

C H A P T E R

1 0

Type 2 Diabetes Across the Life Span



Author

Geralyn R. Spollett, MSN, ANP, CDE

Key Concepts

- ♦ Type 2 diabetes, while historically a disease affecting older individuals, is affecting children, teenagers, young and older adults at alarming rates. Each age group has specific problems requiring specific strategies.
 - ♦ Type 2 diabetes is also associated with hypertension, hyperlipidemia, and cardiovascular disease.
 - ♦ Risk factors for developing type 2 diabetes include ethnic background, family history, obesity, and a sedentary life style.
 - ♦ Treatment primarily consists of physical activity, healthy eating, and multiple medications, which present challenges to the diabetes educator, individual with diabetes, and family.
-

Introduction

This chapter examines type 2 diabetes across the life span. Discussion begins with the concept of diabetes as a progressive disease. A case study is used to provide a brief overview of the pathophysiologic deficits and diagnostic criteria for type 2 diabetes. Next, treatment is discussed, using the clinical practice recommendations of the American Diabetes Association (ADA). The basic principles of care are then outlined for 2 age groups with numerous special considerations: elderly adults and children and adolescents. Similarities and differences in approaches to care for each of these age-specific populations are explored. Questions and controversies are highlighted at the end of the chapter.

State of the Problem

Clinical Presentation

Type 2 diabetes is a disease characterized by hyperglycemia. The dual defects of insulin resistance, primarily at the cell receptor sites of muscle tissue, and a progressive decrease in insulin secretory capacity, result in hyperglycemia.¹

The deficiency of pancreatic beta-cell function, which progresses over time, limits insulin production. Without adequate insulin amounts to compensate for insulin resistance, the transportation of glucose from the bloodstream into the cell cannot occur. Insulin resistance and a reduction in insulin production and secretion are

present in varying degrees, depending upon the duration of the disease.

- ♦ *Phase 1:* The natural progression of type 2 diabetes appears to start with insulin resistance and impaired insulin sensitivity, followed by compensatory insulin hypersecretion.
- ♦ *Phase 2:* In the second phase, now referred to as prediabetes, impairment of pancreatic beta-cell secretion of insulin produces an abnormal rise in postmeal and fasting glucose levels.
- ♦ *Phase 3:* In the third phase, overt diabetes appears due to progressive impairment of beta-cell insulin secretion and lack of insulin sensitivity accompanied by increased hepatic glucose production.²

In the third phase, fasting glucose levels are greater than or equal to 126 mg/dL; however, many people with type 2 diabetes are unaware they have the disease since the mild elevations in glucose levels do not produce physical signs and symptoms prompting medical evaluation. Based on the number of persons who have long-term complications at initial presentation, scientists have estimated that diabetes may have been present for 4 to 7 years prior to the clinical diagnosis.³

Unlike the abrupt onset of type 1 diabetes, which presents with the classic symptoms of polyuria, polydipsia, and polyphagia, type 2 diabetes is usually insidious and progresses gradually. The first symptoms may be fatigue, poor wound healing, dry mouth, or other poorly

differentiated symptoms. Alternately, type 2 diabetes that has gone undetected for a period of time can present with many of the overt symptoms usually attributed to type 1 diabetes. This wide range of presenting symptoms reflects the level of insulin resistance and the degree of beta-cell dysfunction at diagnosis.

Incidence and Prevalence

In 2005, the Centers for Disease Control and Prevention (CDC) announced that 20.8 million people, or 7% of the US population, have diabetes. Nearly a third of these Americans are undiagnosed. Of those diagnosed, 85% to 90% have type 2 diabetes.

Generally Increases With Age. In looking at how type 2 diabetes affects the demographic groups, the fastest-growing segment of the population diagnosed with this disease are those aged 65 years and older. Prevalence of diabetes increases with age. The incidence may vary between the sexes from one population to another, but in general men and women are afflicted equally.⁴

Children and Adolescents Now Also a Concern. The National Diabetes Fact Sheet 2005 notes that type 2 in children is still rare but of growing concern.⁵ Although type 2 diabetes typically presents in adults over 30 years old, diagnosis of children with type 2 diabetes, particularly among the high-risk ethnic groups (eg, Hispanics, African American, and Native American) has increased over the past 5 years.

Genetics and Environment are Factors. Genetics and environmental/behavioral factors also play an important role in the development of type 2 diabetes. Chapter 2 on diabetes prevention discusses these aspects more fully.

Diabetes is reaching epidemic proportions throughout the world. The CDC and World Health Organization estimate that by the year 2025, 330 million people will have diabetes, predominantly type 2. The greatest areas of growth are in Asia and Africa, where the shift to more industrialized economies, sedentary lifestyles, and Westernized diets has increased the incidence of type 2 diabetes dramatically.⁴

As this explosion in the number of persons with diabetes reaches epidemic proportions, healthcare economics will be seriously affected. The healthcare system will be straining its capacity to effectively and efficiently diagnose, treat, and educate those affected. Prevention and early detection of diabetes play a significant role in controlling this epidemic (see chapter 2).

Risk Factors for Type 2 Diabetes

Most important risk factors for type 2 diabetes:

- ◆ Heredity, which is nonmodifiable
- ◆ Obesity, which is modifiable
- ◆ Physical inactivity, which is also modifiable

Obesity is the most powerful predictor for the development of type 2 diabetes. In high-risk populations, such as the Pima Indians, members of the at-risk group who are not obese have a lower incidence of diabetes. The interplay of other risk factors, however, such as family history with obesity, can increase incidence.

