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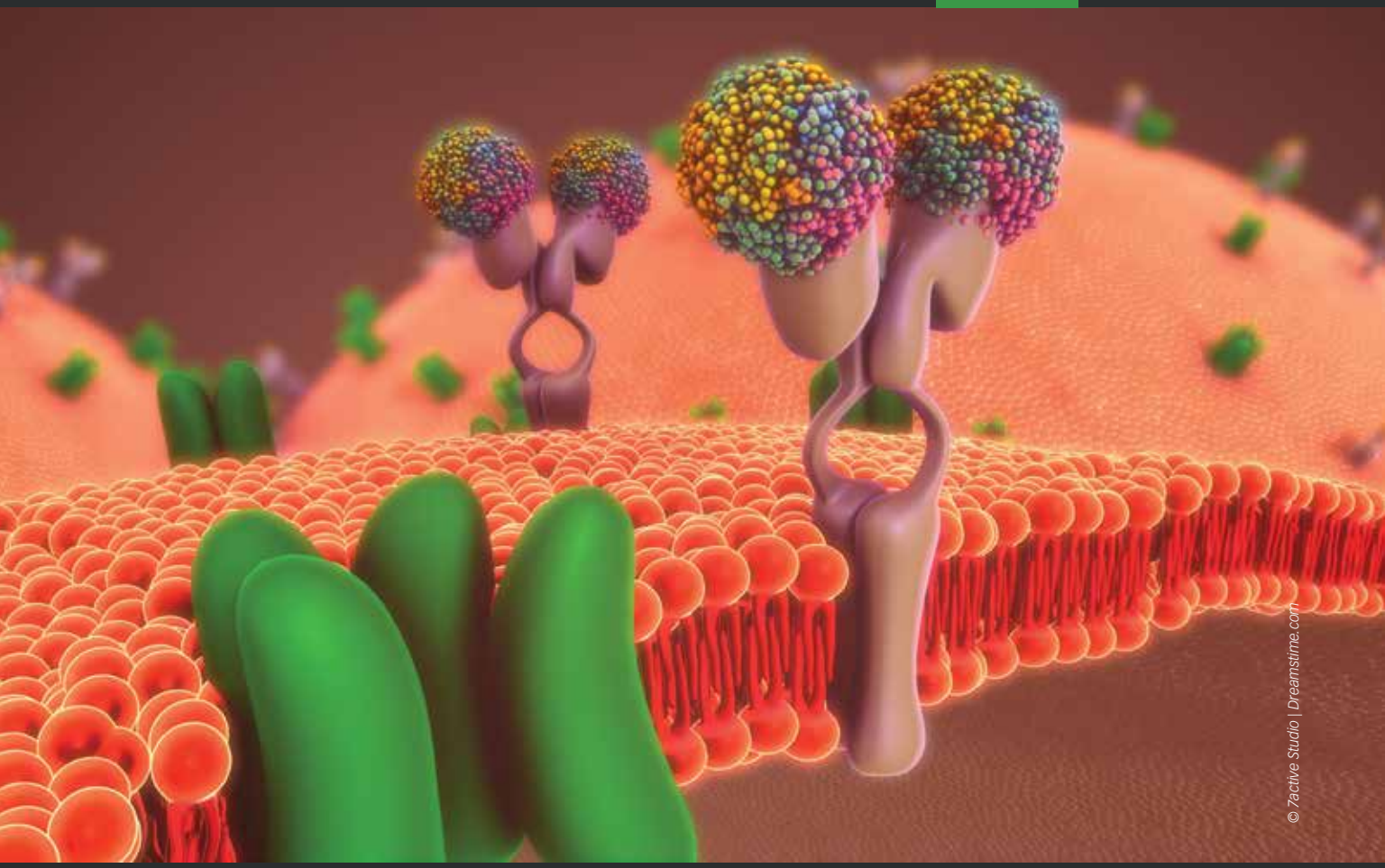

Tooth decay and diabetes mellitus

A Peer-Reviewed Publication Written by Erinne Kennedy, DMD, MPH, MMSc

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ABSTRACT

As oral health professionals, we recognize the role that systemic diseases, such as type 1 and type 2 diabetes mellitus (DM), play in modulating oral health. Specifically, this course outlines the role that diabetes mellitus plays in salivary output and composition and the oral microbiome. This course identifies ways that oral health professionals can help patients with diabetes mellitus achieve oral and overall wellness. Suggestions include increased recare visits, chairside screening for chronic disease and saliva health, and the use of innovative prevention products that improve salivary flow, strengthen the oral microbiome, and neutralize the pH of the oral environment.

