

# Diagnosis, Management, and Dental Considerations for the Diabetic Patient

Aaron Miller, BSc (Hon); Aviv Ouanounou, MSc, DDS, FICO



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## Abstract

Current epidemiological data suggest that the prevalence of diabetes in Canada is increasing. Patients with poor glycemic control are more prone to oral manifestations of diabetes, including periodontal disease, salivary gland dysfunction, halitosis, burning mouth sensation, delayed wound healing and increased susceptibility to infections. Diabetic patients are also at risk of experiencing an intraoperative diabetic emergency in the dental office. Therefore, dentists must appreciate and implement important dental management considerations while providing care to diabetic patients.

The human body possesses an incredible ability to maintain a stable and constant internal environment. Through its complex and well-regulated endocrine system, the body depends on hormones and chemical signaling pathways to respond to external stresses, such as changes in temperature, pH and blood glucose levels. In modern medicine, this steady state is termed “homeostasis.”

Diabetes mellitus (DM) refers to a group of metabolic disorders in which the body's ability to produce or respond to insulin is impaired.<sup>1</sup> This results in abnormal carbohydrate metabolism that eventually leads to elevated blood glucose levels. Therefore, DM represents a situation in which the body's homeostasis is disturbed.

In Canada, the prevalence of DM is rising. In 2015, an estimated 3.4 million Canadians (9.3% of the population) were living with DM.<sup>2</sup> The prevalence of DM is highest in the elderly population. With recent advances in medicine and technology and the growth of Canada's geriatric population (i.e., because this age group now have longer lifespans), the prevalence of DM is expected to rise even further. By 2022, an additional 2 million cases of DM are expected.<sup>3</sup>

## Classification and Etiology of Diabetes Mellitus

Most cases of DM can be classified as type 1 (T1DM) or type 2 (T2DM). Prediabetes refers to a condition in which blood glucose levels are elevated, but not high enough to warrant a diagnosis of T2DM. People with prediabetes have an increased risk of developing DM in the future.<sup>4</sup> To manage patients with DM adequately, a clinician should be able to understand and differentiate between T1DM and T2DM.

### Type 1 Diabetes Mellitus

Approximately 5–10% of all DM cases are T1DM, which was formerly known as insulin-dependent DM.<sup>5</sup> The condition is characterized by hyperglycemia that is secondary to cell-mediated autoimmune destruction of the pancreas's insulin-producing beta cells.<sup>5</sup> The etiology of pancreatic beta cell destruction is unknown, but is thought to result from a combination of poorly defined genetic and environmental factors. The autoimmune process can start in infancy, and, although most cases present in children or young adults, the disease can manifest at any age.<sup>6</sup> Clinically, patients may present with polyuria, polydipsia or polyphagia, and, in many cases, T1DM results in absolute insulin deficiency and subsequent ketoacidosis.<sup>5</sup> Despite increased hunger, weight loss is expected in a T1DM patient.<sup>6</sup> This can be attributed to a compromised cellular glucose-uptake mechanism that is characteristic of individuals with impaired insulin function.

### Type 2 Diabetes Mellitus

This class of DM, which accounts for 90–95% of all cases, is characterized by chronic hyperglycemia that results from a variable defect in insulin secretion, action or both.<sup>7</sup> Risk of developing T2DM is increased by obesity, increasing age and lack of physical activity.<sup>7</sup> New research has suggested that genetic susceptibility plays a role in risk, although the mechanisms of heritability are only partly understood.<sup>8</sup> Patients with T2DM have an overall decrease in life expectancy that is secondary to an increased risk of cardiovascular disease, stroke, peripheral neuropathy and renal disease.<sup>7,9</sup>

## Pathophysiology and Complications

Insulin is a peptide hormone that plays an important role in blood glucose regulation. It is secreted rapidly into the blood in response to changes in blood sugar.<sup>10</sup> When blood sugar levels increase (i.e., after a meal), the hormone promotes cellular glucose uptake and glucose storage in the liver as glycogen. In diabetic patients, insulin-dependent cells are unable to use available blood glucose as an energy source. To compensate, the body turns to its stored triglycerides as an alternative fuel source and ketoacidosis may result.<sup>11</sup> This explains the fruity smelling breath of some diabetic patients that is noted in the dental office.