Summary of risk factors for type 2 diabetes:

The following list summarizes risk factors.⁶ In addition, some public health experts and planners have noted that the economically disadvantaged have increased risk and some groups are targeting public health programs to this group—for example, Healthy People 2010.⁷

- ◆ Age of at least 45 years: The elderly especially have increased risk
- ◆ Overweight (body mass index [BMI] ≥ 25 kg/m²): May not be correct for all ethnic groups; see chapter 2 for more information regarding Asian populations
- ◆ First-degree relative with diabetes
- ◆ Habitual physical inactivity
- ◆ Member of a high-risk ethnic population: African American, Hispanic, Native American, Asian American, Pacific Islander
- ◆ Previously identified prediabetes: impaired glucose tolerance (IGT) or impaired fasting glucose (IFG)
- ◆ History of gestational diabetes mellitus or the delivery of a baby that weighed more than 4.1 kg (9 lb)
- ◆ Hypertension $\geq 140/90$ mm Hg
- ◆ High-density lipoprotein level of up to 35 mg/dL or a triglyceride level of at least 250 mg/dL
- ◆ Polycystic ovarian syndrome
- ◆ History of vascular disease

Diagnosis of Type 2 Diabetes

The American Diabetes Association has outlined 3 options for diagnosing type 2 diabetes.⁸ See Table 10.1 for a summary. Findings should be confirmed by repeat testing on a different day.

TABLE 10.1 Diagnosing Type 2 Diabetes in Adults

3 Options		
Acute Symptoms* Plus Casual† Plasma Glucose ≥200 mg/dL (11.1 mmol/L)	Fasting Plasma Glucose‡ ≥126 mg/dL (7.0 mmol/L)	2-Hour Postload Glucose ≥200 mg/dL (11.1 mmol/L) during oral glucose tolerance test (75-g glucose)§

Note: These results should be confirmed by repeat testing on a different day

*Classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss

†Casual is defined as any time of day without regard to time since last meal

‡Fasting is defined as no caloric intake for at least 8 hours

§The oral glucose tolerance test is not recommended for routine clinical use

Source: Data from the American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2004;27 Suppl 1:S9.

Treatment of Type 2 Diabetes

At diagnosis of type 2 diabetes, the person with diabetes and the healthcare professional work together to create an individually tailored management plan that will focus on the treatment of hyperglycemia present as well as the underlying physiologic deficits. The plan addresses the following:

- ◆ Medical nutrition therapy
- ◆ Physical activity and exercise plan
- ◆ Blood glucose control
- ◆ Reduction of risks for chronic complications
- ◆ Medication as the disease progresses

This multifaceted approach requires that the patient and provider consider a significant range of options. Much of the initial treatment aims to reduce troublesome symptoms such as polyuria and dry mouth and restore physiologic balance.

Lifestyle Interventions

For newly diagnosed patients with diabetes, medical nutrition therapy (MNT) is an essential first step in controlling glucose levels. Increasing physical activity is also important. The case in this chapter exemplifies this; more information on these topics can be found in chapters 13 and 29 (on nutrition) and 14 and 30 (on physical activity).

Reducing Complications

The major cause of death in persons with type 2 diabetes is related to cardiovascular disease. In 2001, an estimated 19% of all deaths for which cardiovascular disease was listed as the primary cause of death were attributed to diabetes. This accounted for 108,000 (58%) of all deaths attributable to diabetes.¹⁰ Both nutrition plans and exercise plans for individuals with type 2 diabetes must incorporate prevention of cardiovascular disease. Reducing saturated

fat, limiting sodium use, encouraging physical fitness and weight reduction when appropriate are all components of a healthy-heart strategy. After the diagnosis of diabetes, screening for hypertension and hypercholesterolemia is appropriate; if these comorbidities are present, aggressive treatment is initiated.

Blood Glucose Control

The following target goals have been established by the ADA to minimize the effects of the disease and its chronic complications:¹¹

- ◆ *Before-meal glucose:* 90 to 130 mg/dL
- ◆ *Bedtime glucose:* 110 to 180 mg/dL
- ◆ *A1C:* below 7%

Studies such as the Diabetes Control and Complications Trial (DCCT)¹² and the UK Prospective Diabetes Study (UKPDS)¹³ demonstrated that maintaining glyce-mic control with an A1C of <7% significantly reduced the microvascular complications associated with diabetes.

Self-Monitoring. Self-monitoring of glucose is an essential component to self-care. Self-monitoring empowers those with diabetes to make needed adjustments in their daily care and gives them the necessary data to evaluate those changes.

Glucose meters for home use are simple to use, requiring only 2 to 3 steps in the procedure. A small sample of capillary blood, which can be taken from a variety of sites, is applied to a testing strip; results are reported in 5 to 45 seconds. Small and portable, meters can use either language

Heart Disease is the Leading Threat

More than half of all deaths attributable to diabetes are due to cardiovascular disease.

Case in Point: An Adult Develops Type 2 Diabetes

EB, a widowed Hispanic woman age 46, noted that in the past year she had had a 15-lb weight gain, recurrent vaginitis, and a tendency to become fatigued after her main meal. She attributed these problems to her stressful life, which included caring for both her ill mother and a new grandchild in her home. Her past medical history was significant for hypertension and dyslipidemia, notably an elevated triglyceride and decreased HDL level. Her social history revealed that she had never smoked and drank red wine approximately 1 to 2 times per month. She had not been sexually active since the death of her husband 3 years prior. During the medical evaluation for urinary tract infection and the subsequent follow-up laboratory testing, the following data were gathered:

- Urine analysis: glycosuria
- BMI: 35
- BP: 130/85 mm Hg
- Skin: marked acanthosis nigricans in folds of neck and axillae
- Fasting glucose: 199 mg/dL and 233 mg/dL

The lab data confirmed the diagnosis of diabetes. EB was upset but not surprised by the diagnosis. Her mother, two sisters and a brother all had type 2 diabetes; she had wondered in the past if she, too, had diabetes. During the course of the visit, EB stated she knew very little about managing diabetes and could not see herself incorporating changes in diet or exercise into her already busy life. She expressed fear at the possible development of blindness and kidney disease and worry that her children will be burdened with her care.

