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# The ABCs of HbA1c: A review of in-office diabetes testing for the dental professional

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# The ABCs of HbA1c: A review of in-office diabetes testing for the dental professional

## ABSTRACT

Diabetes mellitus is a metabolic disorder affecting an estimated 463 million people or one in 11 adults worldwide. As research unpacks the codependent relationship between diabetes mellitus and a variety of diseases of oral origin, dental providers become an integral aspect to the identification, counseling, and referral of at-risk patients. Moreover, dental professionals are now encouraged to take an active role in the early identification of diabetes through hemoglobin A1c (HbA1c) testing, which strengthens a partnership between primary care providers and dental specialists while enhancing multidisciplinary involvement in optimal patient care. This article investigates the risks as well as signs and symptoms associated with undiagnosed diabetes mellitus, the manifestations of diabetes mellitus, and the step-by-step process for integrating HbA1c testing into the dental practice.

## EDUCATIONAL OBJECTIVES

Upon completion of this course, the dental professional should be able to:

1. Understand the current scientific literature indicating implications for incidence and prevalence of diabetes mellitus and oral disease, as well as the signs and symptoms of uncontrolled diabetes mellitus in the dental patient.
2. Review the oral manifestations as well as the systemic sequelae of diabetes mellitus, while identifying the risk factors and potential shared etiologic factors associated with diabetes mellitus and oral disease.
3. Discuss the opportunities for cotherapeutic management of diabetes mellitus and associated complications, including counseling strategies and guidelines for the implementation of dental services for patients with diabetes.
4. Identify the clinical provision, indications, and process for gathering HbA1c point-of-service tests in the dental office while utilizing the Code on Dental Procedures and Nomenclature (CDT)-approved code.



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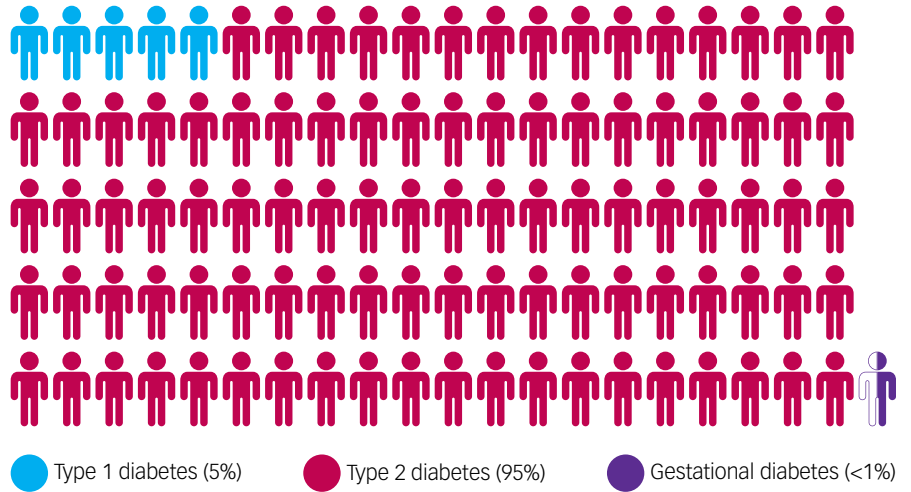
**INTRODUCTION**

Diabetes mellitus (DM) encompasses a group of metabolic disorders affecting an estimated 463 million people or one in 11 adults worldwide.<sup>1</sup> It is estimated to affect 34.2 million Americans (including children and adolescents) or 10.5% of the United States population.<sup>2</sup> Of the estimated 34.2 million Americans with DM, only 26.8 million carry a diagnosis, leaving an estimated 7.3 million individuals living with undiagnosed DM. Every year, 1.5 million Americans are newly diagnosed with diabetes.

Type 1 (formerly insulin-dependent) DM patients comprise approximately 5% of all patients with DM. The remaining 95% of patients with DM present with type 2 (formerly noninsulin-dependent) DM (figure 1).<sup>3</sup>

Patients with gestational diabetes comprise a small portion of the DM population. Although the disease typically resolves after delivery, gestational diabetes still places the patient at an elevated risk with future pregnancies.<sup>3</sup>

The estimated global cost of diabetes has been reported to be \$850 billion per year, or approximately 10% of all global health expenditures,<sup>4,5</sup> and is not only attributed to the cost of medications to control DM, but mainly to addressing complications of DM such as eye problems, limb amputations, kidney disease, oral disease, and others. In addition, DM is the seventh leading cause of death in the United States. This statistic, however, is currently



**FIGURE 1:** Distribution of diabetic cases in the United States

thought to be underreported.<sup>2</sup>

As the medical community continues to work to screen, identify, diagnose, treat, and manage DM and its subsequent sequelae, many are looking to the dental industry to join efforts in testing and evaluating for early or undiagnosed DM.

