Patients With Type 2 Diabetes: Anesthetic Management in the Ambulatory Setting

Part 1: Pathophysiology and Associated Disease States

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The increasing prevalence of diabetes mellitus in the general population has many implications for the ambulatory anesthesia provider. Complications, particularly associated with poor glycemic control, can affect multiple organ systems and jeopardize the safety of any planned anesthetic. It is essential that anesthesiologists and sedation providers have in-depth knowledge of the pathophysiology of diabetes mellitus and the comorbid conditions that commonly accompany it. Anesthesiologists and sedation providers must also understand certain surgical and anesthetic considerations when planning an effective and safe anesthetic for diabetic patients. This is a 2-part series concerning perioperative glycemic control for patients with diabetes mellitus. Part 1 will focus on the physiology of diabetes and its associated disease states. Part 2 will address the pharmacology associated with the wide variety of medications used to treat the disorder and the most recent guidelines for blood glucose management in ambulatory surgical patients.

Key Words: Type 2 diabetes; Prediabetes; Hyperglycemia; Hypoglycemia; Hemoglobin A1c.

CURRENT BURDEN OF DISEASE

Currently, there are approximately 22 million people in the United States diagnosed with diabetes.^{1,2} These patients represent approximately 6.9% of the country's population, a statistic that has been steadily growing for the past 4 decades.³ Unfortunately, it is estimated that more than 8 million additional persons have diabetes but are undiagnosed.^{1,4} The National Health and Nutrition Survey (NHANES) indicates that nearly 13% of patients older than 20 years have diabetes; alarmingly, 40% of these cases are undiagnosed.⁵ It is important to realize that more than 1 of every 10 patients anesthetized for ambulatory surgery may potentially have diabetes.

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Prediabetes, or “dysglycemia,” can be defined as impaired fasting plasma glucose (greater than 100 mg/dL [5.6 mmol/L] but less than 125 mg/dL [6.94 mmol/L]), impaired oral glucose tolerance (blood glucose of 140 mg/dL [7.8 mmol/L] to 199 mg/dL [11.0 mmol/L] 2 hours after a 75-g oral glucose challenge), or a hemoglobin A1c (HbA1c) of 5.7% to 6.4%.^{5,6} HbA1c is used to approximate a patient's plasma glucose concentration over the previous 3 months. HbA1c represents the percentage of hemoglobin that is glycosylated, or bound to glucose, and increases as the amount of glucose in the blood rises (Table 1). The American Diabetes Association has provided a mathematical formula in which estimated average glucose in mg/dL can be calculated from HbA1c for comparison to daily glucose values obtained from a glucometer^{4,6} (Tables 2 and 3). One in 3 Americans has prediabetes, and it has been estimated that more than 40% of ambulatory patients may exhibit baseline dysglycemia.^{5,7} Therefore, when accounting for the additional hypergly-

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Table 1. Hemoglobin A1c Levels and the Distinction Between Normal Glycated Hemoglobin, Prediabetes, and Diabetes

HbA1c Level	Diagnosis
4.0–5.6%	Normal glycated hemoglobin
5.7–6.4%	Prediabetes
>6.5%	Diabetes
<7.0%	An A1c of less than 7.0% is used as a reasonable goal for patients with diabetes

cemia that is often induced as a result of surgical stress, it is prudent to assume that many ambulatory surgical patients will be in a prediabetic state.

The prevalence of diabetes among seniors is very high; approximately 26% of Americans aged 65 years or older have the disease.^{2,4} It is expected that the number of persons with diabetes in this population will nearly double by the year 2025.⁸ Minority populations are afflicted with diabetes at higher rates than people of Anglo descent, with 9.0% of Asians, 12.8% of Hispanics, 13.2% of non-Hispanic blacks, and 15.9% of Native Americans diagnosed.^{2,4} Diabetes is the seventh leading cause of death in the United States and contributes \$245 billion to national health care costs annually.⁴ It is estimated that the morbidity associated with diabetes is responsible for \$69 billion in annual lost productivity.⁴ Globally, diabetes afflicts 422 million people and is responsible for 1.5 million deaths annually.⁹ By some estimates, type 1 diabetes shortens life expectancy by 20 years; type 2 diabetes shortens life expectancy by 10 years.¹⁰