Since coming to the United States from Puerto Rico 4 years ago, EB was learning to speak English, but still preferred to read in Spanish. Her children, particularly her daughter who lived with her, usually assisted in language interpretation at EB's medical appointments.

Discussion

The diagnosis of type 2 diabetes in EB signifies the increased incidence of the disease among certain

ethnic groups, in this case among Hispanic Americans. With a significant family history, EB had a genetic predisposition: 4 first-degree relatives already diagnosed with diabetes. A history of obesity with further weight gain, diminished exercise, and significant life stressors may have been the environmental and behavioral triggers that led to the manifestation of type 2 diabetes. The presence of acanthosis nigricans, a thickening of the stratum corneum that becomes pigmented, was a marker for the presence of insulin resistance. Insulin and IGF-1 receptors were present and respond to high levels of insulin. This hyperinsulinemia promotes keratinocyte proliferation resulting in acanthosis nigricans and/or skin tags.⁹

EB had a significant number of risk factors for diabetes. She was obese with a BMI of 35, and although active, had limited exercise. Her family history was strongly positive for diabetes and her ethnicity further increased risk. EB also had a past medical history of hypertension and elevated lipid values.

In those with underlying pathophysiologic changes indicative of prediabetes, the overt presentation of type 2 diabetes often occurs after an illness or other stressor. In EB's case, she had the physical stress and exhaustion of being a multigenerational caregiver. Determining whether the underlying and as-yet untreated diabetes exacerbated the urinary tract symptoms, which brought her to the clinic, or if the UTI was an initial symptom of the diabetes is difficult. Often, UTI or vaginitis are the presenting symptom in a woman with abnormal glucose levels.

The presence of glucose in the urine indicated that the level of serum glucose had exceeded approximately 180 mg/dL, the level considered the usual adult renal threshold. Urine results are not diagnostic, but heighten the suspicion for the diagnosis of diabetes. Renal threshold is reduced in children and pregnant women and elevated in the aged. Applying the diagnostic criteria (Table 10.1) to EB's lab results shows that her glucose values are indicative of diabetes.

or symbols to prompt the person to perform the next step of the procedure. Most meters now have a memory to store the time, date, and testing results of multiple glucose tests. The person with diabetes tests blood at certain times of the day to assess a response to food intake, medication, and/or exercise. Recording these results creates a diary of diabetes care that can act as a reference to assist in future therapeutic decisions.

A point to consider for the diabetes educator is the psychomotor and cognitive ability of the individual performing the skill of blood glucose monitoring. Even for patients who have experience with a glucose-testing device, these skills must be demonstrated at least once to the diabetes educator. During the evaluation, the diabetes educator assesses the individual's ability to properly calibrate or code the meter, insert strips, obtain the sample, replace the battery, and troubleshoot meter errors.

Pharmacologic Interventions

The pathways to controlling blood glucose levels and achieving the target goals vary for each person with diabetes. Initially, lifestyle modifications may be sufficient, but as the disease progresses, the pathophysiologic changes diminish insulin sensitivity and beta-cell production, requiring medications to reach target goals.

Individualized Plan

The provider must tailor the medication regimen to the individual and adjust it as necessary to maintain glycemic control. During the first few years of type 2 diabetes, the use of oral medications, usually in a multiple drug regimen, are effective in reaching target goals.

Oral medications (discussed in depth in chapter 15) used for the treatment of diabetes address the various pathophysiologic deficits:

<i>Biguanides (metformin):</i>	Reduce hepatic glucose output
<i>Sulfonylureas (glyburide, glipizide):</i>	Improve insulin secretion
<i>Thiazolidinediones (rosiglitazone, pioglitazone):</i>	Increase insulin sensitivity
<i>Meglitinides (repaglinide, nateglinide):</i>	Increase circulating insulin levels but have a shorter duration than the sulfonylureas
<i>Alpha-glucosidase inhibitors (miglitol, acarbose):</i>	Act within the intestinal wall to prevent/delay the breakdown of certain carbohydrates

As diabetes progresses, oral agents may need to be supplemented with additional medications. Injectable exenatide may be added to the regimen, or insulin therapy may be initiated. In addition to the traditional injectable formulation, an inhaled form of insulin was approved by the US Food and Drug Administration in January 2006. (See chapter 15 for more information on medications.) With increasing duration of disease, many people with type 2 diabetes require insulin therapy to remain in a healthy glycemic range. Both the person with diabetes and the healthcare professional need to determine when to add or convert to insulin therapy.

The decision to start an injectable therapy, particularly insulin, can be a difficult one. Fear of needles or injections, myths and fallacies about insulin therapy, concerns about hypoglycemia when using insulin, and alterations in lifestyle due to the use of injectable therapies all can present barriers to initiation of this therapy. (See chapter 4 for more information on anxieties and diabetes-specific fears.) Those who did not adhere to their diabetes regimen may have been threatened with the prospect of insulin therapy, further compounding their reluctance to switch to this therapy when the time is appropriate. Coercion of this type increases fear and resistance to using this safe and effective drug.