EDUCATIONAL OBJECTIVES

1. Define and understand the key differences between types 1 and 2 diabetes mellitus.
2. Identify the relationship between dental caries and diabetes mellitus.
3. Understand the role of saliva in the progression of tooth decay in patients with diabetes mellitus.
4. Describe the ways in which the oral microbiome changes in patients with chronic disease.
5. Discuss unique ways to improve the oral health and reduce the risk for disease in patients with diabetes mellitus.

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INTRODUCTION

In 2018, the total percentage of the US population with types 1 and 2 diabetes mellitus (DM), including children, was 10.5%.[1] Type 1 DM can be divided into two subcategories, type 1A and type 1B, by determining the root cause of the disease process. Both types 1A and 1B result in the complete destruction of B-pancreatic cells. Both types 1A and 1B result in the complete destruction of β–pancreatic cells. Type 1A is caused by an autoimmune process that destroys these cells and results in a nonfunctioning pancreas. Type 1B occurs when β–pancreatic cells are destroyed by an idiopathic or unknown reason. Type 2 DM results from insulin resistance and reactive pathway that inhibits some of the function of these β–pancreatic cells often associated with metabolic syndrome or obesity. Patients with type 2 DM are often treated with medication, insulin (delivered via injection or pump), or a combination of both treatments. Although, in the past, we have associated this condition with older adults who are overweight or obese, from 2002-2015 the overall incidence of adolescents aged 10-19 diagnosed with type 2 diabetes significantly increased.[1]

The percentage of US adults aged 18 years and older diagnosed with diabetes mellitus has dramatically risen from 3.7% in 1980 to 10.2% in 2018.[1,2] With the overall prevalence of DM conditions increasing, understanding the impact DM has on the oral health of patients is paramount for dental team members. In dentistry, we have an important interdisciplinary role for patients with diagnosed and undiagnosed diabetes, including screening, preventing and treating oral disease, and helping patients improve their daily health habits. Data suggests that, while many cases are diagnosed, some patients have undiagnosed diabetes. The total estimate of patients with diabetes in 2018, regardless of diagnosis, was 13%,[1] meaning about 2.8% of all diabetes cases among adults are undiagnosed. As health-care providers, we have an opportunity to look for the signs and symptoms of undiagnosed disease. We can screen for undiagnosed DM by conducting and reviewing a thorough medical history and completing chairside screening for blood glucose or hemoglobin A1c (HbA1c). Referring patients who have the signs and symptoms of DM or uncontrolled disease is a way that we can continue to practice interdisciplinary care.[3]

DIABETES MELLITUS AND TOOTH DECAY

In a 2020 systematic review and meta-analysis, researchers found a significant association between patients with type 1 DM and a higher mean dmft score in primary dentition. dmft represents decayed, missing, and filled teeth in ***primary*** dentition. DMFT represents decayed, missing, and filled teeth in ***permanent*** dentition. These scores help researchers understand the amount of disease present in a population that has been treated or has been left untreated. In this study, 11 articles supported a higher mean dmft score in patients with type 1 DM, four articles showed a lower mean dmft score, and 20 articles showed no significant association. In the same study, when looking at type 2 DM, the research was less conclusive; there was no significant association between patients with type 2 DM and a higher mean DMFT score. Among the articles included in this analysis, seven showed a higher mean DMFT score in patients with type 2 DM, one showed a lower mean DMFT score, and seven showed no significant difference.[4] Overall, this research suggests patients with type 1 diabetes are at an increased risk for tooth decay. While no association was found between duration of disease and metabolic control in this review, educating patients on ways to reduce risk factors for tooth decay is important.[4]

Individual research reports have more clearly articulated some of the health behaviors of patients with DM. Twetman et al. found over a three-year study period that children with type 1 DM who developed dental caries during the study period also had a higher hemoglobin A1c (HbA1c) or glycated hemoglobin test, which signifies less metabolic control of the disease.[5] Throughout the study, he found that metabolic control, poor oral hygiene, previous caries experience, and increased levels of ***Lactobacilli*** were associated with incidence of tooth decay. The study demonstrated that understanding and addressing traditional caries risk factors and metabolic control are important for caries prevention for patients with DM.