This article will investigate the risk associated with undiagnosed and/or uncontrolled DM and the risk factors, signs, and symptoms a dental clinician should notate. Finally, this article will discuss the ABCs of HbA1c, a step-by-step approach in the use of approved technology, and the American Dental Association (ADA) procedure codes for integrating HbA1c testing in the dental practice.

**ORAL SIGNS AND SYMPTOMS OF DIABETES MELLITUS**

Dental providers around the globe have identified and agreed on several key oral manifestations associated with DM. Notably, diseases of the periodontium are stated as the sixth complication of DM.<sup>6</sup> As such, a codependent relationship between DM and the advancement of periodontal disease yields significant challenges when it comes to the control and maintenance of a healthy periodontium.

Research has identified specific oral markers that influence the diabetic periodontium, such as the subgingival microflora of patients with diabetes containing high levels of *Capnocytophaga*, anaerobic *Vibrios*, and *Actinomyces* species.<sup>7</sup> Of great concern are the ways in which periodontal disease can promote a spilling of inflammatory mediators systemically, thereby influencing glycemic control.<sup>8</sup>

The classification of periodontitis as it relates to systemic disease was recently evaluated by the American Academy of Periodontology (AAP) at its 2017 World Workshop.<sup>9</sup> During this meeting, the evidence discussing the ways in which DM impairs host response and increases the risk for periodontal disease was considered, and subsequently, DM was included as a modifier to periodontitis (table 1).<sup>10,11</sup>

As such, the nondiabetic, controlled, or uncontrolled status of a patient will subsequently impact the grading of active periodontal disease based on the utilization of

TABLE 1: AMERICAN ACADEMY OF PERIODONTOLOGY GRADING OF PERIODONTAL DISEASE CRITERION					
	Progression		Grade A: Slow	Grade B: Moderate	Grade C: Rapid
Primary criteria	Direct evidence	RBL or CAL	No loss over 5 years	< 2 mm over 5 years	2+ mm over 5 years
	Indirect evidence	% bone loss/age	< .25	.25 to 1.0	> 1.0
Case phenotype		Heavy biofilm, low destruction	Destruction commensurate with deposit	Destruction exceeds expectations. Rapid progression/early onset	
Grade modifier	Risk factors	Smoking	Nonsmoker	< 10 cigarettes/day	10+ cigarettes/day
		Diabetes	Normal	HbA1c < 7.0%	HbA1c 7.0%+

**FIGURE 2: ORAL MANIFESTATIONS OF DIABETES**

- Diminished salivary flow
- Burning mouth syndrome
- Enlarged parotid glands
- Elevated dental caries risk
- Altered taste
- Halitosis
- Candidiasis
- Stomatitis
- Lichen planus
- Lichenoid reaction
- Benign migratory glossitis
- Angular cheilitis
- Traumatic ulcers

HbA1c readings to determine a grade modifier.

Additionally, patients with DM may experience delayed wound healing,<sup>12</sup> potentially impairing immune response to surgical or nonsurgical periodontal therapy,<sup>13</sup> as well as an elevated risk of acute medical emergencies in the dental chair such as hypoglycemic episodes. Dental providers must recognize these symptoms.

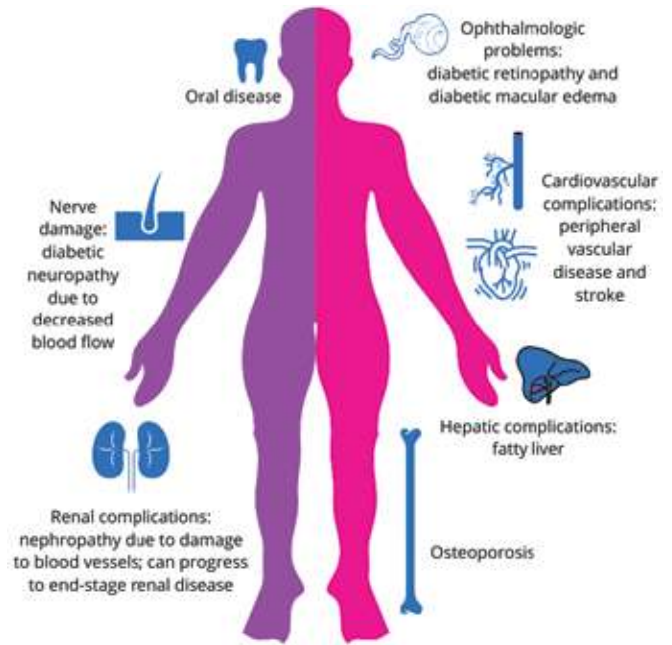
The patient with diabetes may also present with one or several oral manifestations affiliated with complications of DM (figure 2).<sup>14</sup>

**SYSTEMIC SEQUELAE OF UNTREATED/UNCONTROLLED DIABETES**

Untreated DM leads to macrovascular disease, including cardiovascular, cerebrovascular, and arterial occlusive diseases as well as microvascular disease leading to nephropathy, retinopathy, and neuropathy<sup>15</sup> (figure 3).