PATHOPHYSIOLOGY

Diabetes mellitus is the inability to properly metabolize carbohydrates, fats, and proteins. It is caused by either a complete lack of insulin production, an inadequate amount of insulin secreted by the beta cells of the pancreas, tissue insensitivity to insulin, or insulin that is ineffective or destroyed before it can reach its target site.¹¹

Normal cellular energy demands are usually met when carbohydrates are broken down into glucose and transported across cellular membranes. Insulin binds to an alpha chain of the insulin receptor on the extracellular surface of the target cell, causing phosphorylation of a transmembrane beta subunit. Phosphorylated beta subunits activate intracellular tyrosine kinase, which in turn

Table 2. Conversion of HbA1c in Percentages to Estimated Average Glucose Levels in mg/dL

$(\text{HbA1c level} \times 28.7) - 46.7 = \text{average plasma glucose in mg/dL}$ (to covert final result to mmol/L, divide by 18)

Table 3. HbA1c Values and the Corresponding Estimated Average Blood Glucose Level ($R^2 = 0.84$, $P < .0001$)

HbA1c (%)	Estimated Average Glucose
5	97 mg/dL (5.4 mmol/L)
6	126 mg/dL (7.0 mmol/L)
7	154 mg/dL (8.5 mmol/L)
8	183 mg/dL (10.2 mmol/L)
9	211 mg/dL (11.7 mmol/L)
10	240 mg/dL (13.3 mmol/L)
11	269 mg/dL (14.9 mmol/L)
12	298 mg/dL (16.5 mmol/L)

activates insulin receptor substrates. Activated insulin receptor substrates participate in a host of important functions including glycogen, fat, and protein synthesis.^{12,13} Arguably, the most important action that activated insulin receptor substrates mediate is to stimulate the movement of glucose transport molecules to the cell surface. Once bound to the cell membrane, glucose transport molecules open a transmembrane channel through which glucose can flood into the cytoplasm of the cell. Phosphorylated intracellular glucose is the main energy source for cellular metabolism (Figure).

The pancreas consists of 2 different types of tissues: pancreatic acini, which are composed of exocrine cells, and islets of Langerhans, which are composed of endocrine cells. The acini make up the vast majority of the pancreatic mass (80%) and secrete digestive enzymes, bicarbonate ions, and water into the duodenum of the small intestine via the pancreatic duct.¹² Approximately 20% of the pancreas consists of the 1 to 2 million islets that release the hormones glucagon, insulin, amylin, somatostatin, and pancreatic peptide directly into the blood stream.

In type 1 diabetes, the pancreas is unable to secrete proper amounts of insulin because of the destruction of beta cells in the islets of Langerhans. Destruction of beta cells is typically due to autoimmune disorders or viral infections and may or may not be associated with heredity.¹² Type 1 diabetes contributes only 5% to 10% of total diabetes mellitus cases and is usually diagnosed in children and adolescents.^{10,12}

Type 2 diabetes is typically found in people older than 30 years of age; however, the number of individuals developing type 2 diabetes at a younger age is rapidly increasing.^{2,11,12} There is most likely a direct correlation between the growing number of obese children and adolescents and the rise in type 2 diabetes in people younger than 20.^{5,12,14} Obesity is, in fact, the major risk factor for developing type 2 diabetes. It is thought that weight gain causes the development of fewer insulin receptors on liver, fat, and muscle tissues. Impaired or abnormal signaling pathways between existing insulin receptors and certain cellular responses also may play a role in obesity-related diabe-

Insulin receptor and glucose transport.

tes.¹² Other causes of insulin resistance that may lead to type 2 diabetes include gestational diabetes, polycystic ovary syndrome, excess formation of growth hormone, Cushing's syndrome, and hemochromatosis.

