

Diabetes and oral health

An overview

JONATHAN A. SHIP, D.M.D.

Diabetes mellitus is a syndrome of abnormal carbohydrate, fat and protein metabolism that results in acute and chronic complications due to the absolute or relative lack of insulin. There are three general categories of diabetes: type 1, which results from an absolute insulin deficiency; type 2, which is the result of insulin resistance and an insulin secretory defect; and gestational, a condition of abnormal glucose tolerance during pregnancy.

Diabetes develops in people of all ages, although in greater frequency in African-Americans and Hispanics, and prevalences have increased dramatically over the past several decades. Diagnosis is made on the basis of a host of systemic and oral signs and symptoms, including gingivitis and periodontitis, recurrent oral fungal infections and impaired wound healing.

Safely managing the patient with diabetes requires effective communication among multiple health care providers.

Approximately one-third of adults with diabetes in the United States are undiagnosed, and preventive care among patients with diabetes falls below national health objective standards.¹ Therefore, dental professionals can play an important role in diagnosing and managing patients with dia-

betes. Furthermore, because poorly controlled diabetes leads to significant morbidity and mortality, dentists can counsel their patients with diabetes about improving glucose regulation, maintaining oral and nutritional health, performing daily glucose monitoring

Background. Diabetes is a common disease with concomitant oral manifestations that impact dental care. The purpose of this review is to summarize the prevalence, signs, symptoms, diagnosis and treatment of diabetes, as well as dental treatment considerations for the patient with diabetes.

Conclusions. Safely managing the patient with diabetes requires effective communication among multiple health care providers. Dentists must be familiar with techniques to diagnose, treat and prevent stomatological disorders in patients with diabetes.

Practice Implications. Dental practitioners will be treating more patients with diabetes in the future, and this article provides an overview of the systemic and oral aspects of the disease that impact dental treatment.

tests and seeing medical professionals for routine care.

Owing to the increasing longevity of the American population and the growing prevalence of diabetes, as well as the increased effectiveness of diagnostic and therapeutic protocols, researchers have predicted that dental practitioners will be treating more patients with this disease.²

PREVALENCE AND INCIDENCE OF DIABETES

In 1999, the National Centers for Health Statistics reported that more than 10 million Americans were living with diabetes (distributed among white, black, Hispanic and other racial/ethnic groups³). In 1997, an estimated 124 million people worldwide were living with diabetes.⁴ By the year 2010, the number of people with diabetes worldwide is projected to reach 221 million, and in certain regions of the world (for example, Asia, Africa), diabetes rates could rise twofold or threefold.⁴

People with diabetes have a substantially higher risk of mortality and shorter life expectancy than do those without diabetes.⁵ Diabetes was the sixth most common cause of death in 2001, accounting for more than 71,000 deaths in the United States.⁶ In

1996, nearly 3 percent of the adult population reported experiencing diabetes as a chronic condition, with rates increasing from less than 1 percent in people younger than 18 years of age to greater than 10 percent in adults aged 75 years and older.³

Diabetes has great racial discrepancies. A survey conducted in 1996 found that 8.7 percent of whites aged 65 years and older had diabetes compared with 19.9 percent of blacks,³ and the prevalence of diabetes among Hispanics in the United States is approximately twice the prevalence among non-Hispanic whites.⁷ Blacks aged 45 years and older report higher rates of chronic diabetes-related problems than do their white counterparts (Table). Premature death is a significant problem due to diabetes, and the problem is getting worse with time. In 1999, a nationwide survey estimated that 180 years of potential life were lost per 100,000 Hispanics before the age of 75 years as a result of diabetes, an increase from 134 years of potential life lost per 100,000 Hispanics in 1980.⁸

The burden of diabetes on the health care system is remarkable; in 2000, 23.6 million visits to physicians' offices were for diabetes-related issues.⁹ During the past two decades, the prevalence of diabetes has increased 30 to 40 percent,¹⁰ and the burden of diabetes and its complications are likely to increase as the population grows older.¹¹ Obesity is a major risk factor in the development of diabetes at any age, and the number of overweight children and adolescents in the United States has increased substantially in the past two decades.¹² In summary, diabetes represents a growing medical disorder, with concomitant morbidity and mortality that can affect people of all ages.