As hyperglycemia proceeds, the body will attempt to get rid of excess blood glucose by excreting it in the urine. This explains why polyuria is a classic sign of DM. Increased fluid loss from excessive urination results in dehydration; therefore, polydipsia is another classic sign.<sup>12</sup> Because the glucose-starved, insulin-dependent cells of diabetic patients are deprived of adequate fuel, polyphagia is experienced as well.

DM is also associated with an increased incidence of microvascular and macrovascular complications. Some possible long-term sequelae include neuropathy, nephropathy and chronic kidney disease and retinopathy with possible loss of vision.<sup>13</sup> A close link also exists between cardiovascular disease and DM. Obesity, hypertension, dyslipidemia and atherosclerosis are common in diabetic patients and increase their risk of cardiac events.<sup>14</sup> People with DM also experience an increased susceptibility to infection and delayed wound-healing processes.<sup>15</sup>

## Diagnosis

Several diagnostic tools are available to clinicians to assess their patient's blood glucose control (**Table 1**). The fasting plasma glucose (FPG) test measures blood glucose level following a period of zero caloric intake for at least 8 h. An FPG level of about 5.6 mmol/L or less is considered normal.<sup>16</sup> The hemoglobin A1C (HbA1c) test provides information

about average blood glucose levels over the past 3 months. This test, which is reported as a percentage, is used by clinicians to assess control and management of DM. In a healthy, non-diabetic patient, an HbA1C level of 5.7% or lower is considered normal.<sup>17</sup>

**Table 1.** Current diagnostic criteria for diabetes.

Test	Information provided	Normal value	Diabetes value
<b>Fasting plasma glucose test</b>	<ul style="list-style-type: none"> <li>Measures blood glucose following zero caloric intake for at least 8 h</li> </ul>	≤ 5.6 mmol/L	≥ 7.0 mmol/L
<b>Hemoglobin A1C test</b>	<ul style="list-style-type: none"> <li>Provides information about glycemic control over the past 3 months</li> <li>Is the gold standard for assessing diabetes management and control</li> </ul>	≤ 5.7%	≥ 6.5%

Sources: Diabetes Canada Clinical Practice Guidelines Expert Committee et al.,<sup>1</sup> Janghorbani and Amini,<sup>16</sup> American Diabetes Association.<sup>17</sup>

## Diabetes Management

At the core of every DM management or treatment plan is an attempt to restore blood glucose levels to as close to normal as possible. Notably, if blood glucose levels can be adequately managed and controlled, progression to complications can be delayed or even prevented.<sup>18</sup> In many cases, DM management becomes quite complex with intensive treatment plans; therefore, patient compliance is an important factor in predicting success. Thorough patient education, compliance with medication, adherence to lifestyle changes (i.e., diet, exercise) and at-home blood glucose monitoring are all essential in achieving adequate glycemic control. The dentist should be aware of their patients' treatment plans and should reinforce the importance of compliance.

Numerous randomized controlled trials have demonstrated beneficial metabolic effects of nutritional recommendations for diabetic patients.<sup>18</sup> Studies have also shown that physical exercise has resulted in benefits, such as decreased insulin resistance and increased glucose uptake.<sup>18</sup> Further, the administration of exogenous insulin is seemingly the most obvious treatment for T1DM. In an attempt to override insulin resistance, physicians may incorporate exogenous insulin into the treatment plans of some T2DM patients as well.<sup>19</sup> Commonly used insulin preparations and their properties are summarized in **Table 2**.<sup>20</sup>

The major classes of oral hypoglycemic medications include biguanides, sulfonylureas, meglitinides, thiazolidinedione, dipeptidyl peptidase 4 inhibitors, sodium-glucose cotransporter inhibitors and α-glucosidase inhibitors.<sup>21</sup>

**Table 2.** Commonly used insulin preparations and their properties.

Insulin preparation			Onset	Peak, h	Effective duration, h
	Generic name	Trade name			
<b>Rapid acting</b>	Lispro	Humalog	< 15 min.	~ 1	3–5
	Aspart	Novolog	< 15 min.	1–3	3–5
	Glulisine	Apidra	15–30 min.	0.5–1	4
<b>Short acting</b>	Regular	Humulin R	1 h	2–4	5–8
		Novolin R			
<b>Intermediate acting</b>	NPH	Humulin R	1–2 h	4–10	14+
		Novolin R			
<b>Long acting</b>	Detemir	Levemir	3–4 h	6–8	20–24
	Glargine	Lantus	1.5 h	—*	24

Note: NPH = neutral protamine Hagedorn; h=hours.