The insulin resistance associated with type 2 diabetes can cause blood glucose to approach exceedingly high levels. An acceptable fasting plasma glucose level is typically considered to be less than 100 mg/dL (5.6 mmol/L) (with 110 mg/dL [6.1 mmol/L] being the upper limit of normal) and a normal HbA1c level is less than 5.7%.^{6,12,15} Diabetic patients will often present with a fasting plasma glucose level of greater than 125 mg/dL (6.9 mmol/L); levels greater than 600 mg/dL (33.3 mmol/L) may be present in hyperosmolar hyperglycemic state, an acute, life-threatening complication of type 2 diabetes.^{14,16}

COMORBID CONDITIONS

There are many comorbidities associated with type 2 diabetes mellitus. The NHANES concluded that only

14% of patients with type 2 diabetes had no other comorbidities.^{17,18} Among the most common comorbid diseases found in patients with type 2 diabetes are obesity, cardiovascular disease, hypertension, dyslipidemia, and kidney disease. Depression, sleep disorders, and cancer are also commonly found in diabetic patients.¹⁷ It is imperative that ambulatory anesthesiologists understand the association between type 2 diabetes and these comorbid conditions and the complications that may present during sedation and general anesthesia.

The NHANES study found that nearly 90% of type 2 diabetic patients were either overweight or obese (body mass index greater than 25 kg/m²).¹⁷ Obesity presents additional challenges to the anesthesia provider including difficult airway management and ventilation, with associated difficulty in oxygenation, obstructive sleep apnea, gastroesophageal reflux disease, proper drug dosing, and delayed emergence.

Cardiovascular and atherosclerotic disease, including cerebrovascular disease and ischemic heart disease, is

the major cause of death in patients with type 2 diabetes.¹⁷ Insulin's stimulation of triglyceride synthesis and inhibition of the breakdown of triglycerides is impaired by either the lack of insulin or insulin resistance and is a primary cause of these complications. Tachycardia is poorly tolerated; there is a 10-fold increase of death in diabetic patients with coronary artery disease who have a sustained heart rate of greater than 105 bpm for longer than 5 minutes in the postoperative period.¹⁹ Patients with cardiovascular disease are often on antiplatelet therapy and are at higher risk of perioperative bleeding. Lipid disorders associated with diabetes greatly increases the risk of developing cardiovascular disease and its associated morbidities. The NHANES study found that nearly half of type 2 diabetic patients have elevated lipid values.¹⁸

Nearly 70% of patients with type 2 diabetes suffer from hypertension.¹⁷ Hypertension combined with diabetes increases a patient's risk of perioperative myocardial infarction, cerebrovascular accident, and microvascular disease including retinopathy and autonomic and sensory neuropathies. The American Diabetes Association recommends that diabetic patients be treated to a target blood pressure of less than 140/80 mm Hg.²⁰ Proper control of blood pressure will have a greater and more immediate effect on morbidity and mortality than glycemic control or lipid management.^{17,21}

Chronic kidney disease, also a form of microvascular disease, affects up to 40% of diabetic patients.²² Because of the way chronic kidney disease affects insulin pharmacokinetics, insulin-dependent diabetic patients with this comorbidity have a higher risk of developing hypoglycemia.¹⁷ Many oral antidiabetic drugs cannot be used in chronic kidney disease patients including biguanides (metformin), sulfonylureas, and alpha-glucosidase inhibitors.^{17,23}

PREANESTHETIC GLYCEMIC CONSIDERATIONS

When considering the diabetic patient who is planned for anesthesia and surgery, it is important to know what level of plasma glucose or HbA1c is acceptable for elective procedures. Is there a level of hyperglycemia that is too high for surgery to proceed? When do the risk factors associated with uncontrolled diabetes determine that a surgery should be canceled or rescheduled? Much controversy has surrounded what glycemic level is considered safe and how strict glycemic control should be for diabetic patients needing or wanting surgery.

In the early part of the 21st century, many practitioners advocated a course of treatment for diabetic patients called tight glycemic control citing the morbidity and

mortality associated with hyperglycemia in the intensive care unit.⁵ Tight glycemic control involved a rapid reduction in plasma glucose levels in order to achieve HbA1c levels of less than 6%.¹³ Further investigation, however, revealed that tight glycemic control measures increased the risk of mortality associated with hypoglycemia. In fact, the ACCORD trial of 2008 was halted because of the high death rate of the study participants undergoing tight glycemic control regimens.^{5,8} The NICE-SUGAR study of 2009 also showed an increase in mortality for diabetic patients subjected to drastic reductions in hyperglycemic levels.^{5,24} Currently, there are more than 7 different guidelines from reputable sources that recommend varying strategies for glycemic control, however, the overall consensus is to avoid rapid fluctuations in blood glucose.^{8,25} Current literature shows that managing fluctuations in blood glucose levels may be as important as managing hyperglycemia and that mortality may be affected more by blood glucose variability than by absolute mean levels.^{13,26}

