities and promote your career advancement. A coach asks questions, a mentor advises, and a sponsor talks about you in important places, moving you forward. I confess I used to have some prejudice against the figure of the coach, the same way I am weary of self-help gurus. During ELAM, fellows were required to work one-on-one with high-level, professional coaches. The experience completely changed my perspective. Their practical advice was instrumental in developing my IAP and through some professional changes I was going through during the program. The take home message is that we need all three. The same person can play all three roles some of the time, but we likely need different people depending on the situation.

**Work-life balance.** Put simply, you cannot have it all, all the time. We became acquainted with the Maslow's hierarchy of needs, ranging from basic needs to things that bring you joy, which can be used for ourselves or in our roles as leaders. We were also introduced to the concept of 4-way wins, on how to integrate "work, home, community and self" domains. One of our LC mini-projects was styled in the form of a "work-life balance hackathon," a light-hearted way to build community and share strategies to manage the modern hectic lifestyle.

### Application, tuition and time commitment

A lot of information is available on the ELAM website. In summary, the annual application process opens on September 1 and proceeds through a competitive process. Given the significant financial commitment, each institution nominates a limited number of prospective fellows each year. At OHSU, it is the responsibility of the unit leaders to identify and fund the fellowship.

There are active ELAM alumni at OHSU who provide feedback for candidates on the extensive application process. This consists of not only a comprehensive CV and description of academic credentials, but also short essays with reflections on the candidate's leadership experience. For this reason, the program is intended for individuals at least at the advanced mid-career level, already with some managerial or leadership experience, with interest in advancing in their leadership roles. It is not uncommon for people to reapply before being accepted into the program.

ELAM's program fee for 2026-27 is $19,600. In addition to the program fee, the fellow or their institution is responsible for travel, lodging and some meals during the sessions. Tuition includes 19 days in session, distance learning, course materials, resources, references, expert facilitators, conference site expenses, continuing education fees, executive coaching and special events. In addition to the in-person sessions, fellows are expected to be present at the distance learning live sessions and complete all class assignments in advance of the synchronous sessions. It is paramount to come to these sessions prepared and ready to participate—these are truly active learning sessions. Not being prepared means your experience will be severely limited, as there will be far less opportunities to practice voicing ideas in public within high-stakes situations. I dedicated at least eight hours weekly to this program throughout the year.

### Take home message

Other than the practical tools described here, I feel extremely fortunate to have had the opportunity to be in a room with fellows and faculty who I now consider to be role models. There was palpable power in the room. I had the sense that I had found my people, normalized the same strengths and struggles I have experienced. But also, this program was a rich opportunity for self-reflection and to gain clarity of my own goals. This would definitely not be the first leadership program I would take; there are many excellent resources available at OHSU for a softer start in learning these skills. Mainly, I learned that I am far more capable than I give myself credit for.  I can normalize a situation by asking what I need. Sounds simple, right?

**Acknowledgements**

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**Additional resources and references**

Found pilots: https://www.cfar.com/found-pilots/

Med360 feedback gathering tool: https://www.pilgrimpro.com/med-360-suite.html

Personality test: https://www.themyersbriggs.com/en-US/Explore-Solutions/MBTI

Light version of Myer-Briggs: https://www.16personalities.com/free-personality-test

Leadership styles: https://professional.dce.harvard.edu/blog/how-to-determine-what-my-leadership-style-is/#Why-You-Need-a-Leadership-Style

Time management: https://www.pomodorotechnique.com/

Science of persuasion: https://www.youtube.com/watch?app=desktop&v=cFdCzN7RYbw

STAR conversation method: https://capd.mit.edu/resources/the-star-method-for-behavioral-interviews/

Negotiation: https://www.saralaschever.com/

Situational leadership: https://situational.com/situational-leadership/

Maslow's hierarchy of needs: https://www.simplypsychology.org/maslow.html

Work-life balance: https://knowledge.wharton.upenn.edu/article/four-way-win-how-to-integrate-work-home-community-and-self/

ELAM: https://drexel.edu/medicine/academics/leadership-and-professional-development/elam/how-to-apply/

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# An M.B.A. journey in human-centered innovation: Redesigning dental education through empathy

Alexandria Case, CDA, EFDA, EFODA, BSHA, and M.B.A. candidate

**Abstract**

Dental anxiety remains a significant barrier to equitable oral health care and presents challenges for dental students who often feel underprepared to manage emotionally distressed patients. A 2021 meta-analysis estimated that dental fear affects a significant proportion of adults globally, reinforcing its role as a persistent and systemic challenge within oral health care delivery.[1] This paper describes an educational quality-improvement project conducted as part of an M.B.A. program in health care management, applying human-centered design, or HCD, to explore the emotional and sensory dynamics of anxious dental encounters. Through empathy interviews, mapping exercises, student survey data and reflective analysis, I examined how both students and patients experience anxiety, communication breakdowns and sensory triggers within the dental environment.

While the initial goal was to identify ways to eliminate or improve dental anxiety, it is recognized that complete eradication is not feasible. However, patients succeed in their dental experiences while also teaching

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## Introduction

Dental anxiety remains a persistent barrier to equitable and effective oral health care, affecting patient trust, treatment adherence and overall outcomes. These challenges also influence the educational environment, where dental students frequently encounter anxious or sensory-sensitive patients yet often feel unprepared to respond with confidence or empathy. During my 21 years at the OHSU School of Dentistry, serving as a trained dental assistant, oral radiology educator and program director of Continuing Dental Education, I have observed how fear, sensory overload and communication gaps impact clinical care and students' growth as emerging professionals. Despite the prevalence of these issues, traditional dental curricula devote limited structured attention to the emotional and sensory dimensions of patient care, as well as to the development of self-care, emotional regulation and coping strategies for providers. As a result, learners may enter clinical practices well prepared technically but insufficiently equipped to manage patient anxiety, navigate emotionally complex interactions or sustain their own well-being in high-stress clinical environments.

My own experience returning to graduate school in my 40s has strengthened my understanding of these dynamics. As a full-time adult learner, balancing family responsibilities, a full-time job and a busy life, I understand feeling overwhelmed. Yet this stage of life also brings clarity, resilience and experience that I did not possess when I entered college in my early 20s. These insights have deepened my empathy for today's students, who face a rapidly changing landscape marked by technological demands, financial pressures, constant exposure to information and heightened social comparison, all while entering a demanding health professions curriculum.