\*No peak.

Source: Adapted from Donner and Sarkar.<sup>20</sup>

These pharmacologic agents are most commonly used to treat T2DM and, through various mechanisms of action, aim to lower blood glucose levels.<sup>11</sup> The common classes of these drugs are summarized in **Table 3**.<sup>21</sup>

**Table 3.** Common classes of oral hypoglycemic medications.

Class	Representative agents	Mechanism of action
<b>Sulfonylurea</b>	Glimepiride	Increases insulin secretion
	Glipizide	
	Glyburide	
<b>Meglitinide</b>	Repaglinide	Increases insulin secretion
	Nateglinide	
<b>Biguanide</b>	Metformin	Insulin sensitizer Inhibits hepatic glucose production
<b>Thiazolidinedione</b>	Rosiglitazone	Increases tissue sensitivity to insulin
	Pioglitazone	
<b>Dipeptidyl peptidase 4 inhibitor</b>	Sitagliptin	Exacerbates the effect of intestinal hormones (incretins) involved in blood glucose control
	Saxagliptin	
	Vidagliptin	
	Linagliptin	
	Alogliptin	
<b>Sodium-glucose cotransporter inhibitor</b>	Canagliflozin	Enhances glucosuria by blocking glucose reabsorption in renal proximal convoluted tubule
	Dapagliflozin	
	Empagliflozin	

Source: Adapted from Chaudhury et al., 2017<sup>21</sup>

## Oral Complications and Manifestations

The effects of DM on the oral cavity have been studied extensively. Complications, such as periodontal disease, salivary gland dysfunction, halitosis, burning mouth sensation and taste dysfunction, have been associated with DM in scientific literature.<sup>22</sup> People with DM are also more prone to fungal and bacterial infections, oral soft tissue lesions, compromised oral wound healing processes, dental caries and tooth loss.<sup>22</sup> Notably, the degree of a patient's glycemic control appears to be an significant factor in predicting the severity and likelihood of oral complications.<sup>23</sup> Therefore, it is important that dentists take an active role in educating patients about DM control and the potential impact of lack of control on their oral well-being. **Table 4**<sup>23</sup> highlights the influence of glycemic control on the oral manifestations of T2DM.

**Table 4.** Prevalence of oral manifestations in controlled vs. uncontrolled diabetes.

Oral complication	Prevalence in controlled type 2 diabetes mellitus, %
Salivary gland dysfunction	68
Halitosis	52
Periodontitis	32
Burning mouth sensation	32
Candidiasis	28
Taste disturbance	28

Source: Adapted from Indurkar et al.<sup>23</sup>

Numerous studies have identified a link between DM and periodontal disease. Although the mechanisms are not entirely understood, increased periodontal tissue destruction in diabetic patients is thought to result from reduced polymorphonuclear leukocyte function that is secondary to the formation of advanced glycation end products and changes in collagen metabolism.<sup>22</sup> Research has shown a bidirectional relationship between DM and periodontitis. Although effective management of DM can lower susceptibility to periodontitis, evidence suggests that periodontal therapy can improve glycemic control as well.<sup>22</sup>

Salivary gland dysfunction is another widely reported oral manifestation of DM.<sup>24</sup> Although the mechanism of hyposalivation is unknown, some have hypothesized that it is related to polydipsia and polyuria.<sup>11</sup> Xerostomia in a diabetic patient may lead to halitosis, taste disturbances, exacerbated periodontal disturbance, dental caries and tooth loss.<sup>24</sup> Therefore, it is important for dentists to anticipate and manage xerostomia in a diabetic patient.

Several authors have reported that diabetic patients are susceptible to fungal and bacterial infections.<sup>22</sup> Also, people with diabetes are prone to more severe bacterial infections and their recurrence. This can be attributed to impaired host defense mechanisms associated with poor glycemic control. Further, oral soft tissue regeneration and

osseous healing processes are compromised in a diabetic patient. This is thought to result from delayed vascularization, reduced blood flow, decreased growth factor production, weakened innate immunity and psychological stress.<sup>22</sup> Therefore, dentists must anticipate, prevent and promptly treat infections in their diabetic patients. Especially during invasive procedures, dentists should take extra precautions to avoid the need for profound wound-healing processes.