In addition to understanding the impact of control in type 1 diabetes, there is similar research among type 2 diabetes patients. In 2017, Yonekura et al. designed a study to look at tooth decay, type 2 DM, and health behaviors. Their study used a cutoff for the HbA1c groups of 75 mmol/mol (9.0%) to define poorly controlled type 2 DM patients, while HbA1c <75 mmol/mol (9.0%) was used to define well or moderately controlled type 2 DM patients as a control group. Researchers found a statistically significant relationship between uncontrolled type 2 DM and tooth decay. Specifically, the number of decayed teeth was higher when the group had uncontrolled blood glucose levels.[6] They also found that the group with uncontrolled type 2 DM had a lower measure of treated caries. They used a marker called Met Need Index (MNI), which is a measure for assessing treated caries. MNI results showed that those with a lower MNI had fewer of their caries treated and were more likely to be uncontrolled. Yonekura et al. also found that patients with an increased number of dental visits showed a lower number of decayed teeth and a higher MNI.[6] These results support increasing dental visits among patients with chronic disease in order to decrease risk for disease development and improve control of the disease.

Specifically, the goal is to understand the effect that the disease process of diabetes mellitus has on the biology and physiology of the oral cavity. Ultimately, there are multiple mechanisms in which diabetes mellitus can affect the overall oral health status of patients. Diabetes mellitus has been shown to change the quantity and quality of saliva in patients. In regard to the quantity of saliva, or flow rate, Sreebny showed that the primary effect of aging is on the quantity of salivary output, independent of disease and/or pharmacological therapy.[7] However, if specific subgroups are examined, including patients who are healthy, patients with hypertension, and patients with DM, some groups face greater challenges with salivary flow than others. In the case of diabetes, research shows a statistically significant decrease in unstimulated and stimulated sublingual and submandibular output compared to the other subpopulations. Additionally, the mean flow rate of saliva in the US decreases with age, but more significantly decreases

among patients with DM.[7]

In addition to quantity, quality of saliva is important in understanding caries risk and preventing disease. For example, a patient can have a high quantity of poor-quality saliva and have rampant disease, and another patient can have a low quantity of high-quality saliva and be disease free. The key is understanding the individual patient's relationship between quality and quantity of saliva in order to create preventive plans that are successful. One study looked at the composition of saliva and DMFT differences among children with type 1 diabetes and healthy children. They found that children with type 1 DM had a lower buffering capacity, higher DMFT, and lower stimulated salivary flow. This is consistent with the biology of salivary output, since the majority of saliva production at rest comes from the submandibular glands, and research shows that their output is drastically affected by DM. Without adequate quantity of saliva, clearance of substrates is reduced, acidity is increased, and contact time with cariogenic substances is prolonged.

Another aspect to understanding the quality of saliva in patients with DM is the resting concentration of salivary glucose. Researchers have generated a hypothesis when it comes to resting concentrations of salivary glucose and its role in changing the oral microbiome through salivary acidification.[7] When looking at salivary glucose concentrations, blood glucose concentrations, and the oral microbiome, researchers found that salivary bacterial load predicts salivary glucose concentration. As salivary glucose increases, the bacterial count decreases. Under high salivary glucose concentrations, certain bacteria from the phyla *Bacteroidetes* decreased the most, and *Firmicutes* increased the most.[8] While an acidic mouth inhibits the growth and reproduction of bacteria, certain aciduric bacteria thrive. An acidic oral environment results in a change in the oral microbiome and has been associated with an increased risk for dental erosion, tooth decay, and gingivitis or gingival inflammation.

Twetman et al. examined the quantity of caries-causing bacteria, *Streptococcus mutans* and *Lactobacillus,* in the saliva of children (aged 4–19) with type 1 DM compared to healthy children. His research found a relationship between low levels of *Lactobacillus* and children with controlled type 1 DM and low glucose concentrations in their saliva. These hopeful findings suggest that well-controlled DM can change the oral microbiome and reduce the number of *Lactobacilli* in saliva.[9]

WHAT CAN ORAL HEALTH PROVIDERS DO?