My decision to pursue an M.B.A. in health care grew from a desire to navigate these systemic challenges more effectively and to advocate for the learners, faculty, and patients at the heart of our institution. Through the MBA Healthcare Innovation course, I developed a deeper understanding

of HCD as a framework for exploring the emotional, sensory, and relational complexities present in dental encounters. Empathy interviews, mapping exercises and reflective analysis revealed how students and patients experience anxiety and where communication breakdowns arise, highlighting meaningful opportunities for curricular enhancement.

**Understanding the innovation problem**

Dental students frequently encounter anxious or sensory-sensitive patients, yet many feel underprepared to respond effectively. Survey data from OHSU students indicated that a substantial proportion regularly provide care for patients with high levels of anxiety. At the same time, more than half reported limited or no formal education in anxiety management. Unmanaged anxiety can negatively affect patient comprehension, pain perception, recovery timelines and adherence to care.[2,3]

Although the initial goal was to identify methods for managing dental anxiety through educational programs, it's important to recognize that eliminating it may not be achievable. Nonetheless, we can focus on strategies to reduce the impact, enhance patient experiences and equip future dentists with the skills to support their patients and build their emotional resilience.

Research indicates that effective communication skills are crucial for managing dental anxiety among patients and dental students.[4] Additionally, factors contributing to dental anxiety often overlap with the emotional resilience required of students in high-pressure environments, as recent studies have shown the prevalence of anxiety among dental patients and students.[5] This alignment underscores the need for educational models that prioritize emotional health, which can directly influence future dentists' ability to manage patients with similar emotional needs effectively.

**Methods: educational quality improvement and consent**

This activity was completed as part of an educational quality-improvement project and was not classified as human subject research. Therefore, Institutional Review Board, or IRB, approval was not required. All participants provided either verbal or written consent.

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future dentists crucial skills to assist patients and develop their resilience. Findings revealed substantial alignment between patient and student stressors, including fear of pain, sensory overload, perceived judgment and uncertainty about expectations. These insights indicate that clinical and technical skills are essential components of dental education; traditional curricula often fall short to address emotional competencies adequately. Training programs tend to emphasize procedural proficiency, with limited attention to emotional resilience, empathy and communication skills that are necessary for supporting anxious patients and maintaining effective patient–provider relationships. Using HCD mindsets, empathy, curiosity, collaboration and experimentation, I identified possible opportunities to enhance dental education through low-cost, scalable strategies such as communication skill training, sensory-awareness training, reflective debriefing and prototype educational interventions.

This paper also reflects on the integration of business and design thinking during my M.B.A. journey, highlighting how understanding organizational structures, leadership approaches and system-level influences can strengthen innovation within health professions education.

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### Why this problem applies to human-centered design

HCD is particularly suitable to problems involving emotional complexity, behavioral patterns and lived experiences. Dental anxiety exemplifies these characteristics. Patients and students experience fear, uncertainty and vulnerability, which are all elements requiring empathetic listening and iterative exploration rather than prescriptive direction.

### Scope of the work

This project focused on understanding emotional and sensory components of anxious dental encounters and identifying feasible opportunities for curriculum improvement. Institution-wide curricular overhaul and facility redesign were outside the project scope.

### Tools used to explore the problem

Empathy interviews and empathy mapping (Figure 1) were used to identify emotional triggers, cognitive patterns and communication challenges in anxious dental encounters with patients. Patent surveys were taken to self-identify common appointment stressors (Figure 2).[1,3] Student surveys (Figure 4) collected reflective feedback from third- and fourth-year dental students to assess their perceptions and feelings regarding the treatment of anxious patients.

Recognizing that education is not merely a necessity but a complex business that must adapt to current policies and societal changes makes this work particularly relevant. By combining lived experience, qualitative insights and the principles of HCD, this work proposes pathways to cultivate emotionally attuned, adaptive and empathetic clinicians who are better equipped to care for patients experiencing anxiety and sensory sensitivity.