## Dental Management Considerations

Before initiating treatment of a diabetic patient, dentists must appreciate important dental management considerations (see **Box 1**). In doing so, dentists can help to minimize the risk of an intraoperative diabetic emergency and reduce the likelihood of an oral complication of the disease.

### Box 1. Dental management considerations for the diabetic patient

- Consult with patient's physician to assess diabetes control
- Update medical history and medications and review systems at each appointment
- Confirm that patient has eaten and taken medications before initiating treatment
- Anticipate and be prepared to manage hypoglycemia
- Prevent, treat and eliminate infections promptly
- Do not use or recommend aspirin-containing compounds
- Achieve profound local anesthesia
- Ensure excellent oral hygiene and provide profound preventive care
- Reinforce regular diet and medication regimen before and after dental appointments
- Take glucometer reading if patient is high risk, on insulin or having surgery

Effective management of a diabetic patient begins with the dentist taking a thorough medical history and carrying out a review of systems. Dentists should collect information about the patient's recent blood glucose levels, at-home monitoring practices, frequency of HbA1C tests and their readings and the frequency of hypo- or hyperglycemic episodes. Also, the dentist should review the current DM management plan, including doses and times of administration of all medications, as well as any lifestyle modifications, such as exercise or nutritional changes. Of note, a variety of medications that are taken for reasons other than DM may interact with and potentiate the effect of oral hypoglycemic agents.<sup>11</sup> Therefore, dentists should be mindful of their patients' entire medication list.

Cortisol is an endogenous hormone that increases blood glucose levels. Because cortisol levels are typically higher in the morning and during times of stress (e.g., a dental procedure), it is advisable that diabetic patients are scheduled for morning appointments.<sup>11</sup> In taking this precaution, the dentist reduces the risk of a hypoglycemic episode. For patients receiving exogenous insulin therapy, appointment scheduling should avoid the time of peak insulin activity when the risk of hypoglycemia is highest. If these patients require surgery or invasive procedures, the dentist should consult their physician regarding possible adjustment of insulin doses.

At the beginning of each appointment, the dentist should

make sure that the diabetic patient has eaten and taken their medications as usual. If not, the patient may be at risk of a hypoglycemic episode. In some cases, the dentist may need to measure and record blood glucose level before initiating treatment. The need for in-office blood glucose monitoring depends on the patient's risk, medical history, medications and the procedure being performed. If blood glucose is low, the patient should consume a source of oral carbohydrates before treatment is initiated. If blood glucose is high, treatment should be postponed, and the dentist should refer the patient to their physician to re-assess glycemic control. Electronic blood glucose monitors are relatively inexpensive and quite accurate.<sup>11</sup> The target values for blood glucose in diabetic patients are summarized in **Table 5**.<sup>25</sup>

**Table 5.** Target values for most patients with diabetics.

	HbA1C	Fasting blood glucose, mmol/L	Blood glucose 2 h after eating, mmol/L
Target value	≤ 7.0%	4.0–7.0	5.0–10.0 (5.0–8.0 if HbA1C targets not being met)

Source: Adapted from Diabetes Canada.<sup>25</sup>

The most common intraoperative complication of DM is a hypoglycemic episode.<sup>11</sup> The risk is highest during peak insulin activity, when the patient does not eat before an appointment or when oral hypoglycemic medication and/or insulin levels exceed the needs of the body. Initial signs and symptoms of hypoglycemia include hunger, fatigue, sweating, nausea, shaking, irritability and tachycardia.<sup>26</sup> If a hypoglycemic episode is suspected, the dentist should stop dental treatment immediately and administer 15 g of oral carbohydrate via a candy, juice or glucose tablet.<sup>27</sup> Studies have shown that 15 g of glucose will cause a blood glucose increase of approximately 2.1 mmol/L within 20 min.<sup>28</sup> Following emergency treatment, the dentist should monitor the patient's blood glucose level to determine whether repeated carbohydrate dosing is required. If the patient is unconscious or cannot swallow, the dentist should seek medical assistance. In these cases, the patient should be administered 20–50 mL of 50% dextrose solution intravenously or should be given 1 mg of glucagon via intravenous, intramuscular or subcutaneous injection.<sup>27</sup> The emergency management of a hypoglycemic episode is summarized in **Table 6**.<sup>27</sup>