SYSTEMIC ASPECTS OF DIABETES

Signs and symptoms. The onset of symptoms is rapid in type 1 diabetes, and includes the classic triad of polyphagia, polydipsia and polyuria, as well as weight loss, irritability, drowsiness and fatigue. Symptoms of type 2 diabetes develop more slowly, and frequently without the classic triad; rather, these patients may be obese and

TABLE

NUMBER OF ADULTS PER 1,000 PERSONS REPORTING HAVING EXPERIENCED CHRONIC DIABETES-RELATED PROBLEMS, 1996.*				
RACE	AGE GROUP (YEARS)			
	Younger Than 45	45-64	65-74	75 and Older
White	7.5	44.7	89.5	85.0
African-American	8.4	149.5	154.7	281.8

* Source: Adams and colleagues.³

may have pruritus, peripheral neuropathy and blurred vision. Opportunistic infections, including oral and vaginal candidiasis, can be present. Adults with long-standing diabetes, especially those with poorly controlled hyperglycemia, may develop microvascular and macrovascular conditions that can produce irreversible damage to the eyes (retinopathy, cataracts), kidneys (nephropathy), nervous system (neuropathy and paresthesias), and heart (accelerated atherosclerosis), as well as recurrent infections and impaired wound healing.

It is less common to encounter a dental patient with acute signs and symptoms of hyperglycemia, although glucose control worsens in the presence of an uncontrolled infection. An insulin-deficient patient with acute hyperglycemia often may have a "fruity" breath. Alternatively, hypoglycemia is more commonly observed owing to an imbalance of glucose intake and use of hypoglycemic agents. Weakness, sweating, mental confusion, incoordination and trembling occur when a person's serum glucose level falls below 50 to 70 milligrams per deciliter, and symptoms become severe (loss of consciousness and convulsions) when levels fall below 40 mg/dL.

Diagnosis. The American Diabetes Association's diagnostic criteria for diabetes require a fasting blood glucose level of 126 mg/dL or greater.¹³ The measurement of glycosylated hemoglobin, or HbA_{1c}, is a good measure of long-term (six to 12 weeks) glucose regulation.¹⁴ For people with diabetes, the goal is to maintain HbA_{1c} levels below 7 percent (normal levels fall between 4 and 6 percent). HbA_{1c} levels above 9 percent reflect poorly controlled diabetes, and indicate the need for aggressive diabetic control.

Treatment. Diabetes is not a curable disease, and therapy has four goals:

BOX**ORAL MANIFESTATIONS OF DIABETES.**

- **Burning Mouth Syndrome**
- **Candidiasis**
- **Dental Caries**
- **Gingivitis**
- **Glossodynia**
- **Lichen Planus**
- **Neurosensory Dysesthesias**
- **Periodontitis**
- **Salivary Dysfunction**
- **Taste Dysfunction**
- **Xerostomia**

- to normalize blood glucose levels;
- to prevent acute complications and eliminate symptoms;
- to maintain ideal body weight;
- to prevent or minimize chronic complications.

Oral hypoglycemic medications depend on functioning pancreatic beta cells to stimulate insulin secretion and, therefore, are used to treat many patients with type 2 diabetes. Insulin is required for patients with type 1 diabetes, as well as for patients with type 2 diabetes who do not respond to dietary therapy alone or in combination with oral hypoglycemic therapy. Diet and physical exercise are a necessary component of therapy for patients with both type 1 and type 2 diabetes.

Dentists should be familiar with the medications used for diabetes; updated lists of common therapies are available.^{15,16} Oral hypoglycemic agents include sulfonylureas (which enhance insulin secretion), biguanides (which reduce hepatic glucose production), alpha-glucosidase inhibitors (which delay glucose adsorption) and thiazolidinediones (which enhance insulin sensitivity). Insulin is available in short-acting (one to 1½ hours), regular-acting (four to six hours), intermediate-acting (eight to 12 hours) and long-acting (24-36 hours) formulations. Insulin pumps provide a continuous burst of insulin to help control serum glucose levels.