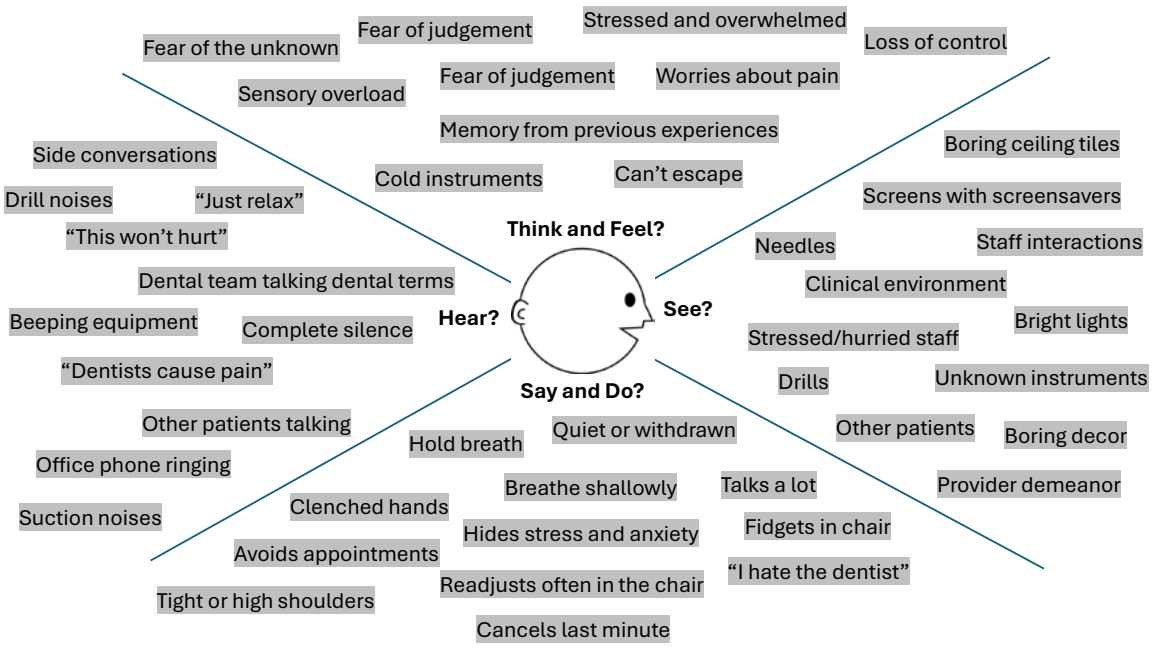


**Figure 1.** Empathy map of the anxious dental visit.

**Patient survey questions on dental anxiety and sensory sensitivity**

1. Q1. What is your age group?
   - Male or Female
2. Q2. How do you usually feel before a dental appointment?
3. Q3. Have you ever delayed or skipped a dental visit because of fear, anxiety, or sensory discomfort (e.g., lights, sounds, smells)?
4. Q3a. If yes, what made you hesitate most?
5. Q4. Which parts of a dental visit makes you feel most nervous or uncomfortable? (Select all that apply)
6. Q5. What helps you feel calmer or more comfortable during a dental visit? (Select all that apply)
7. Q6. How comfortable are you sharing your anxiety, fears, or sensory needs with dental staff?
8. Q6a. If uncomfortable, what makes it difficult to share these needs?
9. Q7. How much do you agree with the following statements? (1 = Strongly Disagree, 5 = Strongly Agree)
   - Q7a. I feel anxious or nervous before dental visits.
   - Q7b. The sounds and lights in a dental office increase my anxiety.
   - Q7c. My anxiety makes it harder for me to complete treatment.
   - Q7d. Kind and empathetic communication helps me feel safer.
   - Q7e. Small environmental changes (lighting, music, breaks) can help reduce my stress.
   - Q7f. I would feel more comfortable if dental staff asked about my comfort and sensory needs before treatment.
10. Q8. Would you find it helpful to have educational tools (videos, pamphlets, or online guides) that explain what to expect and share coping tips for dental anxiety?
11. Q9. If available, would you utilize a “menu” of de-stressing options to choose from when you are getting seated in the dental chair?

**Figure 2.** Patient survey questions on dental anxiety and sensory sensitivity.

### Mindsets that guided the work

The Experiencing Design mindset from Jeanne Liedtka, Karen Hold and Jessica Eldridge, which emphasized empathy, curiosity and collaboration, all shaped how I approached this work and interpreted the findings.[6]

### Constraints

Time limits, recruiting challenges, academic scheduling and institutional boundaries influenced the scope and feasibility of this project.

### Primary audience

Primary stakeholders include dental students, dental patients and faculty who shape the learning environment.

### Exploration questions

Key exploration questions included identifying patients' primary stressors and sensory triggers, as well as determining effective communication delivery strategies for reducing anxiety. Additional questions focused on students perceived preparedness to treat anxious patients and their preferred learning methods, helping to identify educational approaches that best support readiness for emotionally complex encounters (Figure 3).

### Expected outcomes

Expected outcomes included identifying curricular gaps, synthesizing emotional insights and developing prototype educational concepts.

### Success metrics

The success of this innovative effort was assessed across multiple dimensions. Initially, it assessed the clarity and relevance of insights from empathy interviews, mapping activities and student surveys, ensuring they accurately reflected patient and student experiences and identified meaningful curricular gaps. Next, success was assessed by the feasibility and scalability of prototype concepts, such as sensory-awareness training and communication skill development, with attention to their practicality within current curricular frameworks and alignment with institutional goals. Additionally, success was marked by my growth in human-centered design skills, including conducting qualitative research, analyzing emotional and behavioral patterns and translating insights into testable educational interventions. Collectively, these criteria ensured the project contributed to immediate educational insights and the development of long-term empathy-driven innovation.