The Society of Ambulatory Anesthesia has produced a consensus statement for perioperative glycemic management in diabetic patients undergoing ambulatory surgery. The recommendations state that prior to surgery, anesthesia providers should have knowledge of the patient's current fasting blood glucose level and most recent HbA1c.^{25,27,28} This is because patients with acute hyperglycemia have more perioperative and postoperative complications including dehydration, ketoacidosis, hyperosmolar hyperglycemic state, delayed wound healing, and wound infection.^{5,27} The decision to cancel or postpone surgery should be made in conjunction with the surgeon and should be based on the urgency of the surgery as well as the risks versus the benefits of proceeding.^{27,29} There is currently no evidence for an optimal blood glucose level for diabetic patients. The Society of Ambulatory Anesthesia states that for patients with well-controlled diabetes, perioperative blood glucose levels should be maintained at less than 180 mg/dL (10.0 mmol/L).²⁷ Those patients with more poorly controlled diabetes, as stated earlier, should be maintained around baseline blood glucose levels.²⁷

Blood glucose levels should be checked before and after surgery. If a surgical procedure is planned for less than 2 hours, intraoperative testing of blood glucose is probably not necessary.^{27,29} However, for long procedures, it is reasonable to monitor blood glucose levels every 1 to 2 hours.^{25,27,29} Portable glucose meters are an acceptable method for obtaining blood glucose levels. However, it must be understood that the Food and Drug Administration accepts a 20% manufacturer's measurement error for meters reading levels greater than 100 mg/dL (5.6 mmol/L) and a 15% error for levels less than 100 mg/dL (5.6 mmol/L).^{27,28} When precise blood

glucose levels are desired, laboratory tests should be used if possible.

OTHER PREANESTHETIC CONSIDERATIONS

There are many effects of diabetes on the human body that complicate the administration of anesthesia. For instance, diabetic patients often have high levels of irreversibly glycated collagen and ineffective collagenase activity that leads to a buildup of collagen and mucin in the extremities.³⁰ This sclerotic skin condition, known as diabetic scleroderma, causes the epidermis of the upper extremities to take on a tough, woody nature that can make intravenous cannulation very difficult.

Glycated collagen can also build up in the joints of diabetic patients, causing limited joint mobility. Often times, “stiff joint syndrome” is manifest by the inability of the patient to properly display the “prayer sign”: When the patient puts their palms together, they are unable to approximate the palmar surfaces of their fingers.³¹ Diabetic stiff joint syndrome is of concern to the anesthesiologist because it may severely limit the motion of the Atlanto-occipital joint or, more rarely, the temporomandibular joint, making conventional laryngoscopy almost impossible.

Gastroparesis, or “diabetic stomach,” occurs when autonomic neuropathy caused by chronic plasma glucose elevation affects the vagus nerve. When the vagus nerve is damaged, motor control of the stomach and intestines is impaired; the result is delayed gastric emptying of food and other stomach contents.^{32,33} Improperly digested food that will not move through the gut forms structures called “bezoars,” which can cause stomach obstruction and increase the risk of nausea and vomiting.³² Gastroesophageal reflux is another common side effect of gastroparesis. The anesthesiologist must be keenly aware of these potential problems associated with impaired motility because they can result in aspiration of stomach contents during induction and emergence or during monitored anesthesia care cases. Movement of clear liquids is not impaired, however, and clear liquids may be ingested up to 2 hours before anesthesia.^{32,33}