Increase visits: When I encounter patients with DM, one of the first recommendations that I have for them is to increase recare visits. Years ago, I was at the 2018 Harvard School of Dental Medicine Initiative to Integrate Oral Health and Medicine conference where they were discussing chronic disease management in diabetic patients. They made the point that even if a patient sees their doctor three or four times per year, for one hour at a time (an overestimate), most of their disease management efforts will be at home. If they see a primary care provider for four hours, that is only 0.05% of the 8,760 hours in a year. One of the opportunities that we have in dentistry is increasing the contact time patients have with health-care providers so that we can educate, encourage, and empower our patients to manage their chronic disease well. Although this article is about treating and preventing tooth decay, increased recare visits will also improve the patient's chronic disease management of periodontal disease and DM. Research has demonstrated a strong bidirectional relationship between reducing HbA1c levels and treating chronic periodontal disease with nonsurgical periodontal therapy. When we treat chronic periodontal disease, we are able to improve or lower HbA1c levels, and when we improve HbA1c levels, we are able to improve the health of the gum tissue. Increased recare will only benefit the patient long term.

Conduct chronic disease screening: While this has been somewhat of a controversial topic in dentistry, more and more offices are starting to conduct chairside screening for chronic disease such as DM. This can be completed by testing glucose levels or HbA1c levels at routine dental visits. This adds value to your practice by educating patients and connecting with primary care providers in order to practice interdisciplinary health care. By screening patients in the dental office, we may be able to identify patients who do not have primary care doctors and have undiagnosed prediabetes or diabetes. When a patient has type 1 DM, the body can no longer produce its own insulin, so the patient has to be supported by insulin injections or an insulin pump. We often think of children or young adults when we think of type 1 DM; however, I caution you to be aware of the symptoms and presentation of this disease. I treated a patient with type 1 diabetes who had a late onset in her 60s due to an autoimmune condition. By screening and educating all patients, we can empower them to seek and receive care with a primary care doctor when needed.

For patients who have been diagnosed already with prediabetes or DM, screening in the operatory can help provide evidence for behavior change (e.g., diet or exercise) and compliance with medication recommendations. In my practice, I have found that screening can help create a dialogue to encourage patients to have healthy eating habits, exercise habits, and to take their medications as directed. I cannot count the number of conversations I have had with patients to encourage them to refill their medications, take them as directed, or speak with their health-care providers about unwanted or dangerous side effects. Our role in dentistry is to not simply drill and fill, but rather to treat the whole patient as a part of their primary care team to help treat and prevent chronic disease.

Provide dietary suggestions: Patients with DM have the opportunity to curate their daily routines and habits to not only create health for their mouths, but also health for their whole bodies. Patients with DM often have frequent meals to help stabilize their blood sugar levels. While we are conducting nutritional counseling in our offices for oral health, we help patients identify foods that will help them with their glycemic control as well. We believe that the more you know, the more you can change. For many patients, it's all about small, targeted changes (e.g., swapping fruit juice for a piece of fruit with fiber). We encourage high protein diets with lots of leafy greens, legumes, and foods with arginine. Food products with arginine, such

as kale, sunflower seeds, and lean meats, are also great for diabetic patients trying to eat healthy. Arginine negatively affects the growth, pathogenic potential, and the ability to handle environmental stressors of *Streptococcus mutans* (cariogenic bacteria).[10] Increased levels of arginine result in a more pH-neutral oral environment, so encouraging the consumption of foods high in arginine can help patients with DM keep their oral environment more neutral.

Use salivary screening: Another form of chairside screening that I use in my practice to help educate patients is salivary screening. Chairside salivary screening has helped my patients and team ask better questions, learn to make co-decisions in the operatory, practice evidenced-based dentistry, practice iteratively, and create preventive treatment plans that address salivary imbalances. For patients with DM, we find that their inflammatory markers for gum disease, including blood, leukocytes, and protein levels, are increased when they have gingivitis and chronic periodontal disease. When it comes to tooth decay, we also look at markers such as acidity, buffering capacity, and cariogenic bacteria. After screening for these elements of saliva, in combination with a caries risk assessment (CRA), we can better understand a patient's risk for tooth decay. Patients with low levels of acid and cariogenic bacteria and a high buffering capacity are at a lower risk for developing caries. Alongside diet and medication changes to control DM, using products to improve the chemistry of the saliva is one way of improving a diabetic patient's risk for disease.