There are many different types of insulin and various delivery devices. Patient education is a critical component of management of type 2 diabetes with insulin therapy. Not only must the individual with diabetes and ancillary caregivers understand how to administer the insulin; they must also learn about the type, timing, and action of insulin. Chapters 15 and 31 provide detailed information.

Type 2 Diabetes in Older Adults

Undiagnosed and untreated diabetes is more common in older adults than in any other age group. Approximately 20.9% of all people age 60 or older have diabetes.⁵ Those age 65 and older account for almost 50% of the population with diabetes.⁵ In 2004, the prevalence of diagnosed diabetes among people aged 65 to 74 years (16.7%) was approximately 12 times that of people less than 45 years of age (1.4%).¹⁴ The risk of developing diabetes increases with age, but diminishes after the age of 80.

Screening and Diagnosis of Older Adults

Diagnostic criteria for diabetes do not alter or become less stringent for older adults. The same set of criteria is applied to the nonpregnant adult regardless of age (only in the case of pregnancy do guidelines for screening and diagnosing

Case—Part 2: Implementing the Adult's Treatment Plan

Although EB had stated her reservations about attempting lifestyle changes, the individualized approach to nutrition, presented in a step-wise manner, addressed these concerns and endeavors so that the necessary adjustment could be made.

Nutrition Plan

MNT involves a thorough assessment of the person's current lifestyle, eating patterns, ethnic, and cultural or traditional food preferences as well as nutritional requirements for stages of growth and development. MNT also incorporates nutritional changes necessary to prevent or treat other health conditions, such as dyslipidemia or osteoporosis. For EB, her nutrition plan would incorporate the following key elements:

- She could eat the Hispanic foods she loved, but was encouraged to limit portion sizes where appropriate to enhance weight loss
- During early phases of treatment, reduction of carbohydrates such as juices and concentrated sweets would be emphasized to lower the glycemic load, which would help reduce insulin resistance from glucose toxicity

Physical Activity Plan

EB's life was very active, but she was doing little to improve her cardiovascular system or to increase her metabolism to burn calories and contribute to weight loss. An increase in aerobic exercise would address both of these concerns. In addition, weight loss and exercise might improve her lipid values—raising HDL and lowering triglycerides. Exercise would also provide a healthy outlet for the stress EB experienced in her role as caregiver. Although beginning an exercise program can be daunting, most patients find a walking program an easy and effective way to increase aerobic activity. Planning brief 10- to 15-minute periods of time to walk throughout the day helps improve insulin sensitivity, reduce weight, and improve cardiovascular fitness.

Blood Glucose Control

A significant part of EB's treatment plan focused on obtaining and maintaining blood glucose ranges in accordance with target goals established by the ADA. The role of maintaining glycemic control in reducing microvascular complications was an important and empowering message for EB, who feared blindness and renal disease.

Monitoring. To monitor changes in blood glucose levels and the response to treatment, EB needed to learn to check her glucose at home. Self-monitoring of glucose is an essential component to self-care. It empowers the patient to make needed adjustments in their daily care and gives them the necessary data to evaluate those changes. EB had been checking her mother's glucose level at home sporadically. She had never self-tested. She told the diabetes educator she felt confident using the brand of meter she had used for her mother and did not feel the need for further instructions. EB demonstrated proper techniques in the use of her glucose meter and agreed to test before breakfast and again before supper. She was given an instruction sheet written in Spanish that delineated the steps needed to periodically check the accuracy of the meter, including the help-line number for the meter manufacturer.

Medication

EB needed not only MNT, but also medication because she was symptomatic. She was started on metformin (Glucophage). She received all written instructions and material in both Spanish and English. During the appointment, her daughter had been helpful in translating certain difficult English words to Spanish for EB; however, once EB was at home, she would need to be able to read and formulate her own questions regarding her therapy.

After receiving a prescription to treat the UTI, a sample of metformin, and instructions to increase her fluid intake while on the antibiotics, EB was scheduled for an appointment for follow-up care in 1 week, at which time she would bring her glucose test results diary for discussion and participate in further dietary instruction.

gestational diabetes change, relying on an oral glucose tolerance test to determine the diabetes state).

Older adults should be screened annually for diabetes. Although measuring fasting plasma glucose increases detection of diabetes in the young, this test may actually miss 31% of cases in older adults.¹⁵

Recommended screening method for older adults:

For older adults, a 2-hour oral glucose tolerance test may better reveal the presence of diabetes than measuring plasma glucose increases.

Clinical Presentation

As in the younger adult population, type 2 is the most common type of diabetes in older adults. Older adults with diabetes rarely present with the typical symptoms of hyperglycemia.¹⁶ Physiologic changes associated with aging may diminish thirst and increase dehydration. Glycosuria at the usual levels may not be seen because of the advance in renal threshold associated with aging.

Older, Lean Patients. Lean older adults may exhibit signs of autoimmune changes like that usually seen in type 1. Latent autoimmune diabetes of adults (LADA) does occur, presenting in older adults who are not obese. Often, this presentation creates a confusing clinical picture of acute hyperglycemia because this population normally is diagnosed with type 2 diabetes. To be well controlled, LADA requires insulin treatment to preserve beta-cell function and promote euglycemia. Although the rates of occurrence are small, the healthcare professional must be aware of the possibility of this diagnosis in older lean patients. A laboratory blood test to measure antigitamic acid decarboxylase (anti-GAD) or islet cell antibodies (ICAs) can confirm the autoimmune state and improve treatment of the person with LADA.¹⁷

Other Presentations. Others may present with glucose elevations due to an acute illness, a transient medical condition, or the introduction of a certain medication (steroids, antihypertensives, cardiac medications). This increase in plasma glucose levels may be a clue to previously

Care With Older Adults

Interventions must carefully consider nutrition and exercise limitations and medication side effects pertinent to the older adult's situation.

undiagnosed diabetes, IGT, or IFG and present an opportunity for further assessment and treatment.