Home glucose monitoring is recommended several times daily to help regulate rapid fluxes in

blood sugar levels due to diet, medications and physical and psychological stresses. Many tools are available to help people with diabetes, including home-based urine and blood tests and glucometers. Patients must undergo regular examinations by physicians to monitor triglyceride, fasting glucose and HbA_{1c} levels. Dentists should document their patients' most recent home-based glucose and laboratory test results, and monitor blood pressure levels in the dental office to assist in oral health supervision.

Nutritional supervision is a critical component of diabetes management, and dentists can assist in this endeavor. Risk factors for impaired nutritional intake include gingivitis and periodontitis, oral microbial infections, poorly fitting or lack of removable prostheses, dysphagia and salivary dysfunction. A realistic nutritional plan that includes regular oral hygiene and requisite dental treatment can help patients maintain good blood glucose control and nutritional status.¹⁷

ORAL SIGNS AND SYMPTOMS OF DIABETES

Oral signs and symptoms (Box). *Gingivitis and periodontitis.* Persistent poor glycemic control has been associated with the incidence and progression of diabetes-related complications, including gingivitis, periodontitis and alveolar bone loss^{18,19} (Figures 1 and 2). Nationwide surveys have demonstrated that people with diabetes, especially poorly controlled diabetes, have a significantly higher prevalence of severe periodontitis.²⁰ Several mechanisms have been proposed to explain the increased susceptibility to periodontal diseases, including alterations in host response, subgingival microflora, collagen metabolism, vascularity, gingival crevicular fluid and heredity patterns. Multiple pathophysiological mechanisms (compromised neutrophil function, decreased phagocytosis and leukotaxis) also have been implicated in the increased alveolar bone loss found in patients with diabetes.^{18,21} Furthermore, poorly controlled diabetes, particularly in connection with tobacco use, is a risk factor for periodontal disease.²²

In addition, evidence supports the observation that periodontal infections contribute to problems with glycemic control.²³ For example, adults with diabetes who received ultrasonic scaling and curettage in combination with systemically administered doxycycline therapy demonstrated, at three months, significant reductions in mean

HbA_{1c}, reaching nearly 10 percent from the pre-treatment values.²⁴ The mechanisms for this relationship are undergoing investigation and require validation.²⁵ However, evidence suggests that periodontitis-induced bacteremia will cause elevations in serum proinflammatory cytokines, leading to hyperlipidemia, and ultimately causing an insulin-resistance syndrome and contributing to destruction of pancreatic beta cells.²⁶ Treating chronic periodontal infections is essential for managing diabetes.¹⁹

Dental caries. The relationship between diabetes and dental caries has been investigated, but no clear association has been clarified. It is important to note that patients with diabetes are susceptible to oral sensory, periodontal and salivary disorders, which could increase their risk of developing new and recurrent dental caries. For example, several studies have reported a greater history of dental caries in people with diabetes.^{27,28} Factors for caries development include the traditional elements (for example, *Streptococcus mutans* levels, previous caries experience), as well as poor metabolic control of diabetes,²⁹ underscoring the need for dental professionals to follow up all patients with diabetes on a regular basis for new and recurrent dental decay.

Salivary dysfunction. People with diabetes have been reported to complain of dry mouth, or xerostomia,³⁰ and experience salivary gland dysfunction³¹⁻³³ (Figure 3). A recent study detected impaired salivary uptake and excretion by salivary scintigraphy in adults with type 2 diabetes.³⁴ The cause is unknown, but may be related to polyuria or to alterations in the basement membranes of salivary glands.³⁵ Xerostomic complaints may be due to thirst, a common manifestation of diabetes. Saliva may be useful to diagnose and/or monitor systemic diseases,³⁶ and it may be possible in the future to evaluate glucose levels³⁷ or diabetes-specific autoimmune markers³⁸ from oral fluids, thus eliminating the need for serum blood evaluation for diagnosis and monitoring.

Oral mucosal diseases. Diabetes is associated with a greater likelihood of developing certain oral mucosal disorders.³⁹ There are reports of greater prevalences of lichen planus⁴⁰ (Figure 4) and recurrent aphthous stomatitis,⁴¹ as well as oral fungal infections. While these associations have not been found consistently in all populations of subjects with diabetes,³⁹ they may be due to chronic immunosuppression and require con-



Figure 1. Periodontal abscess in a mandibular right first molar in a patient with type 1 diabetes.