Suggest products to improve cariogenic bacteria: We often find that patients with uncontrolled glucose levels have higher rates of cariogenic bacteria when we test their saliva. It is interesting to observe chairside what we read in the extensive literature on the oral microbiome. This data allows us to have an entrance into a conversation with the patient about potential behavioral changes. We encourage the use of a four-carbon sugar called xylitol. Some patients use this product in mints, gum, or granules in their water or beverage of choice. This helps them bombard the cariogenic bacteria in their mouth throughout the day. Xylitol has been shown to be an effective caries-reducing agent.[11] Overall, xylitol has an antimicrobial effect, affecting the ability of plaque adherence to teeth and bacteria adherence, and it specifically targets the energy generating capacity of *Streptococcus mutans* (SM*)* resulting in cell death. Through this antibacterial action and specific ability to decrease the amount of SM, xylitol helps change the oral microbiome to a less pathogenic flora resulting in a decrease of tooth decay.[11]

Use products to improve salivary flow: Treating dry mouth can be challenging for the patient and the provider. Since I started chairside screening of saliva, I have found that achieving salivary health for patients who take medications or have conditions that induce dry mouth takes longer than I had imagined. Many times, I find that I can achieve adequate flow of saliva relatively quickly with the right chemotherapeutic (e.g., pilocarpine lollipops). However, achieving both quantity *and* quality takes more time, because I have to identify the products that alter the exact necessary components of the saliva. I explain it this way to my patients: "It's rather easy to put crushed tomatoes in a big pot, but it takes time and finesse to have a sauce."

It is not enough to ask patients, "Is your mouth dry?" Often, they may not be able to tell you, but what they can tell you is how their lives have changed. I notice that their saliva has changed when they mention carrying around a bottle of water, a sour taste in their mouth when they wake up in the morning, food not tasting the same, having trouble swallowing food, dentures fitting differently, white crust at the corners of their mouths, or even a persistent feeling of being thirsty. One of the products that we use in our office to alleviate the symptoms of dry mouth is a product that contains chitosan. Chitosan technology—which is a shellfish derivative—mouth rinse and spray are able to treat dry mouth and maintain a basic pH.[12] I recommend patients keep Moisyn spray handy, such as in a purse, pocket, or on a nightstand.

Use products to improve pH: Many patients with DM have acidic saliva due to their reduced salivary flow, decreased buffering capacity, and increased salivary glucose levels. Patients with acidic saliva often report saliva that tastes sour. The reason is that the sour taste buds detect acid in the environment (in this case the saliva).[13] From food science, we learn that certain tastes balance each other, and people have "cravings" until they achieve the balance. Patients with acidic saliva and a sour taste crave the taste of sweet beverages or snacks to eliminate the sourness by titrating something sweet. Think of it this way: add lemon juice and water to a cup and taste it. It will taste sour and acidic. Slowly add in a pinch of sugar and taste again. Add sugar until you no longer taste the acid or sourness of the lemon juice. Subconsciously, patients do the same with their acidic saliva and sweet foods. Patients with acidic saliva often crave something sweet all day long, making sipping on pop (soda), sweet tea, or coffee with sugar enticing. One of the ways to counteract this craving is to recommend a pH-neutral lozenge that can last all day. Research by Delgado et. al has shown that many of the lozenges that claim to be beneficial for oral health are acidic, with products that result in a pH as low as 2.9. However, some products have demonstrated the ability to create a long-lasting neutral pH as high as 8.04.[14] It is important to make sure to evaluate the pH of your patient's saliva after they use various lozenges to make sure that they are achieving a beneficial effect from each product. If my patients sip on soda all day at work, I may recommend they keep a box of these lozenges at their desk to help counteract their craving for sweets, increase the pH of their saliva, and over time lessen their need for overcoming the sour taste of acid with sweet treats.

CONCLUSION

In conclusion, patients with diabetes mellitus are often at risk for tooth decay. Understanding the relationship between the disease process of DM and tooth decay will help dental team members coach, empower, and support patients in managing their chronic disease(s) well. Increased recare, chairside screening, and innovative oral health therapeutics will help patients reduce their risk for tooth decay.