Considerations Regarding Older Adults

Older adults are a heterogeneous group; some may be active and functional, providing their own self-care, while others may suffer from multiple comorbidities and require assistance or total care. The following factors must be carefully considered in planning education and care for the unique needs of individuals in this age group:

- ◆ Medical complications
- ◆ Physical limitations
- ◆ Other prescribed medications
- ◆ Effects of aging
- ◆ Greater risk of hypoglycemia

Complications

Older persons with type 2 may have a long duration of diabetes with an increase in complications, both macrovascular and microvascular. The UKPDS showed that macrovascular complications of diabetes are 1.5 to 2 times more prevalent in the older diabetic populations than in the nondiabetic population.¹⁸ Based on diabetes mortality and morbidity rates collected from Medicare claims data on the elderly population in the United States, the following conclusions have been drawn:¹⁹

- ◆ Leading causes of morbidity are ischemic heart disease and stroke
- ◆ Gangrene, amputation, and lower extremity infection make up the next cohort of diseases associated with morbidity
- ◆ Acute complications (hypoglycemia, ketoacidosis, hyperosmolar syndrome) comprise the last group

Physical Limitations

Older adults with diabetes are about 1.5 times more likely to have physical limitations and alterations in the activities of daily living than those without diabetes.²⁰ Disabilities may be directly linked to eye disease, strokes, cardiovascular disease, neuropathies, and peripheral vascular disease. Older persons with diabetes may also respond more symptomatically to both hyperglycemia and hypoglycemia. Coupled with additional comorbidities, the long tenure of diabetes may contribute to frailty. Physical limitations necessitate adjustment in management goals and interventions.

Polypharmacy

Older adults with diabetes may also be on multiple medications for a variety of ailments. This can lead not only to dosing and timing errors, but also the heightened possibility

of drug interactions. The healthcare professional must use caution when prescribing certain diabetes medications for older adults.

Cautions with diabetes medication in older adults:²¹

- ◆ *Metformin.* In patients >80 years of age, evaluate renal function with creatinine clearance; if <60 mg/dL, do not administer drug. Serum creatinine is a poor correlate of renal health because of the low muscle mass characteristic of the elderly person.
- ◆ *Thiazolidinediones.* Contraindicated in Class 3 and 4 congestive heart failure (CHF); avoid if CHF is present, determine benefit versus risk.
- ◆ *Sulfonylureas.* Beware of long half-life and propensity for hypoglycemia; caution in liver and renal dysfunction.
- ◆ *Insulin.* Risk of severe hypoglycemia increases with age.

Aging

Physiologic changes in aging affect signs and symptoms associated with diabetes and its complications. Below are facets of normal aging that can significantly impact diabetes care:

- ◆ Diminished taste and olfactory sense
- ◆ Reduced metabolic rate that alters digestion
- ◆ Decreased renal clearance
- ◆ Altered pain perception

Higher Risk for Hypoglycemia

Slowed counterregulation of hormones, erratic food intake, certain medications (beta-blockers), and slowed intestinal absorption place the older adult at higher risk for hypoglycemia. The adrenergic response to low blood glucose levels may be diminished or absent. Instead, the initial symptoms, such as lack of motor skills or confusion, represent a neuroglycopenia that may be misdiagnosed or pose a safety risk to the individual.

In light of all of the changes in the older adult's health, close attention must be paid to nutrition and exercise interventions and medication side effects. The healthcare professional must keep in mind the individual's preferences and physiologic alterations.

Factors Influencing Education Strategies

For those with diabetes who are still hardy, diabetes self-care and management goals must reflect their capabilities. Despite the fact that age can affect the processing of information, the capacity to learn and integrate new information remains intact throughout the life cycle. In the

educational process, accommodations should especially be made for the following:

- ◆ Hearing changes
- ◆ Visual changes
- ◆ Cognitive status

Paced Learning and Feedback. As with all adult learners, older persons with diabetes benefit from a step-wise approach to education that recognizes their past experience and builds upon it. In addition, several studies have demonstrated that some older adults with type 2 diabetes may experience some mental slowing that affects the ability to perform diabetes self-care behaviors.^{22,23} The diabetes educator must assess older patients for comprehension and memory through both verbal and skill feedback.

Equipment Difficulties. Self-care devices that require technical skill and manipulation, such as those for self-monitoring of glucose and insulin administration, have become much easier for the older adult with diabetes to use.

- ◆ Glucose meters have larger display screens, audible beeping prompts, reduced sample size, and ergonomically designed easy-to-grip bodies to facilitate ease of use. Some meters have test strips in drums or cartridges that are easier for arthritic hands to maneuver.
- ◆ *Insulin administration.* Insulin pens have made self-administration of insulin safer for the older person with diabetes. Since it is easier to read dosage marks on insulin pens than on syringes, accuracy of dosing is increased. These devices reduce dosage errors and do not require the manual dexterity of the vial and syringe method. The advantages and disadvantages of inhaled insulin delivery may also be considered as products in this category become available.

Since some third party payors do not routinely reimburse for some of these devices, the diabetes educator must endeavor to educate third party payors regarding the need for these devices and to advocate on behalf of the patient.

Other Barriers. In an older, retired population, financial concerns, insurance issues, and transportation difficulties can become staggering problems, confounding the delivery of health care and health maintenance. For the person with type 2 diabetes, expenses can be a concern—both the expense of medication for diabetes and its comorbidities and the cost of coverage for multiple medical visits plus podiatric, dental, and eye care. The healthcare provider must be aware of these issues and seek to ameliorate them whenever possible. For example, prescribing medications that are preferred and offer maximal reimbursement or coverage whenever possible reduces the financial burden of the person with diabetes.