Microvascular disease is caused by thickening of the basement membrane, creating inelasticity and small capillary size, which leads to microcirculatory dysfunction supplying the kidneys, retina, brain, and peripheral nerves.

Sensory and autonomic neuropathy is caused by axonal degeneration and demyelination causing the accumulation of sorbitol in the peripheral sensory nerves.<sup>16</sup> Motor neuropathy and cranial mononeuropathy result from vascular disease in blood vessels supplying nerves. Motor neuropathy induces painful cramps, muscle weakness, bone degeneration, and changes in the skin, hair, and nails. These conditions lessen one's ability to feel vibrations, light touch, and position sense, resulting in a sense of numbness and making it



**FIGURE 3:** Common systemic diabetic complications

difficult to walk and to detect injury. Small sensory fibers may also transmit pain and temperature sensations. The inability to sweat typically may lead to heat intolerance, dry skin, and ulcers. Loss of bladder control may lead to infection. Inability to control muscles that expand or contract blood vessels to maintain safe blood pressure levels may cause dizziness or lightheadedness.

Polyuria (excessive urination) is caused by osmotic diuresis secondary to hyperglycemia.<sup>17</sup> Polydipsia (excessive thirst) is caused by a hyperosmolar state and dehydration. Polyphagia (excessive hunger) results from intracellular starvation, which causes weight loss from a release of triglycerides from adipose tissue, and catabolism of amino acids into muscle tissue, which leads to loss of both fat and lean mass.

Oftentimes, patients present to specialty or subspecialty providers, such as podiatrists, ophthalmologists, and dentists, with secondary symptoms of DM (e.g., infections, gingivitis, visual difficulty,



**CASE 1:** Preoperative presentation: A diabetic neuropathic patient presents with right foot necrotizing fasciitis originating from a foot deformity and neuropathic foot ulcer.

Images courtesy of Elizabeth A. Sanders, DPM, AACFAS, DABPM, of Clinica Avanzada del Pie in Bayamon, Puerto Rico.



ulcers, gangrene) even prior to a diagnosis of DM. For example, patients with undiagnosed/uncontrolled DM often present to podiatrists with weeping wounds that are reluctant to heal or infections of the foot that may require amputation (case 1).

The images in case 1 depict a 64-year-old male with uncontrolled diabetes, who presented as an emergency patient, diagnosed as septic with a fever of 101.7, white blood cell count of 18,800, and glucose 360 mg/dl. The foot ulcer has been present for 28 years. Radiographs and an MRI show ascending gas from the ulcer to the ankle and fourth metatarsal osteomyelitis. The suggested therapy upon consult was amputation. Patient requested incision and drainage for wound salvage and life salvage.

It may not be until an admission to the hospital for parenteral antibiotics and limb salvage surgery with a complete medical workup that the patient is diagnosed with uncontrolled DM. In this regard, all health-care providers must be able to recognize signs and symptoms of this disease for timely diagnosis and treatment.



**CASE 1:** Postoperative result of an incision and drainage for wound salvage in a patient with necrotizing fasciitis.

Images courtesy of Elizabeth A. Sanders, DPM, AACFAS, DABPM, of Clinica Avanzada del Pie in Bayamon, Puerto Rico

**THE ABCs OF DIABETIC TESTING**

Current criteria for diagnosing DM includes a fasting plasma glucose level greater than or equal to 126 mg/dL (7.0 mmol/L) or a two-hour plasma glucose level greater than or equal to 200 mg/dL (11.1 mmol/L) during a 75 gram oral glucose tolerance test (OGTT), or a random plasma glucose greater than or equal to 200 mg/dL (11.1 mmol/L) in a patient with classic symptoms of hyperglycemia or hyperglycemic crisis (table 2).<sup>18</sup>

While the above tests provide only a snapshot of the blood glucose level at the moment the blood is drawn, hemoglobin A1c (glycated hemoglobin, HbA1c) readings are typically gathered every three months to reflect the life span of a red blood cell, which is about 120 days. HbA1c, a protein on the surface of blood cells,<sup>19</sup> is a component of hemoglobin that reflects the adherence of glucose to erythrocytes. As the concentration of glucose increases in the bloodstream, a higher percentage of the HbA1c fragment of hemoglobin becomes glycated.

The American Diabetes Association recommends that patients with diabetes receive

HbA1c testing at a minimum of every six months and ideally at three-month intervals to survey treatment parameters.<sup>20</sup> However, research has demonstrated that most diabetic patients do not adhere to these recommendations, leaving a gap in observations of diabetic activity.<sup>21</sup>

The following includes a three-step approach for gathering and utilizing data

from HbA1c point-of-service testing: (A) assess testing candidates, (B) blood collection, and (C) collect data and counsel.