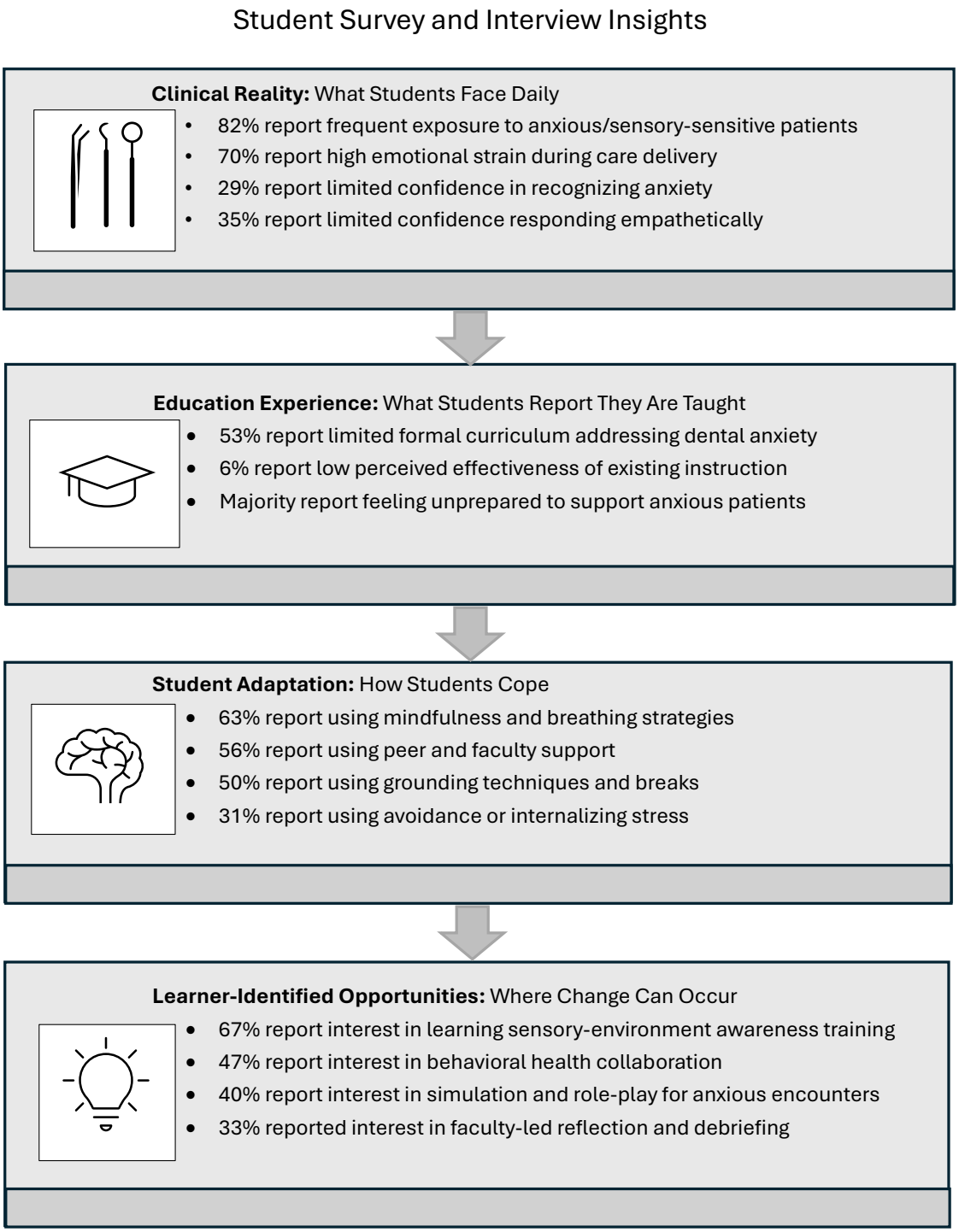


**Figure 3.** Summary of dental student interview themes.

**Dental Student Survey: Supporting Patients with Dental Anxiety and Sensory Sensitivities**

**Purpose:**
This brief survey aims to understand dental students' perspectives, confidence and educational needs regarding caring for patients with dental anxiety, fear or sensory sensitivities (e.g., bright lights, sounds or smells). Your feedback will help identify opportunities to enhance empathy, communication skills and sensory-environmental awareness within dental education.

**Participation statement:**
Participation is voluntary and anonymous. The survey will take approximately 3 minutes. Responses will be used for educational improvement and curriculum design purposes only.

**Section 1: Confidence and Experience**

**1.** How confident do you feel in recognizing signs of dental anxiety or sensory discomfort in patients?

- ☐ Very confident
- ☐ Somewhat confident
- ☐ Neutral
- ☐ Somewhat unconfident
- ☐ Very unconfident

**2.** How confident do you feel in responding empathetically to a patient who is visibly anxious, fearful, or overstimulated?

- ☐ Very confident
- ☐ Somewhat confident
- ☐ Neutral
- ☐ Somewhat unconfident
- ☐ Very unconfident

**3.** How often do you encounter patients who appear anxious, fearful, or sensitive to environmental stimuli (e.g., sound, lighting, smell)?

- ☐ Frequently (weekly)
- ☐ Occasionally (monthly)
- ☐ Rarely (a few times per term)
- ☐ Never / Unsure

**Figure 4.** Dental student survey: Supporting patients with dental anxiety and sensory sensitivities. *(Continued on next page)*

*Continued from previous page*

**Section 2: Education and Training**

**4.** Have you received formal education or guidance on managing patients with dental anxiety or sensory sensitivities as part of your dental program?

- ☐ Yes, integrated into coursework
- ☐ Yes, through workshops or special sessions
- ☐ No, not formally covered
- ☐ Unsure

**5.** How effective do you feel your current dental education has been in preparing you to support these patients?

- ☐ Very effective
- ☐ Somewhat effective
- ☐ Neutral
- ☐ Somewhat ineffective
- ☐ Very ineffective

**6.** Which types of learning experiences would most help you feel more confident and prepared? (Select up to two)

- ☐ Empathy and communication training focused on patient emotions and comfort
- ☐ Role-playing or simulation scenarios with anxious or sensory-sensitive patients
- ☐ Collaboration with behavioral health professionals for coping and communication skills
- ☐ Sensory environment awareness training (lighting, sound, scent, tactile elements)
- ☐ Faculty-led debriefing and feedback on patient interactions
- ☐ Other (please specify):

**Section 3: Student Stress and Emotional Readiness**

**7.** When treating anxious or sensory-sensitive patients, how often do you personally feel stressed or anxious?

- ☐ Often
- ☐ Sometimes
- ☐ Rarely
- ☐ Never

**Figure 4.** Dental student survey: Supporting patients with dental anxiety and sensory sensitivities. *(Continued on next page)*

*Continued from previous page*

**8.** How comfortable are you discussing patient anxiety, empathy challenges, or your own stress management with faculty or peers?

- ☐ Very comfortable
- ☐ Somewhat comfortable
- ☐ Neutral
- ☐ Somewhat uncomfortable
- ☐ Very uncomfortable

**9.** Which strategies do you currently use to manage stress or emotional strain in the clinic? (Select all that apply)

- ☐ Deep breathing or mindfulness
- ☐ Talking with peers or faculty
- ☐ Taking short breaks or using grounding techniques
- ☐ Avoidance or internalizing stress
- ☐ Other (please describe):

**Section 4: Reflection**

**10.** In your opinion, what could the OHSU School of Dentistry do to help students feel more prepared and supported when treating patients who experience dental anxiety or sensory sensitivities?

Thank You

Your feedback helps us identify ways to enhance empathy, sensory awareness, and emotional readiness in dental education — improving both patient experiences and student learning outcomes.

**Figure 4.** Dental student survey: Supporting patients with dental anxiety and sensory sensitivities.

### Conclusion

Dental anxiety and sensory sensitivity are complex challenges that extend beyond technical competence to include emotional, behavioral and sensory dimensions affecting patients, students and providers. Addressing these challenges requires educational approaches grounded in observed evidence and empathetic engagement. Through the MBA Healthcare Innovation course, I applied human-centered design methodologies to examine emotional dynamics within dental education. Empathy interviews and mapping exercises revealed recurring patterns of uncertainty, cognitive overload and vulnerability that are often insufficiently addressed in traditional dental curricula. This underscores the importance of understanding human experience as a foundation for improving well-being and clinical outcomes. Findings from the surveys and empathy mapping exercises were synthesized into a prototype concept aimed at reducing anxiety and sensory overload within dental learning environments (Figure 5).

## Prototype Summary

| Prototype | Description | Purpose | Success Indicators |
|---|---|---|---|
| Faculty-Led Simulated Patient Encounters | Students rotate roles to experience multiple perspectives: patient, clinician, observer. | Builds empathy, strengthens communication, and exposes students to emotional and sensory dynamics from all viewpoints. | Improved student confidence, stronger communication ratings, richer reflection notes during simulations. |
| Structured Reflective Debriefs | Guided reflection sessions following patient interactions or simulations | Helps students process emotional responses, identify communication strategies, and integrate learning. | Deeper reflective writing, evidence of emotional insight, improved interpersonal communication skills. |
| Sensory-Environment Awareness Training | Students evaluate operatories from the perspective of anxious or sensory-sensitive patients | Raises awareness of environmental triggers, supports empathetic, trauma-informed care. | Reduced patient anxiety behaviors, improved environmental adjustments, more confident student reports. |
| Comfort Chair Menus | All patients receive a menu of available comfort items (e.g., headphones, ear plugs, stress balls, weighted blanket, neck pillow, screens, etc.) | Enhances patient comfort and autonomy, reduces anxiety through sensory support and choice. | Higher patient comfort scores, reduced chairside anxiety, positive feedback from students and patients. |

**Figure 5.** Emerging prototype concepts chart.

As I approach the completion of my M.B.A. in June 2026, I recognize how the program has expanded my analytical skills and reframed my role in health care education. Business education provides essential structure, rigor and decision-making frameworks that shape contemporary health care and educational systems. Applying these tools through a human-centered design lens enables me to engage more effectively within complex institutional environments while centering human relationships, professional development and well-being in organizational decision-making.