Figure 2. Radiograph of the patient in Figure 1 demonstrating rapid and aggressive periodontitis-associated alveolar bone loss.



Figure 3. Salivary hypofunction, xerostomia and dental caries in a patient with long-standing type 1 diabetes.



Figure 4. Oral reticular lichen planus in a patient with type 2 diabetes.



Figure 5. Oral pseudomembranous candidiasis in a patient with poorly controlled type 1 diabetes.

tinued follow-up by health care practitioners. In patients with type 1 diabetes, chronic immunosuppression most likely is a sequelae of the disease, whereas in patients with type 2 diabetes, acute hyperglycemia causes alterations in immune responsiveness. Oral mucosal disorders represent an opportunity to coordinate diabetes care between physicians and dentists, which can improve the referral of patients to oral health practitioners.⁴²

Oral infections (candidiasis). Another manifestation of diabetes and an oral sign of systemic immunosuppression is the presence of opportunistic infections, such as oral candidiasis. Fungal infections of oral mucosal surfaces and removable prostheses are more commonly found in adults with diabetes (Figure 5). *Candida pseu-*

dohyphae, a cardinal sign of oral *Candida* infection, have been associated significantly with cigarette smoking, use of dentures and poor glycemic control in adults with diabetes.⁴³ Salivary hypofunction also may increase the oral candidal carriage state in adults with diabetes.⁴⁴ The oral health care professional can readily make the diagnosis of oral candidiasis and provide therapy,⁴⁵ but most importantly, he or she should pursue the infection's etiology, which could include a diagnosis of diabetes mellitus.

Taste disturbances. Taste is a critical component of oral health⁴⁶ that is affected adversely in patients with diabetes.⁴⁷ One study reported that more than one-third of adults with diabetes had hypogeusia or diminished taste perception, which could result in hyperphagia and obesity.⁴⁸ This sensory dysfunction can inhibit the ability to maintain a proper diet and can lead to poor glycemic regulation.

Neurosensory and visual disorders. Patients with diabetes have reported increased complaints of glossodynia and/or stomatopyrosis. A common, yet poorly understood, orofacial neurosensory disorder, burning mouth syndrome,⁴⁹ has been associated with diabetes mellitus.⁵⁰ Patients may experience long-lasting oral dysesthesias, which could adversely affect oral hygiene maintenance. Peripheral neuropathies can impair the use of oral hygiene devices, and diabetic retinopathy can produce visual disturbances, ultimately leading to blindness,⁵¹ which, in turn, also could impair daily oral and prosthesis hygiene. Dysphagia, another sequelae of diabetes, is caused by altered strength, speed and/or coordination of the cranial nerve musculature.⁵²

Dental treatment considerations for the patient with diabetes. *Antibiotic coverage.* Patients with poorly controlled diabetes are at risk of developing oral complications because of their susceptibility to infection and sequelae, and likely will require supplemental antibiotic therapy.¹⁵ Anticipation of dentoalveolar surgery (involving mucosa and bone) with antibiotic coverage may help prevent impaired and delayed wound healing. Orofacial infections require close monitoring. Cultures should be performed for acute oral infections, antibiotic therapy initiated and surgical therapies contemplated if appropriate (for example, incision and drainage, extraction, pulpectomy). In cases of poor response to the first antibiotic administered, dentists can select a more effective antibiotic

based on the patient's sensitivity test results.¹⁵

Adjustment of insulin or hypoglycemics. Most forms of dental therapy should not interfere with the medical control of diabetes. However, dento-alveolar surgery, orofacial infections and the stress of dental procedures can increase serum glucose levels and metabolic insulin requirements. Therefore, dentists must consider modifying medical therapy in consultation with the patient's physicians. For example, patients whose condition is controlled with insulin usually will require increased insulin dosages in the presence of an acute oral infection.¹⁵

Medications used by dental professionals may require adjustment of diabetes-associated therapies. For example, large amounts of epinephrine can antagonize the effects of insulin and result in hyperglycemia. Small amounts of systemic corticosteroids can severely worsen glycemic control; patients taking oral hypoglycemic agents who are placed on steroid therapy may require short-term insulin therapy to maintain glycemic control. Alternatively, hypoglycemia can be promoted by aspirin, sulfa antibiotics and antidepressants.