REFERENCES

1. National Diabetes Statistics Report 2020.

Estimates of diabetes and its burden in the United States. CDC website. cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf.
2. United States Diabetes Surveillance System. CDC website. gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html.
3. Genco RJ, Schifferle RE, Dunford RG, et al. Screening for diabetes mellitus in dental practices. J Am Dent Assoc. 2014 Jan;145(1):57–64. linkinghub.elsevier.com/retrieve/pii/S0002817714602701.
4. Coelho AS, Amaro IF, Caramelo F, et al. Dental caries, diabetes mellitus, metabolic control and diabetes duration: A systematic review and meta-analysis. J Esthet Restor Dent. 2020 Jan;1–19.
5. Twetman S, Johansson I, Birkhed D, Nederfors T. Caries incidence in young type 1 diabetes mellitus patients in relation to metabolic control and caries-associated risk factors. Caries Res. 2002;36(1):31-35. doi:10.1159/000057587
6. Yonekura S, Usui M, Murano S. Association between numbers of decayed teeth and HbA1c in Japanese patients with type 2 diabetes mellitus. Ups J Med Sci. 2017 Jun;122(2):108–113.
7. Sreebny LM. Saliva in health and disease: An appraisal and update. Int Dent J. 2000 Jun;50(3):140–161.
8. Goodson JM, Hartman M-L, Shi P, et al. The salivary microbiome is altered in the presence of a high salivary glucose concentration. Nascimento M, editor. PLoS ONE 2017 Mar 1 dx.plos.org/10.1371/journal.pone.0170437.
9. Twetman S, Aronsson S, Björkman S. Mutans streptococci and lactobacilli in saliva from children with insulin-dependent diabetes mellitus. Oral Microbiol Immunol. 1989 Sep;4(3):165–168.
10. Chakraborty B, Burne RA. Effects of arginine on *streptococcus mutans* growth, virulence gene expression, and stress tolerance. *Appl Environ Microbiol*. 2017;83(15):e00496-17. doi:10.1128/AEM.00496-17
11. Janakiram C, Deepan Kumar C, Joseph J. Xylitol in preventing dental caries: A systematic review and meta-analyses. J Nat Sc Biol Med. 2017;8(1):16–21. jnsbm.org/text.asp?2017/8/1/16/198344.
12. Epstein JB, Villines DC, Singh M, Papas A. Management of dry mouth: Assessment of oral symptoms after use of a polysaccharide-based oral rinse. Oral Surg Oral Med Oral Pathol Oral Radiol. 2017;123(1):76-83. doi:10.1016/j.oooo.2016.09.008
13. Da Conceicao Neta ER, Johanningsmeier SD, McFeeters RF. The chemistry and physiology of sour taste—A review. J Food Sci. 2007;72(2):R33-R38. doi:10.1111/j.1750-3841.2007.00282.x
14. Delgado A, Aslam M, Riberio A, et al. Potential erosive assessment of dry mouth lozenges and tablets on dentin. University of Florida College of Dentistry website. cdn.shopify.com/s/files/1/0035/3832/files/Delgado_AADR_2018_Acidity_of_dry_mouth_lozenges.pdf?10451805702918068836.

ERINNE KENNEDY, DMD, MPH, MMSC, graduated from Nova Southeastern College of Dental Medicine in 2015. She is a board-certified public health dentist with a master's in dental education from the Harvard School of Dental Medicine. She serves in an innovative practice model for the Massachusetts State Employee Fund at Alliance Dental Center LLC in Quincy, Massachusetts. Contact her at erinnekennedydmd@gmail.com.

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QUESTIONS

1. What percentage of the US population has diabetes mellitus?

A. 5.5%
C. 15.5%
B. 10.5%
D. 20.5%

2. Select the correct answer.

A. Type 1 diabetes can be divided into two subcategories, A and B.
B. Type 2 diabetes can be divided into two subcategories, A and B.
C. Types 1 and 2 diabetes can be divided into two subcategories, A and B.
D. None of the above

3. Which of the following cells are destroyed in type 1 diabetes mellitus?

A. α–pancreatic cells
B. β–pancreatic cells
C. γ–pancreatic cells
D. δ–pancreatic cells

4. With which of the following conditions is type 2 DM commonly associated?

A. Metabolic syndrome
B. Asthma
C. Cancer
D. None of the above

5. How is type 2 DM commonly treated?

A. Diet and exercise
B. Oral noninsulin medications
C. Insulin (either via injection or pump)
D. All of the above

6. Which statement is correct about adolescent type 2 diabetes incidence from 2002-2015?

A. The overall incidence of adolescents age 10-19 diagnosed with type 2 diabetes remained the same.
B. The overall incidence of adolescents age 10-19 diagnosed with type 2 diabetes significantly increased.
C. The overall incidence of adolescents age 10-19 diagnosed with type 2 diabetes significantly decreased.
D. None of the above