Building on this foundation, I plan to apply human-centered and innovative approaches at the OHSU School of Dentistry to support curricular development that is reflective, emotionally informed and responsive to evolving clinical, educational and economic conditions. Integrating opportunities for self-awareness, emotional resilience and adaptive coping into dental education can better prepare learners to manage stress, engage empathetically with patients and sustain professional well-being.

These experiences have also shaped my leadership approach, emphasized humility and curiosity, and enhanced my perspective. Human-centered design has strengthened my ability to navigate ambiguity, analyze interconnected emotional and systemic patterns, and guide change with clarity and compassion. Ultimately, my goal is to contribute to an adaptive, forward-looking educational culture that proactively responds to shifts in educational systems, clinical practice and economic realities. Achieving this requires a whole-systems perspective that recognizes student wellness, faculty well-being and patient experience as interdependent determinants of institutional effectiveness and high-quality, patient-centered care.

**Acknowledgments**

I want to thank the dental students, faculty members and patients who generously shared their perspectives and experiences during this project. Their willingness to participate made this work possible. I am also grateful to the faculty of the OHSU MBA in Healthcare Management program, whose instruction and mentorship strengthened my understanding of design thinking, organizational systems and leadership. I extend special appreciation to my family for their continual support and encouragement throughout my graduate studies. No financial support or external funding was obtained for this project.

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## Use of artificial intelligence disclosure

During manuscript preparation, the author used Grammarly Pro and ChatGPT (OpenAI) to assist with grammar, clarity, organization and formatting. The author reviewed and edited all content and takes full responsibility for the final version.

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# Designing the financial health snapshot: A human-centered approach

Chris Ewbank, M.B.A. candidate

## Introduction

Academic dental institutions function within a complex environment where patient care, education, research and financial stewardship are deeply interconnected. While financial dashboards are essential for navigating this complexity, they are often designed with technical accuracy rather than user comprehension in mind. At the OHSU School of Dentistry, although financial data was accessible, many faculty and clinic leaders expressed uncertainty about interpreting performance metrics and translating insights into actionable steps.

This gap significantly influenced my decision to pursue a M.B.A. in health care management. Through my involvement in clinical operations, I observed that challenges in financial literacy stemmed less from a lack of capability and more from the way information was presented, communicated and experienced. Although financial data was technically accurate, it often lacked sufficient context to enable confident decision making. In response, I applied a human-centered design, or HCD, approach to this innovative project, transforming financial dashboards from static reports into collaborative decision-support tools. The outcome is a financial health snapshot, a dynamic dashboard I'm developing and intending to evolve through ongoing stakeholder feedback that will align with clinical and organizational priorities.

## Methods

The project uses a qualitative, human-centered design methodology rooted in empathy, co-creation and continuous iteration. The stakeholders are faculty, clinic managers, dental assistants, administrative staff and finance partners. Feedback was collected through structured interviews and surveys to capture a comprehensive range of stakeholder experiences and perspectives. The financial health snapshot is an adaptive tool, shaped by ongoing feedback and early practical application. The analysis involved coding feedback into thematic categories, enabling the identification of common trends and specific areas for improvement and ensuring transparency and replicability of the methodology.

Data collection involved semi-structured conversations and observation of participants as they interacted with financial dashboards during routine operations. Two primary human-centered design tools guided the analysis. Empathy mapping documented stakeholders' cognitive, emotional and behavioral responses to financial information (Appendix A). Journey mapping, by contrast, examined the complete experience from dashboard dissemination to interpretation and action, identifying specific moments where engagement declined (Appendix B).

Insights were synthesized through the human-centered design mindsets of immersion, sensemaking and alignment. These findings will guide iterative refinements to the snapshot, ensuring it adapts to organizational needs rather than remaining a static reporting product.

**Results**

Empathy and journey-mapping analyses revealed that disengagement from financial data was primarily influenced by emotional and experiential factors, rather than technical complexity. Stakeholders frequently noted that while color-coded indicators highlighted performance concerns, they did not provide sufficient context to explain the underlying causes or to suggest appropriate actions. Consequently, many postponed reviewing dashboards until prompted, citing uncertainty and limited confidence in their interpretations.

In response, the financial health snapshot is developed through iterative feedback cycles, with a focus on consolidating essential metrics into a single-page format. Refinements prioritized clarity, relevance and narrative explanation. This involved incorporating plain language descriptions of key variances, establishing a visual hierarchy that supports actionability, and framing the context to connect financial performance to routine clinical operations.

Early pilot reviews with a limited group of stakeholders indicated improved comprehension and greater confidence in interpreting financial information. Ongoing feedback continues to inform refinements, ensuring alignment with clinical workflows, financial priorities and user needs.

**Discussion**

The project illustrates the value of applying human-centered design as a continuous practice rather than a one-time intervention in financial communication. Barriers to financial engagement were not due to a lack of data or technical rigor, but to how users experienced the information. Enhancements in financial literacy resulted from iterative refinement of how existing information was contextualized, prioritized and communicated, rather than from adding more metrics.

By positioning the financial health snapshot as a continuously evolving tool, the project will establish a sustainable feedback loop between finance and clinical partners. Financial reporting is being reframed from a static evaluative mechanism into a shared learning system, fostering clarity, confidence and action across various roles. This approach aligns with the broader OHSU Healthcare M.B.A. program in systems thinking, Lean principles, and financial stewardship, highlighting that financial operations are most effective when designed as integrated systems rather than isolated controls.

The findings further underscore the situational relevance of human-centered design within health care finance. While HCD may have limited application in highly standardized or compliance-driven processes, it is especially effective in areas where interpretation, trust and behavioral response influence outcomes. Financial communication exemplifies this need, requiring methods that

balance analytical rigor with accessibility and relevance. In this context, human-centered design enhances collaboration between finance and clinical teams and aligns financial insights with the organization's mission.