Monitoring glycemic control. Two critical steps are involved in treating patients with diabetes: establishing the diagnosis (type 1 or type 2 diabetes, and the form of therapy) and the level of disease control (well-controlled or poorly controlled). Most commonly, blood glucose or HbA_{1c} levels will be available from the physician's office. Medical updates must be recorded in the dental record at each visit to guide the clinician's treatment decisions. The dentist should be able to use a glucometer to measure blood glucose levels rapidly from a patient's fingertip.⁵³ Finally, the dental office should be equipped with immediate sources of glucose in case a diabetic-induced hypoglycemic event occurs.

One study determined that the risk of infections was directly related to fasting blood glucose levels. Patients with levels below 206 mg/dL had no increased risk, whereas patients with fasting blood glucose levels above 230 mg/dL had an 80 percent increased risk of developing infection.⁵⁴ Therefore, dentists must be familiar with the diabetic status of their patients, and make appropriate accommodations to prevent and treat effectively diabetes-associated oral and systemic disorders.

Communication with physicians. Regular communication with physicians is a critical component of safely treating patients with diabetes.

Communication must be bidirectional: physicians must be apprised of oral manifestations of the disease to help them regulate blood glucose levels, and dentists must be updated on glycemic control to help them maintain a patient's oral health. Treating patients with diabetes also represents an opportunity to expand a dentist's referral base. Physicians who treat children and adults with diabetes could be a good referral source of patients whose oral health care needs may not be satisfied adequately.⁴²

Treatment of oral complications of diabetes. Dentists must be cognizant of the various methods of treating effectively the oral complications of diabetes mellitus.^{15,53} Many treatments are no different from those recommended for patients without diabetes. However, managing patients with diabetes does require more rigorous follow-up, more aggressive interventional therapy rather than observation, regular communication with physicians and greater attention to prevention. Patients with diabetes, particularly those with a history of poor glycemic control and oral infections, require more frequent recall visits and fastidious attention to acute oral infections.

CONCLUSION

Diabetes mellitus affects people of all ages, and its prevalence has been increasing. Providing safe and effective oral medical care for patients with diabetes requires an understanding of the disease and familiarity with its oral manifestations. The goal of therapy is to promote oral health in patients with diabetes, to help prevent and diagnose diabetes in dental patients receiving routine stomatological care and to enhance the quality of life for patients with this incurable disease. ■

Dr. Ship is a professor, Department of Oral Medicine, and director, Bluestone Center for Clinical Research, New York University College of Dentistry, 421 First Ave., 2nd Floor, New York, N.Y. 10010-4086, e-mail "jonathan.ship@nyu.edu". Address reprint requests to Dr. Ship.

1. Levels of diabetes-related preventive-care practices—United States, 1997-1999. *MMWR Morb Mortal Wkly Rep* 2000;49:954-8.
2. Lalla RV, D'Ambrosio JA. Dental management considerations for the patient with diabetes mellitus. *JADA* 2001;132:1425-32.
3. Adams PF, Hendershot GE, Marano MA. Current estimates from the National Health Interview Survey, 1996. Hyattsville, Md.: National Center for Health Statistics, *Vital Health Statistics*; 1999:10(200).
4. Amos AF, McCarty DJ, Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 1997;14(supplement 5):S1-85.
5. Gu K, Cowie CC, Harris MI. Mortality in adults with and without diabetes in a national cohort of the U.S. population, 1971-1993. *Diabetes Care* 1998;21:1138-45.
6. Arias E, Smith BL. Deaths: preliminary data for 2001. *Natl Vital Stat Rep* 2003;51(5):1-44.
7. Self-reported prevalence of diabetes among Hispanics—United