**ASSESS TESTING CANDIDATES**

HbA1c point-of-service testing may be performed on patients with a current diagnosis of DM or a diagnosis of prediabetes, as the data may provide relevant information

TABLE 2: CRITERIA FOR PREDIABETES AND DIABETES			
	Healthy	Prediabetes	Diabetes
<b>HbA1c</b>	< 5.7%	5.7%–6.4%	6.5% and above
<b>Fasting</b>	< 100 mg/dl	100 mg/dl–125 mg/dl	126 mg/dl and above
<b>2-hour</b>	< 140 mg/dl	140 mg/dl–199 mg/dl	200 mg/dl and above

**FIGURE 4: RISK FACTORS FOR DIABETES**

- Obesity/overweight
- Sedentary lifestyle
- Family history
- Patients who report:
  - Polyuria
  - Polydipsia
  - Polyphagia
- Ethnic background:
  - Hispanic/Latino
  - African American
  - Native American
  - Asian American
- Patients who present with ketoacidosis

with regard to appropriate clinical decision-making for safe patient care. However, point-of-service testing is ideal for the early evaluation of undiagnosed diabetes by initiating this test on patients who do not have a current DM diagnosis but present with known risk factors (figure 4).<sup>22</sup>

It should be noted that patients who present with unresolved, nonresponsive, or refractory oral disease are also excellent candidates for the preliminary evaluation of undiagnosed DM, as their lack of response to traditional therapy may be indicative of an underlying systemic condition. Additionally, patients who present with other overt comorbidities oftentimes observed in tandem with DM—such as coronary heart disease, cognitive disorders, hypertension, and hyperlipidemia,<sup>23</sup> to name a few—may also be excellent candidates for the early evaluation of DM.

The American Diabetes Association has a patient-friendly risk assessment form on their website that provides an optimized approach to identifying patients who are appropriate for this testing.<sup>24</sup> This risk assessment screens for modifiers such as age (40+ years of age); biological sex (men are more likely to be undiagnosed); family history of DM in a mother, father, sister, or brother; presence of hypertension; level of physical activity; ethnicity; and body mass index. Individuals who present with one or a combination of these listed risk factors may be excellent candidates for point-of-service HbA1c testing.

It should be noted that there are instances when gathering HbA1c levels are not appropriate. For example, the ADA notes that if a patient with a diagnosis of DM or an individual who is at risk for DM is about to undergo a long and complex dental procedure, use of an immediate blood glucose reading is more appropriate.<sup>25</sup>

**BLOOD COLLECTION**

Typical laboratory testing of HbA1c is done following a blood draw obtained through venipuncture. Point-of-service testing by a dental provider can also be performed by drawing capillary blood from a finger stick. Patient fasting is not required prior to an HbA1c test.

Finger-stick protocol steps include: 1) finger selection; 2) massaging, cleaning, and drying the site; 3) skin puncture with a lancet; 4) wiping away the first blood before collecting the sample without “milking” the finger site; 5) placing the sample into the analyzing device; and 6) reading the results.

The gathering of HbA1c readings requires the purchase of a Food and Drug Administration (FDA)-approved HbA1c point-of-service analyzer, lancets, and reagents that are utilized for sample collection. Of note, the finger-stick point-of-service test is considered of low complexity by the

FDA and therefore requires a two-year certificate of waiver (COW) to dental practices that perform this examination in-office. Use of point-of-service testing devices in the dental office requires compliance with the Clinical Laboratory Improvement Amendments (CLIA) of 1988, subsequently amended. This certificate is acquired by the state and the Centers for Medicare and Medicaid Services (CMS).<sup>26</sup>

Each state’s dental practice act has various regulations with regard to the scope of practice concerning laboratories, which may affect the practice’s decision to provide HbA1c testing. Dental professionals looking to integrate HbA1c point-of-service testing into their dental protocols are encouraged to become familiar with their specific state dental practice act regulations and federal regulations covering in-office testing prior to implementation.

**COLLECT DATA AND COUNSEL**

Upon completion of the blood sample analysis, the HbA1c analyzing device will provide a test result as a percent figure. This result must be documented in clinical notes as well as notations of activities following the test to include appropriate resources, referrals, and recommendations.

Patients who are unaware of their active diabetic state and who present with prediabetic or diabetic readings must be referred to their primary care physicians immediately. While point-of-service HbA1c testing may provide the opportunity to screen for undiagnosed disease, the final diagnosis of DM requires laboratory testing. The ADA encourages the use of a closed-loop referral system in which the patient gives consent for release of information and a medical consultation form is faxed or emailed to the primary care physician with all HbA1c readings and request for a response from the physician.