**Conclusion**

Through the application of a human-centered design methodology, this project redefined financial reporting at the OHSU School of Dentistry as a communicative and experiential system rather than a solely technical process. Empathy and journey mapping revealed that engagement with financial data depended more on clarity and context than on the volume of information. These insights informed the ongoing development of the financial health snapshot, a dynamic dashboard that evolves through ongoing stakeholder feedback.

The snapshot illustrates how financial reporting can serve as a shared language that fosters understanding, accountability and collective decision-making. By integrating analytical precision with intentional design, the snapshot encourages shared ownership of financial performance and aligns financial insights with clinical operations. More broadly, this work highlights that when financial systems are designed with users at the center, they can act not only as reporting tools but also as catalysts for alignment, learning and sustainable financial stewardship.

**Use of artificial intelligence disclosure**

The author used generative AI tools (ChatGPT, OpenAI) to support editing for clarity, concision and flow. All content, analysis and interpretations reflect the author's original work and professional experience. The author reviewed and approved all final language and takes full responsibility for the content of this submission.

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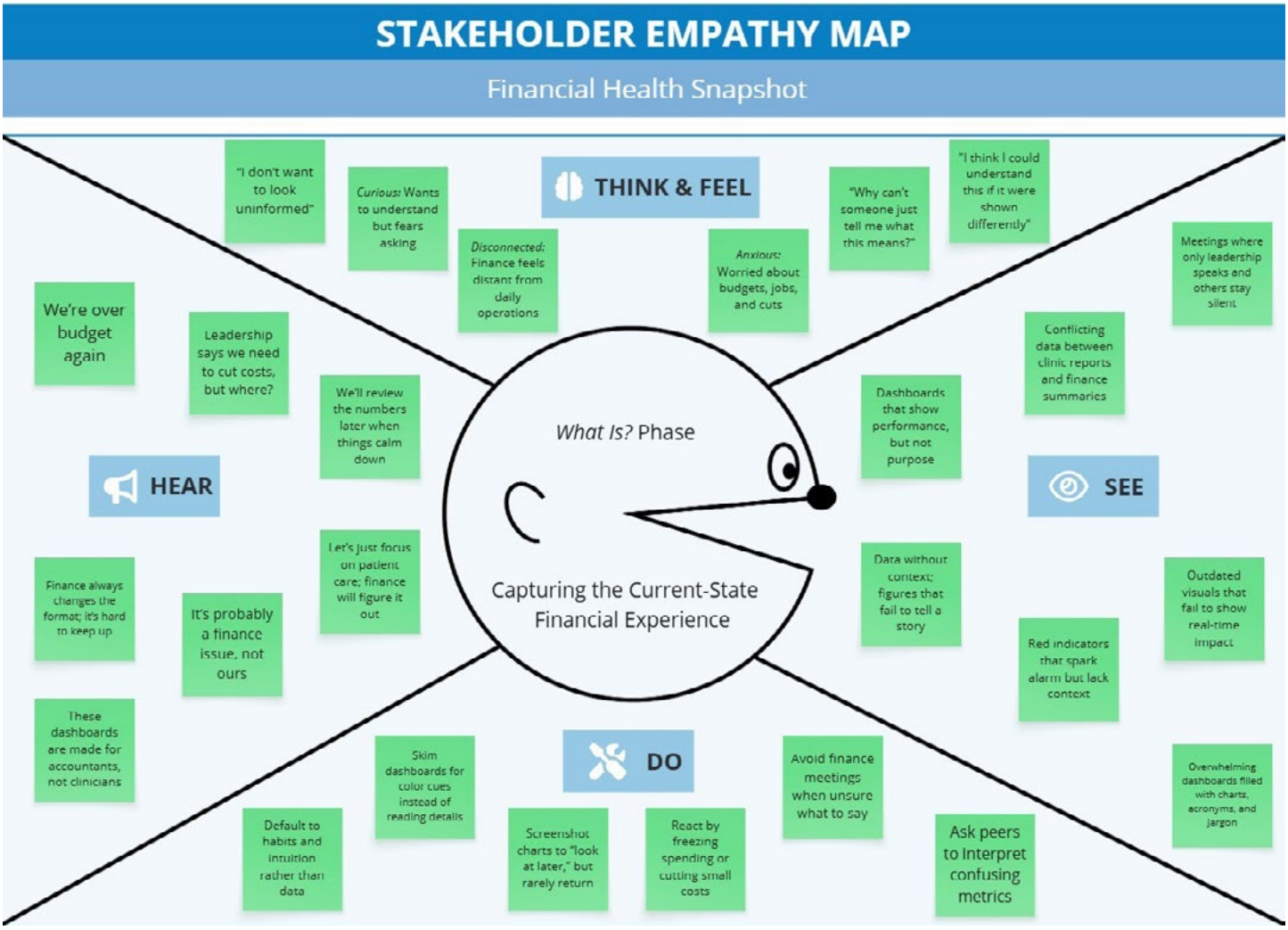
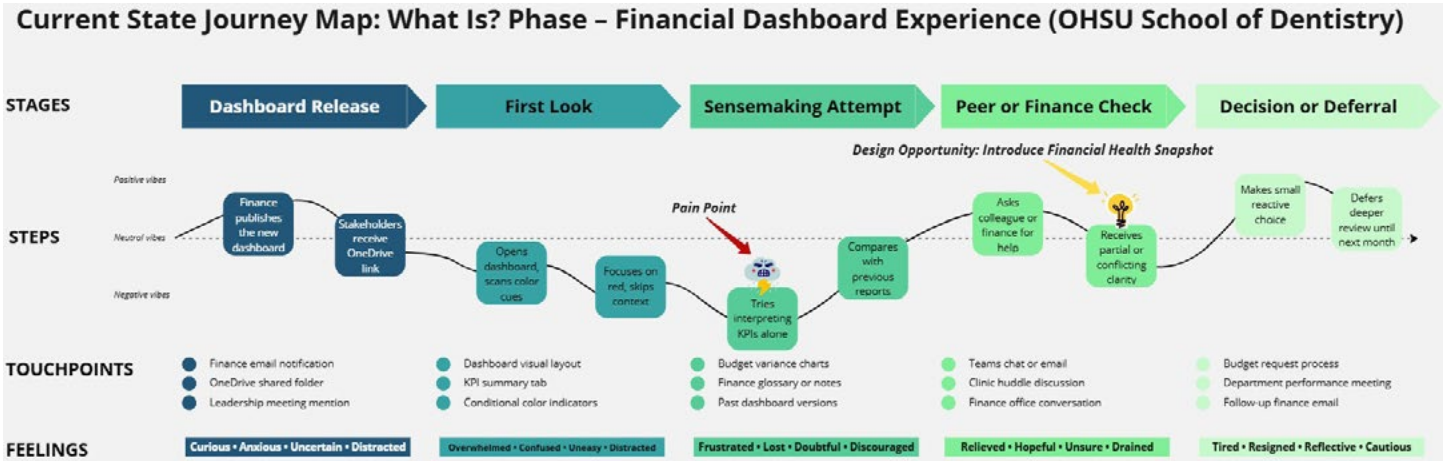