Atherosclerosis and associated ischemic heart disease, as well as hypertension, have been discussed previously. Another of the most common, and serious, complications of diabetic neuropathy also involves the cardiovascular system. It is estimated that more than 20% of patients with type 2 diabetes suffer from cardiovascular autonomic neuropathy.³⁴ Glycosylation of endoneurial blood vessels may cause neural hypoxia, resulting in dysfunction of the autonomic nerves of the heart. The result of cardiovascular autonomic neuropathy is manifest as resting tachycardia, orthostatic hypotension, and

exercise intolerance. Diabetic patients with cardiovascular autonomic neuropathy evidenced by heart rate variability are twice as likely to suffer silent myocardial ischemia and mortality.³⁴ The term *silent myocardial ischemia* is used, because the same process of neural dysfunction that occurs in autonomic neuropathy also occurs in sensory nerves. This manifests as numbness in various body regions (such as the heart in the example above) or as pain, usually a tingling or burning sensation in a nondermatomal pattern. These patients commonly are prescribed serotonin-norepinephrine reuptake inhibitors for pain management, which may lead to an unwanted exaggerated hemodynamic effect from epinephrine-containing local anesthetic solutions.

Liver disease is one of the primary causes of death in patients with type 2 diabetes.³⁵ When compared with the general population, patients with type 2 diabetes have a higher incidence and prevalence of hepatic diseases such as nonalcoholic fatty liver disease, hepatocellular carcinoma, hemochromatosis, hepatitis B, and hepatitis C.^{35,36} For this reason, anesthesia providers should consider reviewing recent liver function test numbers for their diabetic patients; these values can assist providers as they plan the course of anesthetic treatment. Two liver function tests, alanine aminotransferase and aspartate aminotransferase, are indicators of acute hepatocyte injury because they measure the amount of intracellular liver enzymes that have been released into the circulation because of cell damage or cell death. Normal lab values for alanine aminotransferase are approximately 7 to 56 U/L; normal values for aspartate aminotransferase are approximately 10 to 40 U/L. When these liver function tests are significantly elevated (greater than 3 times normal) for longer than 6 months in the diabetic patient, hepatic damage may be present, resulting in impaired metabolism of drugs commonly used in anesthesia.³⁶

Evaluation of kidney function is also important as chronic kidney disease is present in many diabetic patients, as has been mentioned. Plasma creatinine can be used to estimate kidney function. A creatinine level of 2 mg/dL generally implies approximately 50% nephron loss, while a level of 4.8 mg/dL implies 75% loss.³⁷ Urinalysis showing microalbuminuria is generally indicative of at least early-stage renal disease.^{38,39}

SUMMARY

Diabetes is a disease of epidemic proportions both in the United States and globally. The prevalence of type 2 diabetes is increasing rapidly among all age groups and all races. The risks associated with placing diabetic patients under sedation or general anesthesia are

significant; therefore, the ambulatory anesthesia provider has an obligation to understand the pathophysiology of the disease and its common comorbid conditions. Keen attention must be given to many surgical and anesthetic considerations when planning an effective and safe anesthetic for diabetic patients in the ambulatory surgical setting. The forthcoming second article in this 2-part series will further discuss perioperative glycemic control in diabetic patients by reviewing current recommendations in medication management and intraoperative glucose management.