In addition, as DM is treated via multidisciplinary efforts, newly diagnosed patients with DM should be encouraged to establish care with an endocrinologist and other specialists, such as a podiatrist, ophthalmologist, cardiologist, and nephrologist.

**DENTAL BILLING FOR HBA1C POINT-OF-SERVICE TESTING**

Since 2018, the Current Dental Terminology (CDT) code set has allowed for an HbA1c point-of-service diagnostic code. The code allows for the performance and subsequent billing of this service by a dental provider.<sup>27</sup>

The full CDT nomenclature is as follows: D0411 HbA1c in-office point-of-service testing.<sup>28</sup> The filing of a dental claim for the code D0411 involves the traditional submittal of a claim. However, the presence of a CDT code does not guarantee insurance coverage or reimbursement. Dental offices are encouraged to research coverage and contracted fees for D0411 with individual third-party payers. Notably, many third-party payers indicate that reimbursed benefits for D0411 are limited to patients with risk factors for DM who have not been previously diagnosed with DM or prediabetes; it is not a payable benefit for the monitoring of HbA1c levels for patients who have a previous diagnosis of DM or prediabetes.

In 2019, the CDT launched code D0412. The full CDT nomenclature is as follows: D0412 blood glucose level test—in-office using a glucose meter. This procedure provides an immediate finding of a patient’s blood glucose level at time of sample collection for the

point-of-service analysis. It should be noted that an immediate finding of blood glucose is an ideal method for dental professionals to execute when evaluating the level of DM control in known diabetic patients.<sup>29</sup>

The ADA suggests the following actions regarding use of the D0412 procedure prior to extended dental treatment:

- A glucose level below 70 mg/dl is the clinical definition of hypoglycemia. The procedure should not be initiated until blood sugar levels are within an acceptable range.
- A glucose level over 300 mg/dl could lead to delayed wound healing and the potential for severe infection. Elective surgical procedures should be rescheduled until the patient's glucose level is considered acceptable.

Finally, some dental professionals have instituted the utilization of salivary analysis to evaluate salivary quality. This can be used as a specimen analysis for evaluating the presence of periodontally pathogenic bacterial infiltrates, in evaluation of genetic susceptibility to disease or in consideration of salivary acidity, the ability to buffer appropriately, and the presence of aciduric bacteria capable of causing dental decay.<sup>30</sup> As such, the following CDT codes may also be considered for utilization of salivary diagnostic testing in patients with DM:

- D0414 laboratory processing of microbial specimen to include culture and sensitivity studies, preparation and transmission of written report
- D0417 collection and preparation of saliva sample for laboratory diagnostic testing
- D0418 analysis of saliva sample—chemical or biological analysis of saliva sample for diagnostic purposes
- D0422 collection and preparation of genetic sample material for laboratory analysis and report
- D0423 genetic test for susceptibility to diseases—specimen analysis—certified laboratory analysis to detect specific genetic variations associated with increased susceptibility for diseases

### CLINICAL DECISION-MAKING FOR TREATMENT OF PATIENTS WITH DIABETES MELLITUS

In patients with elevated HbA1c readings, a careful treatment plan must be considered. Elevated HbA1c is a strong predictor of surgical complications. Studies suggest that an HbA1c greater than 8.0% should be used as a threshold for elective surgical procedures.<sup>31</sup> As such, elective dental care, ranging from dental restorations to implant placement, is contraindicated in patients with uncontrolled DM. However, therapeutic care such as active periodontal therapy and/or dental extractions in the presence of active infection has demonstrated success in the reduction of active infection and, in turn, a reduction in glycated hemoglobin readings.<sup>32-34</sup>

Studies demonstrate that even decreasing HbA1c by 1% may decrease micro- and macrovascular complications dramatically.<sup>35</sup> This may reduce diabetes-related deaths by 21% and heart attack risk by 14%, among countless other benefits.<sup>36</sup> For patients with periodontal disease, the benefit of receiving periodontal instrumentation minimally every three months is clear. The dental professional must scrutinize the patient's risk-to-benefit ratio prior to identifying specialized patient considerations.

Of note, patients with surgical hardware or joint replacements and uncontrolled DM are considered immunocompromised and may warrant premedication prior to bacteremia-causing procedures.<sup>37</sup> Additionally, patients with an elevated HbA1c reading may benefit from host modulation and/or systemic antibiotic therapy in an attempt to support the immune function during active periodontal therapy.

Patients with uncontrolled DM may require alternative anesthetic choices, morning appointments, and postoperative instructions that avoid the use of salicylates, as they increase insulin secretion and may affect subsequent HbA1c readings.

As with all uncontrolled chronic diseases, the dental professional should be aware and prepared for the potential of a medical emergency. Patients who take oral medications or use insulin for the treatment of DM may easily face episodes of hypoglycemia, which can be experienced during dental care (figure 5).