**Appendix A.** Empathy map




**Appendix B.** Journey map

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# Evidence-based overview of digital dentures and the reference denture technique

Despoina Bompolaki, D.D.S., M.S., FACP

## Introduction

The rehabilitation of edentulous patients with complete dentures remains a fundamental aspect of prosthodontic practice. Although conventional methods have served patients for over a century, they often involve multiple visits, prolonged chairside procedures and substantial laboratory time. In recent years, digital dentistry has reshaped removable prosthodontics, integrating intraoral scanning, computer-aided design, or CAD, and computer-aided manufacturing, or CAM, into denture fabrication.[1-3] These innovations have been driven by improvements in scanning accuracy, design software and material science, all of which have facilitated predictable digital workflows that are more efficient and reproducible than traditional methods.[3-5]

The adoption of digital dentures has been accelerated by the potential to improve patient-centered outcomes.[2,4] Recent literature demonstrates that digital dentures can significantly reduce clinical visits, decrease chairside time and minimize postoperative complications while maintaining or even enhancing functional and esthetic outcomes.[6,7] Furthermore, industrially produced denture resins fabricated under controlled pressure and temperature have introduced new standards of material quality, offering durability and biocompatibility beyond what can be achieved with conventional polymerization methods (such as heat-curing or injection molding techniques).[8-12]

Among the various workflows described, the reference denture technique has gained prominence as a simple and predictable method for incorporating digital technology for removable prosthodontics in clinical practice.[13,14] By using an existing denture as a blueprint, the protocol simplifies the clinical process and enhances patient experience. The present article reviews the most recent evidence on digital denture materials and clinical outcomes and provides a detailed description of the reference denture technique, highlighting its indications, contraindications and clinical workflow.

**Abstract**

Advances in materials, manufacturing and clinical workflows have contributed to the growing adoption of digital complete dentures in prosthodontic care. While conventional (analog) denture fabrication remains the standard of care, it is often time-consuming and technique sensitive, requiring multiple patient visits and extensive laboratory work. Recent studies indicate that digitally fabricated dentures, produced by either milling or 3D printing, demonstrate comparable or even superior outcomes in terms of adaptation, efficiency and patient satisfaction. Milled polymethyl methacrylate, or PMMA, prostheses, fabricated from pre-polymerized blanks, exhibit superior physical properties such as reduced porosity, lower residual monomer content and enhanced mechanical strength, while printed resins offer cost efficiency and design flexibility. Clinical trials and systematic reviews confirm that digital workflows reduce chairside and laboratory time by approximately 200 minutes compared to conventional methods,

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### Advances in digital denture materials

CAD/CAM-milled dentures are fabricated from pre-polymerized PMMA blanks manufactured under high pressure and temperature.[5,8] This industrial polymerization process produces a material that is highly polymerized, with a significantly reduced residual monomer content compared to conventionally processed resins. Clinically, this translates into less mucosal irritation and enhances biocompatibility. In addition, the high degree of polymerization yields a final product with superior mechanical strength, including improved flexural resistance and fatigue performance, reducing the risk of denture base fracture.[5,8,15,16] The material's reduced porosity and smoother, hydrophilic surface characteristics minimize microbial adhesion, lowering the potential for Candida colonization, and improving long-term color stability.[10,11,16-18]

In contrast, additive manufacturing through three-dimensional printing relies on photopolymer resins that are incrementally cured layer by layer.[6] This method is more cost-efficient and conserves material compared with subtractive milling, while also allowing for greater flexibility in design modifications and rapid duplication of prostheses. Recent developments in resin formulations have enhanced the strength and wear resistance of printed dentures, bringing them closer to the performance of milled prostheses.[5,8,9]

However, limitations persist, particularly in long-term color stability, surface wear and interlayer adhesion, which can contribute to fractures or delamination over time.[6,7] While milling remains the gold standard for digitally manufactured definitive prostheses, 3D printing can still be used for trial or interim prostheses, or large-scale clinical settings where reduced cost and quick turnaround time are prioritized.

Despite these technological advances in material science, fundamental prosthodontic principles such as accurate border extension remain essential for clinical success.

### Clinical and patient-related outcomes

Digital workflows demonstrate improved clinical efficiency compared to conventional denture fabrication. Kattadiyil, et al.,[19] reported that conventional dentures required over 200 minutes more clinical time than digital dentures. Similar findings have been replicated in subsequent studies, including a randomized controlled trial by Deng, et al.,[20] who

while also decreasing the total number of appointments and postoperative adjustments.

Among digital workflows, the reference denture technique is a highly predictable and efficient protocol that digitizes the patient's existing prosthesis, allowing it to serve simultaneously as impression tray, occlusal record and esthetic template for tooth arrangement. This article provides a review of recent advances in digital denture materials and outcomes, and describes in detail the reference denture technique, including its indications, contraindications and step-by-step clinical workflow.

reported total clinical times of 130.5 minutes for digital dentures compared with 158.5 minutes for conventional methods. Laboratory times followed a similar pattern, with digital workflows averaging 98.5 minutes compared with 162.8 minutes for conventional workflows.[20]

The reduction in clinical time is largely attributed to the decreased number of appointments. While conventional dentures often require five to six visits, digital workflows can be completed in as few as two to four visits, depending on the protocol used.

However, the evidence is not uniformly positive. A recent systematic review reported that up to 37.5% of patients experienced retention issues and as many as 31.3% required remakes, often necessitating one to four unscheduled follow-up visits.[21] These complications were frequently linked to errors in occlusal vertical dimension, esthetic dissatisfaction or inadequate extension of the denture bases.

Patient satisfaction remains high with digital dentures, with most studies reporting equal or greater satisfaction compared with conventional prostheses. Patients particularly value the comfort, fit and reduced treatment time associated with digital workflows. Nevertheless, esthetic outcomes are occasionally rated higher with conventional dentures,[22] which is likely due to the individualized tooth arrangement and characterization that remain easier to achieve with analog methods, such as simply moving teeth on wax chairside.