Institutional Settings. Many older adults live in long-term care facilities; a large proportion of them have diabetes. In addition to all of the usual therapeutic considerations for type 2 diabetes, in this population, skin care takes on heightened importance—so that infections, ulcerations, and amputations can be avoided. Reduced circulation, neurological impairment, diminished range of motion, and compromised nutritional status contribute to the fragility of the skin. People with diabetes who are no longer capable of self-care depend on healthcare providers to develop effective care strategies to maintain glycemic control and prevent or reduce health-altering consequences. The diabetes educator can help establish strategies to ensure the following:

- ◆ Glucose levels are appropriately monitored and acted upon
- ◆ Acute complications of hypoglycemia and hyperglycemia are avoided when possible and treated if present
- ◆ Insulin and other diabetes medications are given accurately and in a timely manner; other medications are checked for potential negative interactions
- ◆ Nutrition intervention supplies sufficient calories and is delivered in a manner that best suits the patient's needs and preferences
- ◆ Skin and foot care become an integral part of the daily care regimen to promote circulation and avoid breakdown

Type 2 Diabetes in Children and Adolescents

Type 2 represents 8% to 45% of all diabetes reported among children and adolescents.²⁴ Of this group, 94% belonged to minority groups.

Diagnosis of Type 2 Diabetes in Children and Teens

Risk Factors

Type 2 diabetes in children and adolescents has increased as the frequency of obesity has risen in the United States. At diagnosis, 85% of children with type 2 diabetes are overweight or obese.²⁵ Nearly all children diagnosed have a positive family history of type 2 diabetes, with 74% to 100% having a first- or second-degree relative with type 2 diabetes and 45% to 80% having a parent with diabetes. Many of these children are of non-European descent (eg, African American, Hispanic, and Native American).

Clinical Presentation

In general, children and adolescents diagnosed with type 2 diabetes have glycosuria without ketonuria, mild thirst, some increase in urination, and little-to-no weight loss; however, up to 33% will have ketonuria at diagnosis, with 5% to 25% having ketoacidosis unrelated to stress, illness, or infection.²⁵ Polycystic ovarian syndrome (PCOS) and acanthosis nigricans, disorders associated with insulin resistance, are commonly seen²⁴ as well as lipid disorders and hypertension. There are ethnic differences in lipids, lipoproteins, and blood pressure with further indications of the metabolic syndrome in this high-risk population.

At times, the clinical picture of the child with diabetes can be confusing, making it difficult to differentiate type 1 from type 2 without laboratory studies. A variation on the presentation of type 2 diabetes occurs in children with a positive family history of early-onset diabetes. Although the child presents in diabetic ketoacidosis, which is usually seen in type 1 diabetes, the antibody tests are negative (both anti-GAD and ICA), and insulin is not required once the acute episode is resolved. These children have elevated C-peptide levels, which indicates a hyperinsulinemia as opposed to reduced insulin levels found in type 1 diabetes. Many of these children are of African American descent.

Due to the difficulty in establishing the type of diabetes in children by presentation alone, in an ideal situation type 1 diabetes would be confirmed by a test for autoantibodies, while type 2 diabetes would use a test for insulin resistance such as the fasting C-peptide.²⁶

Insulin Resistance. The pattern for development of type 2 diabetes in children appears to follow the insidious pathway seen in adult type 2. Insulin levels may be normal or elevated, but first-phase insulin release is not sufficient to compensate for insulin resistance, which leads to hyperglycemia. Just as in adults with type 2 diabetes, obesity and a lack of physical activity promote overt diabetes. Both of these lifestyle factors promote insulin resistance. The onset of type 2 frequently occurs around the time of puberty, a time when insulin sensitivity declines. This evidence further supports the importance of insulin resistance in the pathogenesis of the disease.

Intrauterine Environment. The intrauterine environment, specifically birth weight and maternal hyperglycemia, may have possible links to type 2 diabetes in children. Low birth weight predicts type 2 diabetes in middle age.²⁷ Low birth weight has also been associated with the development of diabetes in teens and adolescents. Higher levels of amniotic fluid insulin at 33 to 38 weeks' gestation were a strong predictor of later IGT.²⁸ Children born to mothers with gestational diabetes also appear to have a higher risk of developing type 2 diabetes.²⁹

Diagnostic Criteria

With the current explosion in the number of new cases of diabetes and the importance of screening, controversies concerning the criteria and the most effective testing method for screening for diabetes, particularly type 2 in children, abound. At present, the same diagnostic criteria are applied to children; however, whether these established cut-points are valid in a younger population is not known.

Public Health Interventions. The advent of type 2 diabetes in children and adolescents carries with it a significant public health problem. The onset of the disease in younger populations leads to earlier onset of complications, both macrovascular and microvascular. The estimated financial costs and loss of productivity resulting from these health problems represent a significant economic burden. Earlier diagnosis and aggressive treatment may help in preventing or delaying these costly complications, making a strong case for screening. In 2000, the ADA outlined recommendations for testing children at substantial risk for type 2 diabetes. See Table 10.2.