If a patient has not eaten a meal despite taking his/her medications as prescribed, hypoglycemia may occur, leading to a medical emergency in the dental chair. Symptoms include facial pallor, shaking, sweating, confusion, tachycardia, irritability or moodiness, confusion, anxiety, and headache.<sup>38</sup> It is essential that the dental provider be able to recognize these symptoms early and provide glucose supplementation rapidly and efficiently.

### PREVENTIVE RECOMMENDATIONS

As preventive specialists, it is imperative that dental professionals recognize their role as key therapists in the management of DM. As with any chronic disease, it is important to understand any contributing comorbidities with which the patient may present.

#### FIGURE 5: ORAL PRESCRIPTIONS FOR THE CONTROL OF TYPE 2 DIABETES

- **Alpha-glucosidase inhibitors** (acarbose, miglitol) assist the body in breaking down sugars and carbohydrates; taken before meals
- **Biguanides** (metformin, glipizide) decreases the amount of glucose the liver makes, decreases intestinal glucose absorption, helps muscles absorb glucose, makes the body more sensitive to insulin
- **Meglitinides** (nateglinide, repaglinide) helps the body release insulin
- **DPP-4 inhibitors** (alogliptin, sitagliptin, linagliptin, saxagliptin) help the pancreas generate more insulin, lower blood glucose
- **Sodium glucose transporter-2 inhibitors** (dapagliflozin, canagliflozin, empagliflozin) assist the kidneys with excreting glucose via the urine
- **Sulfonylureas** (glimepiride, glipizide) stimulates the pancreas to assist beta cells in producing insulin
- **Thiazolidinediones** (rosiglitazone, pioglitazone) decreases glucose in the liver; helps fat cells utilize insulin more efficiently



Diseases such as heart disease, high blood pressure, and kidney failure, to name a few, can greatly impact patients' ability to control their HbA1c levels.

Of recent interest, it has been noted that DM may increase angiotensin-converting enzyme 2 (ACE2) expression, which may in turn influence the patient's susceptibility to SARS-CoV-2 infection.<sup>39</sup> Additionally, research has noted that DM may worsen the outcome of the new coronavirus disease caused by SARS-CoV-2.<sup>40</sup> This data suggests that the identification and control of DM may reduce the susceptibility and worsening effects of the novel coronavirus, thus increasing the importance of expanding efforts to test for undiagnosed and subsequent uncontrolled DM.

Xerostomia delivers an additional challenge for patients with DM.<sup>41</sup> Strict adherence to xerostomia protocols is an important element of the therapeutic management of dry oral tissues while preventing subsequent *Candida* infections. For consideration, patients suffering from xerostomia struggle to manage a suitable oral pH and often require fluoride and/or remineralization therapy.

The prudent clinician should continually observe active DM patients for oral manifestations of DM through comprehensive head-and-neck examinations as well as continual monitoring and documentation of benign oral findings.

Finally, nutritional counseling services are encouraged for active DM or prediabetic patients as well as those presenting with overt risk factors for DM. Recommendations of foods low in glycemic index or in alignment with an anti-inflammatory diet have proven to be beneficial for the control of blood glucose levels.<sup>42</sup>

## SUMMARY

Currently, oral health professionals utilize a variety of screening techniques and gathering of vital signs to evaluate the presence or risk of several oral and systemic diseases. As dental research continues to validate the bidirectional link between oral and systemic diseases, it is imperative that the dental community consistently evaluate and reevaluate its preventive and diagnostic protocols, including those for the early detection and

ongoing monitoring of DM.

Point-of-service HbA1c testing is quick and reliable and can be performed by dental providers. Beginning in 2018, this became a billable code via the ADA CDT for dental providers with intended use on patients without diagnosed prediabetes or DM but presenting with risk factors. In 2019, the ADA released a CDT code for the gathering of immediate blood glucose levels for active DM patients. These tests encourage a closed-loop referral system between primary care providers and dental specialists, while also enhancing multidisciplinary involvement in patient care.

As research continues to verify the concern of risk for patients with undiagnosed or uncontrolled diabetes seeking elective dental care, it is critical that dental providers acquire appropriate vital signs or perform screening techniques to ensure a timely diagnosis and subsequent intervention.