Cost analyses consistently show that although the material costs of digital dentures are higher compared to the cost of conventional fabrication techniques, the overall cost of treatment is reduced due to fewer appointments, decreased chairside time and simplified laboratory processes requiring less hands-on time.[23,24] Among digital approaches, 3D printing appears to offer the greatest potential for cost minimization, especially in institutional or high-volume settings.[25]

**Reference denture technique**

The reference denture technique builds on the principle that a well-fitting, esthetically acceptable existing prosthesis can serve as the foundation for a new digital denture.[14,26-29] The rationale is that by digitizing a prosthesis with established patient acceptance, clinicians can bypass or combine several conventional clinical steps while maintaining predictability.

Indications for the reference denture technique include patients with an existing denture that provides acceptable esthetics (even if minor changes are needed) and occlusion and is made at the desired/appropriate occlusal vertical dimension, or OVD. It is particularly well-suited for patients who require expedited treatment, as well as those who are generally satisfied with their existing (usually interim) prostheses.

Conversely, the technique is contraindicated in cases where the existing denture is ill-fitting, fractured or esthetically unsatisfactory, or where significant occlusal or esthetic modifications are required. It is also contraindicated in cases where OVD needs to be altered. Lastly, this technique should be avoided for patients with high esthetic demands, who are better served with conventional fabrication methods allowing for highly individualized tooth arrangement.

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### Step-by-step clinical workflow

#### Preparation/impressions

- Evaluate the existing prosthesis for esthetics, occlusion and vertical dimension. (Figure 1)
- If border extension is required, perform border molding using greenstick compound.
- Apply denture adhesive on denture intaglio surface.
- Complete final wash impression using medium- or light-body PVS material. Use closed-mouth technique when making final wash, to prevent changes in OVD or malalignment of occlusal planes (Figures 2, 3).
- Remove excess impression material from facial, lingual and occlusal surfaces, to prevent misalignment during prosthesis scanning and during bite registration.
- In 3Shape, select the “removable prosthesis” and “impression scan” options.

#### Maxillary reference denture scan

- Begin at one tuberosity and scan across the residual ridge to the contralateral tuberosity.
- Return to the midline and complete the palatal scan with smooth lateral swipes.
- Rotate the scanner at a 45° angle to capture the buccal aspect of the ridge.
- Pause briefly to allow rendering and enhance global accuracy.
- Complete scanning of the peripheral borders, facial surfaces and occlusal surfaces of the teeth.

#### Mandibular reference denture scan

- Start at the first molar area and proceed posteriorly to the retromolar pad.
- Continue along the residual ridge with alternating scanner angulation.
- Re-scan lingual and buccal peripheral borders for cross-arch accuracy.
- Capture facial and occlusal surfaces of the prosthesis.
- Avoid over-scanning lingual flanges to prevent closed watertight models.

**Figure 1.** Initial presentation.

**Figure 2.** Maxillary impression using existing denture.

**Figure 3.** Mandibular impression using existing denture.

### Occlusal record

- Return prostheses (with impression material) in the patient's mouth.
- Make a bite registration in CR using a PVS bite registration material (Figure 4).
- Perform right and left buccal bite scans, positioning the scanner 50% on each arch and extending the scan slightly beyond alignment.
- Alternatively, conduct a 360° bite scan to achieve three-point cross-arch alignment of the maxillary and mandibular dentures.
- This step can be completed extraorally after an interocclusal record has been obtained intraorally.

**Figure 4.** Bite registration in centric relation.

### Laboratory instructions

- Ask the laboratory to return a printed try-in to review esthetics, phonetics and occlusion with the patient (Figure 5A); the prototype can also be made in full color and later serve as a spare set of dentures (Figure 5B).
- Make any necessary changes to the try-in and re-scan the adjusted prototype. If no changes are needed, this step can be omitted.
- Fabricate the definitive prosthesis via milling, following the prototype contours. (Figure 6).

**Figure 5A.** Printed prototype for try-in.

### Conclusion

Digital dentures fabricated using CAD/CAM technologies represent a major advance in prosthodontics, with strong evidence supporting their efficiency, reproducibility and patient-centered benefits. Milled prostheses demonstrate superior material properties, while 3D printing offers promising cost and workflow advantages. The reference denture technique is a particularly valuable digital workflow that allows for the rapid and predictable duplication of an existing prosthesis, minimizing visits and enhancing patient satisfaction. Its success, however, is highly dependent on careful patient selection and meticulous execution of scanning and occlusal registration steps. As digital technology continues to evolve, the integration of robust material science with clinically sound protocols promises to further improve outcomes for edentulous patients.

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**Figure 6.** Final milled dentures.

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- Each author's first and last name, degrees, professional title and work affiliations including position.
- Acknowledgments, if applicable.

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- Tables are to use units and phrasing consistent with the manuscript's text.
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(SoDA, D.M.D., oral communication, November 2023)

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2. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *Heliyon*. 2018;19:e00205. https://doi.org/10.1016/j.heliyon.2018.e00205

Reference to a book:
3. Strunk W Jr, White EB. *The Elements of Style*. 4th ed. Longman; 2000.

Reference to a chapter in an edited book:
4. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, eds. *Introduction to the Electronic Age*. E-Publishing; 2009:281-304.

Reference to a website:
5. Zika travel information. Centers for Disease Control and Prevention. January 26, 2016. Updated August 11, 2016. Accessed June 18, 2019. https://wwwnc.cdc.gov/travel/page/zika-travel-information

Reference to software:
7. Coon E, Berndt M, Jan A, et al. Advanced Terrestrial Simulator (ATS) v0.88 (Version 0.88). Zenodo; 2020, March 25. https://doi.org/10.5281/zenodo.3727209

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[data set] 5. Oguro, M, Imahiro, S, Saito, S, Nakashizuka, T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015. http://dx.doi.org/10.17632/xwj98nb39r.1

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**Author contributions**

All authors are to have made substantial contributions to:

- Conceptions and designs of the study, acquisition of data or analysis and interpretation of data.
- Drafting the article or revising it critically for important intellectual content.
- Final approval of the version that is submitted.

All authors should be listed with their affiliations including positions, their academic degrees and their scientific or clinical contributions to the article. The editor and publisher reserve the right to ask for justification for each author's inclusion.

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Authors must ensure that the article describes the practical implications of the findings, answering the question, "What does this mean for oral health care?" This should be included in the abstract.

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