7. From 1980 to 2018, what was the increase in percentage of US adults diagnosed with DM?

A. 4.5%
C. 6.5%
B. 5.5%
D. 7.5%

8. What percentage of diabetes cases was undiagnosed in 2018?

A. 0.028%
C. 2.8%
B. 0.28%
D. 28%

9. Which statement is correct?

A. In a 2020 systematic review and meta-analysis, researchers found a nonsignificant association between patients with type 2 DM and a higher mean dmft score in primary dentition.
B. In a 2020 systematic review and meta-analysis, researchers found a nonsignificant association between patients with type 1 DM and a higher mean DMFT score in permanent dentition.
C. In a 2020 systematic review and meta-analysis, researchers found a significant association between patients with type 1 DM and a higher mean dmft score in primary dentition.
D. In a 2020 systematic review and meta-analysis, researchers found a significant association between patients with type 1 DM and a higher mean DMFT score in permanent dentition.

10. Which statement is correct?

A. In a 2020 systematic review and meta-analysis, researchers found a nonsignificant association between patients with type 2 DM and a higher mean dmft score in primary dentition.
B. In a 2020 systematic review and meta-analysis, researchers found a nonsignificant association between patients with type 2 DM and a higher mean DMFT score in permanent dentition.
C. In a 2020 systematic review and meta-analysis, researchers found a significant association between patients with type 2 DM and a higher mean dmft score in primary dentition.
D. In a 2020 systematic review and meta-analysis, researchers found a significant association between patients with type 2 DM and a higher mean DMFT score in permanent dentition.

11. Which of the following factors is associated with tooth decay and DM?

A. Duration of disease
B. Metabolic control
C. Both A and B
D. None of the above

12. Twetman et al. found that children with type 1 DM who had developed tooth decay had which of the following?

A. Lower HbA1c
B. Higher HbA1c
C. Unchanged HbA1c
D. None of the above

13. Twetman et al. stated that which of the following factors was not associated with caries incidence among children with type 1 DM?

A. Metabolic control
B. Caries experience
C. Age
D. Poor oral hygiene

14. What does MNI stand for?

A. Met Need Index
B. Minimum Need Index
C. Median Need Index
D. Missing Need Index

15. Yonekura et al. stated that which of the following was associated with a higher MNI?

A. Lower number of dental visits
B. Higher number of dental visits
C. No dental visits
D. None of the above

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QUESTIONS

16. What is the primary effect of the aging process on saliva?

A. Decreased buffering capacity
B. Decreased acidity
C. Decreased output
D. Decreased viscosity

17. Among patients with diabetes mellitus, for which salivary glands do we see a statistically significant decrease in salivary output?

A. Parotid gland
B. Submandibular gland
C. Minor salivary glands
D. None of the above

18. Who provides the majority of disease management activity for the patient?

A. Primary care provider
B. Dentist
C. Specialty care provider
D. Themself

19. Which of the following best describes the relationship between reducing HbA1c levels and treating chronic periodontal disease with nonsurgical periodontal therapy?

A. Unidirectional positive
B. Unidirectional negative
C. Bidirectional positive
D. Bidirectional negative (i.e., if we reduce gum disease, we reduce HbA1c and vice versa)

20. Which of the following chairside screening tests can we perform in the dental office?

A. Salivary testing
B. Blood glucose testing
C. Glycosylated hemoglobin testing
D. All of the above

21. Which of the following amino acids helps feed the commensal bacteria in the mouth and can be found in high concentrations in sunflower seeds?

A. Arginine
B. Ornithine
C. Lysine
D. Glycine

22. Which of the following salivary markers help evaluate a patient's risk for gum disease?

A. Acidity, buffering capacity, leukocytes
B. Acidity, blood, cariogenic bacteria
C. Protein, blood, leukocytes
D. Protein, blood, cariogenic bacteria

23. Which of the following salivary markers help evaluate a patient's risk for tooth decay?

A. Acidity, buffering capacity, leukocytes
B. Acidity, blood, cariogenic bacteria
C. Acidity, blood, leukocytes
D. Acidity, buffering capacity, cariogenic bacteria

24. How many carbons does the polyol xylitol have?

A. 3
B. 4
C. 5
D. 6

25. Which of the following is an indication that a patient has dry mouth?

A. Carrying a water bottle around
B. Trouble swallowing
C. Change in the taste of food
D. All of the above

26. Which of the following statements is true when using salivary technology to improve dry mouth?

A. Changing quality and quality is possible but takes time.
B. It is impossible to change quality.
C. It is impossible to change quantity.
D. None of the above

27. Which of the following are benefits of chitosan technology?

A. Neutral pH
B. Address dry mouth
C. Both A and B
D. None of the above

28. What is chitosan derived from?

A. Shellfish
B. Minerals
C. Plants
D. Algae

29. According to the research from Delgado et al. what is the lowest pH over the counter dry mouth lozenges induced in a patient?