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## QUESTIONS

1. **The estimated current global cost of diabetes is:**
  - A. \$85 million
  - B. \$850 million
  - C. \$85 billion
  - D. \$850 billion
2. **Type 1 diabetes mellitus accounts for \_\_\_% of all diabetics.**
  - A. 5
  - B. 10
  - C. 18
  - D. 20
3. **Oral manifestations of patients with uncontrolled diabetes include all of the following except:**
  - A. Enlarged parotid glands
  - B. Elevated caries risk
  - C. Increased salivary flow
  - D. Burning mouth syndrome
4. **Oral manifestations of patients with uncontrolled diabetes include all of the following except:**
  - A. Stomatitis
  - B. Increased sensitivity to taste
  - C. Lichenoid reaction
  - D. Halitosis
5. **The American Academy of Periodontology included diabetes mellitus as a disease that impairs host response. They noted that diabetes mellitus decreases the risk for periodontal disease.**
  - A. The first statement is true; the second statement is false.
  - B. The first statement is false; the second statement is true.
  - C. Both statements are true.
  - D. Both statements are false.
6. **Untreated diabetes leads to macrovascular disease, which can affect all of these organ systems except:**
  - A. Cardiovascular
  - B. Respiratory
  - C. Nervous
  - D. Cerebrovascular
7. **Microvascular disease is caused by:**
  - A. Renal failure
  - B. Respiratory distress
  - C. Inelasticity of the vasculature
  - D. Diabetic neuropathy
8. **The type of neuropathy that induces painful cramps; muscle weakness; bone degeneration; changes in skin, hair, and nails; and lack of position sense are described as:**
  - A. Autonomic neuropathy
  - B. Sensory neuropathy
  - C. Polyphasic neuropathy
  - D. Motor neuropathy
9. **Current diagnostic criteria for diabetes include which of the following?**
  - A. Fasting plasma glucose level greater than or equal to 126 mg/dL (7.0 mmol/L)
  - B. A random plasma glucose greater than or equal to 200 mg/dL (11.1 mmol/L)
  - C. HbA1c greater than 6.5%
  - D. Both A and B
10. **Which of the following is false?**
  - A. HbA1c is a measure used to diagnose diabetes.
  - B. HbA1c identifies blood glucose levels over the course of the previous 120 days.
  - C. HbA1c can be determined through a simple finger-prick method.
  - D. HbA1c reflects the amount of glucose adhered to erythrocytes in blood circulation.
11. **HbA1c point-of-service testing is recommended to be performed by the dental provider on which patients?**
  - A. Patients with ketoacidosis
  - B. Obese patients
  - C. A confirmed controlled diabetic patient considering an elective dental procedure
  - D. Both A and B
12. **Which of the following is true?**
  - A. The HbA1c point-of-service test is a test of low complexity and requires a two-year certificate of waiver to dental practices that perform this examination in-office.
  - B. The certificate of waiver is a certificate that a dental practice can acquire by the state and the Centers for Medicare and Medicaid Services.
  - C. Use of point-of-service testing devices in the dental office requires compliance with the Clinical Laboratory Improvement Amendments of 1988, subsequently amended.
  - D. All of the above are true.
13. **Which of the following is false?**
  - A. HbA1c is a component of the hemoglobin that reflects the adherence of glucose to erythrocytes.
  - B. HbA1c measures a protein on the surface of blood cells.
  - C. The life of a red blood cell is about 120 days.
  - D. The American Diabetes Association recommends patients with diabetes should receive HbA1c readings annually to survey treatment parameters.
14. **Which of the following is true?**
  - A. Elevated HbA1c is a strong predictor of surgical complications.
  - B. Elective dental care is absolutely contraindicated in patients with HbA1c greater than 6.5%.
  - C. No current published HbA1c thresholds are available to guide the dental professional regarding elective dental care.
  - D. A and C
15. **Which of the following is false?**
  - A. Active periodontal therapy and dental extractions in the face of infection have demonstrated reduction in HbA1c readings.
  - B. Patients with surgical hardware or joint replacements with uncontrolled diabetes may warrant premedication with prophylactic oral antibiotics.
  - C. Prophylactic oral antibiotics for dental procedures after orthopedic surgery with surgical hardware are always indicated.
  - D. Patients with elevated HbA1c may benefit from antibiotic therapy during active periodontal therapy to assist with immune function.
16. **Patients with uncontrolled chronic diseases may require all of the following except:**
  - A. Preparation for a medical emergency such as ketoacidosis or hypoglycemia
  - B. Alternative anesthetic choices
  - C. Appointments right after lunch
  - D. Avoidance of the use of salicylates postprocedure

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## QUESTIONS

**17. DDP-4 inhibitors (alogliptin, sitagliptin, linagliptin, saxagliptin):**

- A. Help the pancreas make more insulin
- B. Decrease glucose in the liver and help fat cells utilize insulin more easily
- C. Stimulate the pancreas to help beta cells produce insulin
- D. Assist the kidneys in getting rid of glucose

**18. Sodium glucose transporters (SGLT)-2 inhibitors (dapagliflozin, canagliflozin, empagliflozin):**

- A. Help the pancreas make more insulin
- B. Decrease glucose in the liver and help fat cells utilize insulin more easily
- C. Stimulate the pancreas to help beta cells produce insulin
- D. Assist the kidneys in getting rid of glucose