- States, 1994-1997. MMWR Morb Mortal Wkly Rep 1999;48(1):8-12.
8. Pastor PN, Makuc DM, Reuben C, Xia H. Health United States, 2002: Chartbook on trends in the health of Americans. Hyattsville, Md.: National Center for Health Statistics; 2002.
 9. Cherry DK, Woodwell DA. National ambulatory medical care survey: 2000 summary. Adv Data 2002;328:1-32.
 10. Halter JB. Diabetes mellitus. In: Hazzard WR, ed. Principles of geriatric medicine and gerontology. 4th ed. New York: McGraw-Hill; 1999:991-1011.
 11. Geiss LS, Herman WH, Goldschmid MG, et al. Surveillance for diabetes mellitus—United States, 1980-1989. MMWR CDC Surveill Summ 1993;42(2):1-20.
 12. Prevalence of overweight among third- and sixth-grade children—New York City, 1996. MMWR Morb Mortal Wkly Rep 1998;47:980-4.
 13. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care 1997;20:1183-97.
 14. McCance DR, Hanson RL, Charles MA, et al. Comparison of tests for glycated haemoglobin and fasting and two hour plasma glucose concentrations as diagnostic methods for diabetes. Br Med J 1994;308:1323-8.
 15. Little JW, Falace DA, Miller CS, Rhodus NL. Diabetes. In: Little JW, ed. Dental management of the medically compromised patient. 6th ed. St. Louis: Mosby; 2002:248-70.
 16. Robertson C, Drexler AJ, Vernillo AT. Update on diabetes diagnosis and management. JADA 2003;134(supplement):16S-23S.
 17. Stanley K. Assessing the nutritional needs of the geriatric patient with diabetes. Diabetes Educ 1998;24(1):29-30, 35-7.
 18. Taylor GW, Burt BA, Becker MP, Genco RJ, Shlossman M. Glycemic control and alveolar bone loss progression in type 2 diabetes. Ann Periodontol 1998;3(1):30-9.
 19. Grossi S. Treatment of periodontal disease and control of diabetes: an assessment of the evidence and need for future research. Ann Periodontol 2001;6(1):138-45.
 20. Tsai C, Hayes C, Taylor GW. Glycemic control of type 2 diabetes and severe periodontal disease in the US adult population. Community Dent Oral Epidemiol 2002;30:182-92.
 21. Oliver RC, Tervonen T. Diabetes: a risk factor for periodontitis in adults? J Periodontol 1994;65(supplement 5):530-8.
 22. Moore PA, Weyant RJ, Mongelluzzo MB, et al. Type 1 diabetes mellitus and oral health: assessment of periodontal disease. J Periodontol 1999;70:409-17.
 23. Taylor GW. Periodontal treatment and its effects on glycemic control: a review of the evidence. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87:311-6.
 24. Grossi SG, Skrepcinski FB, DeCaro T, et al. Treatment of periodontal disease in diabetics reduces glycated hemoglobin. J Periodontol 1997;68:713-9.
 25. Taylor GW. Bidirectional interrelationships between diabetes and periodontal diseases: an epidemiologic perspective. Ann Periodontol 2001;6(1):99-112.
 26. Iacopino AM. Periodontitis and diabetes interrelationships: role of inflammation. Ann Periodontol 2001;6(1):125-37.
 27. Moore PA, Weyant RJ, Etzel KR, et al. Type 1 diabetes mellitus and oral health: assessment of coronal and root caries. Community Dent Oral Epidemiol 2001;29:183-94.
 28. Lin BP, Taylor GW, Allen DJ, Ship JA. Dental caries in older adults with diabetes mellitus. Spec Care Dent 1999;19(1):8-14.
 29. Twetman S, Johansson I, Birkhed D, Norderfors T. Caries incidence in young type 1 diabetes mellitus patients in relation to metabolic control and caries-associated risk factors. Caries Res 2002;36(1):31-5.
 30. Field EA, Longman LP, Bucknall R, Kaye SB, Higham SM, Edgar WM. The establishment of a xerostomia clinic: a prospective study. Br J Oral Maxillofac Surg 1997;35(2):96-103.
 31. Chavez EM, Borrell LN, Taylor GW, Ship JA. A longitudinal analysis of salivary flow in control subjects and older adults with type 2 diabetes. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91:166-73.