TABLE 10.2 Diagnosing Type 2 Diabetes in Children

<p><i>Criteria for Considering Screening for Diabetes*</i> Overweight (BMI 85th percentile for age and sex, weight for height 85th percentile, or weight 120% of ideal for height)</p> <p>Plus any 2 of the following risk factors:</p> <ul style="list-style-type: none"> • Family history of type 2 diabetes in first- or second-degree relative • Race/ethnicity (American Indian, African American, Hispanic, Asian/Pacific Islander) • Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, PCOS) <p><i>Age of Initiation:</i> Age 10, or at onset of puberty if puberty occurs at a younger age</p> <p><i>Frequency:</i> Every 2 years</p> <p><i>Test:</i> Fasting plasma glucose preferred</p>

*Clinical judgment should be used to test for diabetes in high-risk subjects who do not meet these criteria.

Source: Data from the American Diabetes Association. Type 2 diabetes in children and adolescents (consensus statement). *Diabetes Care*. 2000;23(3):381-9.

Considerations Regarding Children and Teens

Once a child or adolescent learns he or she has type 2 diabetes, the approach to care must incorporate the youth's developmental needs and psychosocial concerns. Since many of the children and teens diagnosed with type 2 diabetes are overweight or obese, they have already faced issues that may separate them from their peers. Personal appearance (issues of both style and size), participating in competitive athletics, and congregating at fast-food restaurants or malls are often integral aspects of growing up in the United States. Adjustments in lifestyle that help reduce weight and control diabetes can seem to run counter to the norm and become problematic. Striving for independence and developing a sense of self are important developmental tasks that are made more difficult in the presence of diabetes. While parental support and guidance are a necessary part of dealing with a medical condition such as diabetes, at this time of life, the adolescent desires less parental involvement.

For adolescents and children with type 2 diabetes, the goals of therapy are the same as for any person with diabetes:

- ◆ To achieve physical and psychological well-being while maintaining long-term glycemic control and to avoid microvascular and macrovascular complications

Lifestyle Interventions

Medical nutrition therapy and increased physical activity are the cornerstone of therapy for all age groups; however, weight management in children and adolescents must take into consideration health growth and development needs. Thus, aggressive weight-loss programs are not recommended for these age groups. The approach must be one of substitution and reduction, rather than elimination. The following are important dietary adjustments that still leave room for the adolescent lifestyle:

- ◆ Learning to make healthy choices at fast-food restaurants
- ◆ Reducing fatty, calorie-dense foods
- ◆ Drinking less sugary beverages
- ◆ Choosing healthy snacks

Obese youths may lack the stamina and athletic prowess to compete in sports. Therefore, physical activities can be a source of self-degradation and ridicule by peers and can contribute to low self-esteem. In the treatment of type 2 diabetes, physical activity lowers insulin resistance and helps maintain weight loss. The challenge is to make this important therapy agreeable to an audience that usually eschews it.

Rather than focusing on competitive activities, the child needs encouragement to improve fitness through individual activities such as roller-blading, biking, or

dancing.³⁰ Reducing television and computer time and substituting any type of physical movement has benefits. See the list of Web sites with information to help counter childhood obesity at the end of chapter 30.

Pharmacologic Interventions

Many children with type 2 diabetes will require medication in addition to lifestyle modification to achieve glucose goals. Some will need medication at diagnosis. Currently, the US Food and Drug Administration (FDA) approves 2 pharmacologic agents for use in children and adolescents:

- ◆ Metformin (an oral agent)
- ◆ Insulin (injectable formulations)

A third class of medications, the thiazolidinediones, is being investigated for safety and efficacy in this population.

Metformin. The oral agent metformin (Glucophage), a biguanide, has been approved for use in children 10 to 16 years of age with type 2 diabetes. In controlled trials in subjects ages 8 to 16 years with type 2 diabetes, metformin significantly decreased fasting plasma glucose and A1C levels when compared to placebo.³¹ The drug has 2 common adverse effects:

- ◆ Diarrhea
- ◆ Nausea

To minimize adverse effects, metformin should be taken with food and the dosage titrated slowly, starting with one 500-mg tablet per day until the effective dosage is achieved. The extended-release preparation of metformin may lessen or minimize the adverse effects. For children, the maximum dosage of metformin is 2000 mg (in adults it is 2550 mg).

In girls with type 2 diabetes and PCOS, use of metformin may normalize ovulatory abnormalities and increase the risk of unplanned pregnancy; therefore, girls of childbearing age using this therapy should be counseled regarding this risk.²⁴ See also the section on teens in chapter 11, on pregnancy with preexisting diabetes.

Insulin. Insulin therapy has a long history of usage in the pediatric population. Healthcare professionals prescribe insulin for children, whether type 1 or type 2, who present with diabetic ketoacidosis, hyperosmolar hyperglycemic state, moderate ketosis, or symptomatic glycemic levels. The need for insulin in the hyperglycemic state complicated by insulin resistance may persist for weeks after diagnosis. However, once glycemic levels decrease and

lifestyle measures are in place, some children are able to maintain euglycemic levels with metformin.

Insulin therapy should be used if oral agents are not effective or when the disease worsens and clinical goals are no longer met with oral agents alone. Insulin can be used as monotherapy or in combination with metformin.

Some children have been able to meet target goals with 1 injection of a long-acting insulin per day, such as insulin glargine, while others have needed multiple daily injections (MDI) using a basal-bolus regimen. Insulin therapy must be tailored to the physical as well as psychosocial needs of the person with diabetes. Despite the flexibility of an MDI regimen, adolescents may at times feel encumbered by it and switch to prefilled mixed insulin pens to maximize convenience and have a respite from the demands of self-care.³⁰ In the presence of insulin resistance in type 2 diabetes, larger amounts of insulin are necessary to adequately control glycemic levels. This is also true in children and particularly adolescents who have type 2 diabetes. During puberty and growth spurts, insulin resistance increases, necessitating compensatory dosing of insulin. Irrespective of ethnicity, insulin sensitivity is reduced while fasting levels are increased in both obese and nonobese children during Tanner stages II through IV of pubertal development.³²

Other Medications. Sulfonylureas, glucosidase inhibitors, and meglitinides may be effective in treating type 2 diabetes in children, but more research must be conducted to determine the risks of using these drugs in this population. In particular, researchers must explore whether insulin secretagogues such as sulfonylureas, accelerate beta-cell demise in this group, especially in the presence of autoimmunity.³³ Inhaled insulin has been approved for adults in some instances (see chapter 15), but has not been approved for children.