**19. Sulfonylureas (glimepiride, glipizide):**

- A. Help the pancreas make more insulin
- B. Decrease glucose in the liver and help fat cells utilize insulin more easily
- C. Stimulate the pancreas to help beta cells produce insulin
- D. Assist the kidneys in getting rid of glucose

**20. Thiazolidinediones (rosiglitazone, pioglitazone):**

- A. Help the pancreas make more insulin
- B. Decrease glucose in the liver and help fat cells utilize insulin more easily
- C. Stimulate the pancreas to help beta cells produce insulin
- D. Assist the kidneys in getting rid of glucose

**21. Alpha-glucosidase inhibitors (acarbose, miglitol):**

- A. Help the body release insulin
- B. Decrease the amount of glucose the liver makes, decrease intestinal absorption, help muscles absorb glucose, and make the body more sensitive to insulin
- C. Assist the body to break down carbohydrates
- D. Replenish the body with insulin

**22. Biguanides (metformin, glipizide):**

- A. Help the body release insulin
- B. Decrease the amount of glucose the liver makes, decrease intestinal absorption, help muscles absorb glucose, and make the body more sensitive to insulin
- C. Assist the body to break down carbohydrates
- D. Replenish the body with insulin

**23. Meglitinides (nateglinide, repaglinide):**

- A. Help the body release insulin
- B. Decrease the amount of glucose the liver makes, decrease intestinal absorption, help muscles absorb glucose, and make the body more sensitive to insulin
- C. Assist the body to break down carbohydrates
- D. Replenish the body with insulin

**24. Symptoms of a hypoglycemia emergency include all of the following except:**

- A. Shaking
- B. Sweating
- C. Headache
- D. Facial erythema/redness

**25. Dental professionals may contribute to the management of diabetes in the following way:**

- A. Perform active periodontal therapy
- B. Nutritional counseling
- C. Practice a multidisciplinary, closed-loop referral system
- D. All of the above

**26. A 56-year-old male with coronary artery disease and diabetes presents to your office for the first time for a dental cleaning. He has not seen a dental provider in two years and "really needs a cleaning." He does not remember his last HbA1c from one year ago. He takes metformin and insulin. The best course of action would be:**

- A. Obtain an HbA1c point-of-service test that day and proceed with the cleaning while you wait for the results.
- B. Refer the patient to his primary care physician.
- C. Proceed with the cleaning and refer the

patient to an endocrinologist.

- D. Obtain an HbA1c point-of-service test, prescribe an oral antibiotic, and have the patient come back in one week for his cleaning.

**27. A 62-year-old female with diabetes, heart disease, hyperlipidemia, thyroid disease, fibromyalgia, and arthritis presents to your office for her semiannual dental appointment. She takes insulin prescribed by her PCP. Her HbA1c is 13.2% and has been in this range for the past two years. The best course of action would be:**

- A. Proceed with the cleaning because this will help lower her HbA1c.
- B. Contact the patient's PCP and refer the patient to an endocrinologist.
- C. Tell the patient she needs to control her diet and exercise. Tell her to come back when her HbA1c is lower.
- D. Prescribe the patient a higher dose of insulin.

**28. The CDT code used to bill HbA1c in-office point-of-service testing is:**

- A. D0393
- B. D0411
- C. D0412
- D. D0417

**29. The CDT code used to bill blood glucose level test in-office using a glucose meter is:**

- A. D0393
- B. D0411
- C. D0412
- D. D0417

**30. Diabetes mellitus may worsen the outcome of the new coronavirus disease caused by SARS-CoV-2 by:**

- A. An increase of oral candidiasis infections leading to the disease
- B. Increased angiotensin-converting enzyme 2 (ACE2) expression
- C. Causing elevated cardiac enzymes
- D. All of the above

# The ABCs of HbA1c:

## A review of in-office diabetes testing for the dental professional

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### EDUCATIONAL OBJECTIVES

- Understand the current scientific literature indicating implications for incidence and prevalence of diabetes mellitus and oral disease, as well as the signs and symptoms of uncontrolled diabetes mellitus in the dental patient.
- Review the oral manifestations as well as the systemic sequelae of diabetes mellitus, while identifying the risk factors and potential shared etiologic factors associated with diabetes mellitus and oral disease.
- Discuss the opportunities for cotherapeutic management of diabetes mellitus and associated complications, including counseling strategies and guidelines for the implementation of dental services for patients with diabetes.
- Identify the clinical provision, indications, and process for gathering HbA1c point-of-service tests in the dental office while utilizing the Code on Dental Procedures and Nomenclature (CDT)-approved code.

### COURSE EVALUATION

1. Were the individual course objectives met?

Objective #1: Yes No Objective #2: Yes No  
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Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

- |   |       |     |    |     |    |   |
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| 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 bibliography.                               | 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?                 | _____ |     |    |     |    |   |

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