Because of the prolonged onset of symptoms, diabetic ketoacidosis and hyperosmolar hyperglycemic state are unlikely to present as acute emergencies in the dental office.<sup>11,30</sup> As hyperglycemic patients may present with hunger, nausea, vomiting, weakness or abdominal pain, dentists may struggle to differentiate between a hypo- and hyperglycemic episode.<sup>30</sup> Given that a small amount of added sugar will cause no significant harm in an already hyperglycemic patient, the dentist should assume a

hypoglycemic emergency and immediately administer an oral source of carbohydrates.<sup>11</sup> A true hyperglycemic emergency requires medical intervention and insulin administration.

**Table 6.** Management of an intraoperative hypoglycemic emergency.

Signs and symptoms	Emergency management
<b>Mild</b> <ul style="list-style-type: none"> <li>• hunger</li> <li>• fatigue</li> <li>• sweating</li> <li>• nausea</li> <li>• abdominal pain</li> <li>• headache</li> <li>• tachycardia</li> <li>• irritability</li> </ul>	<ul style="list-style-type: none"> <li>• Terminate dental treatment immediately</li> </ul>
<b>Moderate</b> <ul style="list-style-type: none"> <li>• incoherence</li> <li>• uncooperative</li> <li>• belligerence</li> <li>• resistive behaviour</li> </ul>	<b>Awake/alert patient</b> <ul style="list-style-type: none"> <li>• Administer 15 g oral carbohydrate (i.e., glucose tablet, 180 mL orange juice, 15–25 mL sugar)</li> <li>• Monitor blood glucose and repeat carbohydrate dosing as necessary</li> </ul>
<b>Severe</b> <ul style="list-style-type: none"> <li>• unconscious</li> <li>• seizure</li> </ul>	<b>Uncooperative patient</b> <ul style="list-style-type: none"> <li>• Seek emergency medical assistance</li> <li>• Administer glucagon 1 mg via subcutaneous or intramuscular injection followed by oral glucose supplement or</li> <li>• Administer 20–50 mL of 50% dextrose solution intravenously</li> </ul> <b>Unconscious patient</b> <ul style="list-style-type: none"> <li>• Seek emergency medical assistance</li> <li>• Administer 20–50 mL of 50% dextrose solution</li> </ul>

Source: Adapted from McKenna.<sup>27</sup>

Following treatment, the dentist must remember that diabetic patients are prone to infections and delayed wound healing. This is especially true for a diabetic patient whose condition is uncontrolled. Therefore, depending on the dental procedure, some consideration should be given to providing antibiotic coverage. If treatment will result in an interruption to the normal dietary regimen, the dentist should consult the patient's physician regarding a potential adjustment of insulin and antidiabetic medication doses. Notably, salicylates are known to potentiate the effect of oral hypoglycemic agents by increasing insulin secretion and sensitivity.<sup>30</sup> To avoid unintended hypoglycemia, aspirin-containing compounds should not be used by patients with DM.

## Conclusion

Recent estimates suggest that 318 million people are living with DM worldwide.<sup>2</sup> In Canada, the estimated population is 3–4 million.<sup>2</sup> Undoubtedly, any dentist working in Canada will encounter many patients with DM throughout their career. Given the numerous possible oral manifestations of DM and the risk of an intraoperative diabetic emergency, it is important for dentists to recognize and appreciate the impact of the disorder on dental care. With a thorough understanding of DM and its dental management considerations, the dental health care team can work together effectively to provide excellent oral health care to diabetic patients.



## THE AUTHORS



Aaron Miller is a 4th-year dental student in the faculty of dentistry, University of Toronto.



Dr. Ouanounou is an assistant professor, department of clinical sciences (pharmacology & preventive dentistry), faculty of dentistry, University of Toronto.

**Correspondence to:** Dr. Aviv Ouanounou, Dept. of Clinical Sciences, Pharmacology & Preventive Dentistry, Faculty of Dentistry, University of Toronto, Room 513, 124 Edward St. Toronto ON M5G 1G6. Email: [aviv.ouanounou@dentistry.utoronto.ca](mailto:aviv.ouanounou@dentistry.utoronto.ca)

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