REFERENCES

- Centers for Disease Control and Prevention. Diabetes public health resource. Atlanta, GA: Centers for Disease Control and Prevention; 2016. Available at: www.cdc.gov/diabetes/statistics/prev/national/figpersons.html. Accessed June 2016.
- National Center for Chronic Disease Prevention and Health Promotion, Division of Diabetes Translation. National diabetes statistics report, 2014. Estimates of diabetes and its burden in the United States. Atlanta, Ga: Centers for Disease Control and Prevention; 2014. Available at: www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf. Accessed June 1, 2016.
- Population estimates. Washington, DC: US Department of Commerce, United States Census Bureau; 2016. Available at: www.census.gov. Accessed June 2016.
- Statistics about diabetes. Alexandria, VA: American Diabetes Association; April 2016. Available at: www.diabetes.org/diabetes-basics/statistics/?loc=db-slabnav. Accessed June 2016.
- Sheehy AM, Gabbay RA. An overview of preoperative glucose evaluation, management, and perioperative impact. *J Diabetes Sci Technol*. 2009;6:1261–1269.
- Diagnosing diabetes and learning about prediabetes. Alexandria, VA: American Diabetes Association; 2014. Available at: <http://www.diabetes.org/are-you-at-risk/prediabetes/>. Accessed June 2016.
- So . . . do i have prediabetes? New York, NY: Ad Council; 2016. Available at: <https://doihaveprediabetes.org/index.html>. Accessed June 2016.
- Vann MA. Perioperative management of ambulatory surgical patients with diabetes mellitus. *Curr Opin Anaesthesiol*. 2009;22:718–724.
- Global report ON DIABETES. Washington, DC: World Health Organization; January 2016. Available at: <http://www.who.int/diabetes/global-report/en/>. Accessed June 2016.
- Roberstshaw HJ, Hall GM. Diabetes mellitus: anaesthetic management. *Anaesthesia*. 2006;61:1187–1190.
- Diabetes pathophysiology. 3D Medical Animation; June 2014. Available at: <https://youtu.be/C9XYnZdEIPE>. Accessed June 2016.
- Hall JE. *Guyton and Hall Textbook of Medical Physiology*. 12th ed. Philadelphia, PA: Saunders Elsevier; 2011.
- Cornelius BW. Diabetes in the ambulatory surgery setting. Presented at the University of Pittsburgh School of Dental Medicine, Department of Dental Anesthesiology; 2015.
- Longnecker DE, Brown DL, Newman MF, Zapol WM. *Anesthesiology*. 2nd ed. New York, NY: McGraw Hill Medical; 2012.
- Cryer PE. Hypoglycemia, functional brain failure, and brain death. *J Clin Invest*. 2007;117:868–870.
- Hemphill RR. Hyperosmolar hyperglycemic state. New York, NY: Medscape; April 2014. Available at: <http://emedicine.medscape.com/article/1914705-overview>. Accessed June 2016.
- Management of common comorbidities of diabetes. Jacksonville, FL: American Association of Clinical Endocrinologists, AACE Diabetes Resource Center; 2016. Available at: <http://outpatient.aace.com/type-2-diabetes/management-of-common-comorbidities-of-diabetes>. Accessed June 2016.
- Saha DC, Choia IS, Plauschinat C, Kwon J, Baron M. Impact of comorbid conditions and race/ethnicity on glycemic control among the US population with type 2 diabetes, 1988–1994 to 1999–2004. *J Diabetes Complicat*. 2010;24(6):382–391.
- Coronary artery disease (cardiac anesthesia). Open Anesthesia; January 2016. Available at: https://www.openanesthesia.org/coronary_artery_disease_cardiac_anesthesia/. Accessed June 2016.
- American Diabetes Association. Standards of medical care in diabetes—2013. *Diabetes Care*. 2013;36:S11–S66.
- UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ*. 1998;317:703–713.
- Plantinga LC, Crews DC, Coresh J, et al. Prevalence of chronic kidney disease in US adults with undiagnosed diabetes or prediabetes. *Clin J Am Soc Nephrol*. 2010;5:673–682.
- Kroon L. Making sense of medications for diabetes [lecture]. San Francisco, CA: University of California, San Francisco, Osher Center for Integrative Medicine; July 2014.
- The NICE-SUGAR Study Investigators. Intensive versus conventional glucose control in critically ill patients. *N Engl J Med*. 2009;360(13):1283–1297.
- Mathioudakis N, Golden SH. A comparison of inpatient glucose management guidelines: implications for patient safety and quality. *Curr Diabetes Rep*. 2015;15:13.
- Cefalu WT. Glycemic targets and cardiovascular disease. *N Engl J Med*. 2008;358(24):2633–2635.
- Joshi GP, Chung F, Vann MA, et al. Society for Ambulatory Anesthesia consensus statement on preoperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Anal*. 2010;11(6):1378–1387.
- Aldam P, Levy N, Hall GM. Perioperative management of diabetic patients: new controversies. *Br J Anaesth*. 2014;113(6):906–909.
- Korpman T. Society of Ambulatory Anesthesia (SAM-BA) on preoperative blood glucose management in diabetic patients undergoing ambulatory surgery; review of the consensus statement and additional commentary. *CSA Bull*. 2010;58–62.

30. Scleredema. Alphen aan den Rijn, the Netherlands: UpToDate; 2015. Available at: <http://www.uptodate.com/contents/scleredema>. Accessed August 2016.