A. 1.9
B. 2.9
C. 3.9
D. 4.9

30. According to the research from Delgado et al. what is the highest pH over the counter dry mouth lozenges induced in a patient?

A. 5.04
B. 6.04
C. 7.04
D. 8.04

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EXPIRATION DATE:	JUNE 2023

ANSWER SHEET

Tooth decay and diabetes mellitus

Name: Title: Specialty:

Address: Email: AGD member ID (if applies):

City: State: ZIP: Country:

Telephone: Primary ( ) Office ( )

Requirements for obtaining CE credits by mail/fax: 1) Read entire course. 2) Complete info above. 3) Complete test by marking one answer per question. 4) Complete course evaluation. 5) Complete credit card info or write check payable to Endeavor Business Media. 6) Mail/fax this page to DACE. A score of 70% is required for CE credit. **For questions, call (800) 633-1681. Course may also be completed at dentalacademyofce.com.**

EDUCATIONAL OBJECTIVES

1. Define and understand the key differences between types 1 and 2 diabetes mellitus.
2. Identify the relationship between dental caries and diabetes mellitus.
3. Understand the role of saliva in the progression of tooth decay in patients with diabetes mellitus.
4. Describe the ways in which the oral microbiome changes in patients with chronic disease.
5. Discuss unique ways to improve the oral health and reduce the risk for disease in patients with diabetes mellitus.

COURSE EVALUATION

1. Were the individual course objectives met?

Objective #1: Yes No Objective #2: Yes No

Objective #3: Yes No Objective #4: Yes No

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0
8. Please rate the usefulness and clinical applicability of this course.	5	4	3	2	1	0
9. Please rate the usefulness of the supplemental webliography.	5	4	3	2	1	0

10. Do you feel that the references were adequate? Yes No

11. Would you participate in a similar program on a different topic? Yes No

12. If any of the continuing education questions were unclear or ambiguous, please list them.

_____

13. Was there any subject matter you found confusing? Please describe.

_____

14. How long did it take you to complete this course?

_____

15. What additional continuing dental education topics would you like to see?

_____

Mail/fax completed answer sheet to:

Endeavor Business Media
Attn: Dental division
7666 E. 61st St. Suite 230, Tulsa, OK 74133
Fax: (918) 831-9804

☐ Payment of $59 is enclosed.
Make check payable to Endeavor Business Media

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Charges on your statement will show up as PennWell / Endeavor.

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4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

AGD Code 010

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.

INSTRUCTIONS

All questions have only one answer. Grading of this examination is done manually. Participants will receive confirmation of passing by receipt of a verification form. Verification of Participation forms will be mailed within two weeks after taking an examination.

COURSE EVALUATION AND FEEDBACK

We encourage participant feedback. Complete the survey above and e-mail feedback to Aileen Gunter (agunter@endeavorb2b.com) and Laura Winfield (lwinfield@endeavorb2b.com).

COURSE CREDITS AND COST

All participants scoring at least 70% on the examination will receive a verification form for three CE credits. The formal CE program of this sponsor is accepted by the AGD for fellowship and mastership credit. Please contact Endeavor for current term of acceptance. Participants are urged to contact their state dental boards for continuing education requirements. The cost for courses ranges from $20 to $110.

PROVIDER INFORMATION

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RECORD KEEPING

Endeavor maintains records of your successful completion of any exam for a minimum of six years. Please contact our offices for a copy of your CE credits report. This report, which will list all credits earned to date, will be generated and mailed to you within five business days of receipt.

EDUCATIONAL DISCLAIMER

Completing a single CE course should not provide enough information to give participants the feeling that they are experts in the field related to the course topic. It is a combination of many educational courses and clinical experience that allows the participant to develop skills and expertise.

CANCELLATION AND REFUND POLICY

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IMAGE AUTHENTICITY

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