 32. Gilbert GH, Heft MW, Duncan RP. Mouth dryness as reported by older Floridians. Community Dent Oral Epidemiol 1993;21:390-7.
 33. Moore PA, Guggenheimer J, Etzel KR, Weyant RJ, Orchard T. Type 1 diabetes mellitus, xerostomia, and salivary flow rates. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;92:281-91.
 34. Kao CH, Tsai SC, Sun SS. Scintigraphic evidence of poor salivary function in type 2 diabetes. Diabetes Care 2001;24:952-3.
 35. Murrah V, Crosson JT, Sauk JJ. Parotid gland basement membrane variation in diabetes mellitus. J Oral Pathol 1985;14:236-46.
 36. Malamud D. Saliva as a diagnostic fluid. Br Med J 1992;305:207-8.
 37. Belazi MA, Galli-Tsinopoulou A, Drakoulakos D, Fleva A, Papanayiotou PH. Salivary alterations in insulin-dependent diabetes mellitus. Int J Paediatr Dent 1998;8(1):29-33.
 38. Todd AL, Ng WY, Lee YS, Loke KY, Thai AC. Evidence of auto-antibodies to glutamic acid decarboxylase in oral fluid of type 1 diabetic patients. Diabetes Res Clin Pract 2002;57:171-7.
 39. Guggenheimer J, Moore PA, Rossie K, et al. Insulin-dependent diabetes mellitus and oral soft tissue pathologies, part I: prevalence and characteristics of non-candidal lesions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:563-9.
 40. Petrou-Amerikanou C, Markopoulos AK, Belazi M, Karamitsos D, Papanayotou P. Prevalence of oral lichen planus in diabetes mellitus according to the type of diabetes. Oral Dis 1998;4(1):37-40.
 41. Lorini R, Scaramuzza A, Vitali L, et al. Clinical aspects of coeliac disease in children with insulin-dependent diabetes mellitus. J Pediatr Endocrinol Metab 1996;9(supplement 1):101-11.
 42. Levin RP. How treating the patient with diabetes can enhance your practice: recommendations for practice management. JADA 2003;134(supplement):49S-53S.
 43. Guggenheimer J, Moore PA, Rossie K, et al. Insulin-dependent diabetes mellitus and oral soft tissue pathologies, part II: prevalence and characteristics of *Candida* and candidal lesions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;89:570-6.
 44. Kadir T, Pisiriciler R, Akyuz S, Yarat A, Emekli N, Ipbuker A. Mycological and cytological examination of oral candidal carriage in diabetic patients and non-diabetic control subjects: thorough analysis of local aetiological and systemic factors. J Oral Rehabil 2002;29:452-7.
 45. Willis AM, Coulter WA, Fulton CR, Hayes JR, Bell PM, Lamey PJ. The influence of antifungal drugs on virulence properties of *Candida albicans* in patients with diabetes mellitus. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001;91:317-21.
 46. Ship JA, Chavez EM. Special senses: Disorders of taste and smell. In: Silverman S Jr, Eversole LR, Truelove EL, eds. Essentials of oral medicine. Hamilton, Ontario: BC Decker; 2001:277-88.
 47. Settle RG. The chemical senses in diabetes mellitus. In: Getchell TV, ed. Smell and taste in health and disease. New York: Raven Press; 1991:829-43.
 48. Stolbova K, Hahn A, Benes B, Andel M, Treslova L. Gustometry of diabetes mellitus patients and obese patients. Int Tinnitus J 1999;5(2):135-40.
 49. Ship JA, Grushka M, Lipton J, Mott A, Sessle B, Dionne R. Burning mouth syndrome: an update. JADA 1995;126:842-53.
 50. Grushka M, Epstein JB, Gorsky M. Burning mouth syndrome. Am Fam Physician 2002;65:615-20.
 51. Kalina RE. Seeing into the future: vision and aging. West J Med 1997;167:253-7.
 52. Ship JA, Duffy V, Jones JA, Langmore S. Geriatric oral health and its impact on eating. J Am Geriatr Soc 1996;44:456-64.
 53. Vernillo AT. Dental considerations for the treatment of patients with diabetes mellitus. JADA 2003;134(supplement):24S-33S.
 54. Golden SH, Peart-Vigilance C, Kao WH, Brancati FL. Perioperative glycemic control and the risk of infectious complications in a cohort of adults with diabetes. Diabetes Care 1999;22:1408-14.