31. Erden V, Basaranoglu G, Delatioglu H, Hamzaoglu NS. Relationship of difficult laryngoscopy to long-term non-insulin-dependent diabetes and hand abnormality detected using the 'prayer sign'. *Br J Anaesth*. 2003;91(1):159–160.

32. Gastroparesis. Alexandria, VA: American Diabetes Association; 2014. Available at: <http://www.diabetes.org/living-with-diabetes/complications/gastroparesis.html>. Accessed August 2016.

33. Gastroparesis: introduction. Baltimore, MD: Johns Hopkins Medicine; 2013. Available at: http://www.hopkinsmedicine.org/gastroenterology_hepatology/_pdfs/esophagus_stomach/gastroparesis.pdf. Accessed August 2016.

34. Vink AI, Maser RE, Mitchell BD, Freeman R. Diabetic autonomic neuropathy. *Diabetes Care*. 2003;26:1553–1579.

35. Liver function. Charlottesville, VA: Johns Hopkins Medicine; 2015. Available at: http://www.hopkinsguides.com/hopkins/view/Johns_Hopkins_Diabetes_Guide/547086/all/Liver_function. Accessed August 2016.

36. Harris EH. Elevated liver function tests in type 2 diabetes. *Clin Diabetes*. 2005;23(3):115–119.

37. Waikar SS, Bonventre JV. Creatinine kinetics and the definition of acute kidney injury. *J Am Soc Nephrol*. 2009;20(3):672–679.

38. Koroshi A. Microalbuminuria, is it so important? *Hippokratia*. 2007;11(3):105–107.

39. Venkat KK. Proteinuria and microalbuminuria in adults: significance, evaluation, and treatment. *South Med J*. 2004;97(10):969–979.

CONTINUING EDUCATION QUESTIONS

This continuing education (CE) program is designed for dentists who desire to advance their understanding of pain and anxiety control in clinical practice. After reading the designated article, the participant should be able to evaluate and utilize the information appropriately in providing patient care.

The American Dental Society of Anesthesiology (ADSA) is accredited by the American Dental Association and Academy of General Dentistry to sponsor CE for dentists and will award CE credit for each article completed. You must answer 3 of the 4 questions correctly to receive credit.

Submit your answers online at www.adsahome.org. Click on “On Demand CE.”

CE questions must be completed within 3 months and prior to the next issue.

1. Which of the following values would be diagnostic of a patient who has prediabetes or “dysglycemia”?
 - A. An oral glucose tolerance test of 300 mg/dL 2 hours after a 75-g oral glucose challenge
 - B. A hemoglobin A1c level of 6.0%
 - C. A fasting plasma glucose test of 89 mg/dL
 - D. A random plasma glucose test of 89 mg/dL
2. Which of the following statements is FALSE?
 - A. HbA1c levels should be lower than 7% before a patient can be scheduled for surgery
 - B. Patients with type 2 diabetes experiencing hyperosmolar hyperglycemic stat can have a blood glucose level greater than 600 mg/dL
 - C. The cornerstone of any effective treatment regimen for type 2 diabetic patients should include healthy eating, weight control, and physical activity
 - D. It is acceptable to use a blood glucose monitor that reads 15% higher than the patient’s actual blood glucose level
3. Which of the following statements is TRUE?
 - A. More than 50% of patients with type 2 diabetes have no other comorbidities
 - B. Less than 50% of patients with type 2 diabetes are either overweight or obese (body mass index $>25 \text{ kg/m}^2$)
 - C. Fifty percent of patients with type 2 diabetes have elevated lipid values
 - D. Liver disease is the leading cause of death in patients with type 2 diabetes
4. What is the cause of cardiovascular autonomic neuropathy in patients with type 2 diabetes?
 - A. Neural hypoxia caused by glycosylation of endoneurial blood vessels
 - B. The formation of bezoars in endoneurial blood vessels
 - C. High levels of irreversibly glycated collagen and ineffective collagenase activity that leads to a buildup of collagen and mucin in the extremities
 - D. Alanine aminotransferase levels greater than 56 U/L or aspartate aminotransferase levels greater than 40 U/L