Social Support

No matter the therapy selected, patient education and family support are vital components of diabetes management in children and teens. Ideally, a diabetes care team will be able to assess, treat, evaluate, and support the youth and family during the initial stages of the disease. Not all communities have access to such services. In many cases, school counselors and nurses, coaches, teachers, family friends, and peers can assist in providing information, supporting dietary changes, encouraging physical activity, and becoming a sounding board for the frustrations and concerns of the young person with diabetes.

Self-Care Behaviors

The self-care behaviors described in the AADE 7 Self Care Behaviors™ are applicable throughout the life span for those with type 2 diabetes. Each behavior is critical in attaining self-sufficiency in the management of diabetes. However, each behavior must be modified to incorporate the particular developmental needs of the person with diabetes to reflect the individual's physical capabilities and self-care responsibilities. Strategies pertinent to each behavior are covered more fully in the chapters in section 3 of this book.

Being Active

All persons with type 2 diabetes need to maintain a program of physical fitness, the definition of which will vary according to age and ability. Motivation for exercise, creating a program that is sustainable, and integrating it into daily routine may be quite different for a child compared to a nursing home resident, yet for both exercise is an integral factor in reducing insulin resistance and improving cardiovascular health.

Healthy Eating

Nutritional management skills such as knowing how, when, and how much to eat are the basis of self-care in diabetes. Modifications for age, caloric requirements, and activity level individualize this therapy.

Adults and Older Adults. Adults with diabetes must learn to replace harmful dietary habits with healthy ones. Selecting nutritious foods that are easier to chew and digest that are also appetizing and healthy may pose a problem for some older adults. The elderly adult may also experience social isolation and a reduction in appetite. Financial limitations can also affect healthy eating behaviors.

Teens. Learning how to cope with the typical diet of their peers while maintaining glycemic control is a daunting task for teens. Alcohol consumption and eating disorders, particularly overeating, may also prove a threat (see chapter 4).

Taking Medication

Polypharmacy in adults and older persons with diabetes can create problems in accuracy and adherence. Issues of vision and manual dexterity complicate this task. For children, medications can be dispensed by a responsible adult or taken under supervision. Despite this, the child needs an age-appropriate understanding of the importance of the

medication regimen and the ability to recognize and treat possible side effects such as hypoglycemia.

Monitoring

Learning to accurately monitor glucose levels is a basic skill that is integral to self-managing diabetes, regardless of age. The young and the old both experience lifestyle changes that can radically alter glucose levels. In such cases, self-monitoring of blood glucose is an important safety tool for avoiding critical low or high levels.

Problem Solving

Understanding glucose data or interpreting signs and symptoms of acute complications and being able to make appropriate therapeutic adjustments are complex skills that require education and mentoring. Caregivers for those who are home-bound or in nursing facilities may assume this task when the person with diabetes is unable to make these decisions alone. In these situations, diabetes health-care professionals need to educate and support ancillary care providers to ensure that standards of diabetes care are upheld.

Reducing Risks

For the young, much of self-care education focuses on improving glycemic control to prevent future complications. Risk reduction for cardiovascular disease is of paramount importance in obese, type 2 children. Smoking abstinence or cessation and control of lipids and blood pressure are also important in reducing risk. Diabetes educators have the task of informing communities of the lifestyle modifications necessary to prevent and treat diabetes in youth. For older persons with diabetes, vigilance and screening for complications is also important to delay or prevent complications. Eye exams, prophylactic foot care, flu and pneumonia vaccines, and dental care all help to maintain functional status among elderly adults.

Healthy Coping

Psychosocial adaptations are required. Living with a chronic disease requires support, creative coping skills, and a certain hardiness. Remaining motivated in the face of a somewhat capricious disease such as diabetes can be very difficult.

The life stressors present for young and old add considerable burden, and it is not uncommon for persons with diabetes to become depressed. Healthcare providers must help patients learn a variety of coping skills to meet the challenges of life with diabetes and be ready to appropriately screen and treat depression. Chapters 4 and 34 provide more information on depression.

Questions and Controversies

Limited Experience With Children and Teens

The increased incidence of type 2 diabetes in children and adolescents has sparked a number of questions with regard to the following:

- ◆ Criteria for screening and diagnosis
- ◆ Best screening methods
- ◆ Best treatment options

The lessons learned in type 2 diabetes and best-practice scenarios may not be applicable to the younger populations. Many questions remain to be answered through research.

Safe Blood Glucose Targets

The American College of Endocrinologists has recommended lower target levels for diabetes control, specifically these: A1C levels $\leq 6.5\%$, fasting and premeal glucose values of <110 mg/dL, and postprandial glucose values of <140 mg/dL.³⁴ The important issue is, however, safety; these targets must be individualized. In the older adult with a long duration of diabetes and comorbidities, setting less-intensive glycemic goals is

reasonable.³⁵ There is no research that A1C values $<7\%$ are beneficial in the very elderly over 80 years of age.

In children with type 2 diabetes, who face increased risks of vascular complications related to the potentially long duration of diabetes, goals for control are normal fasting blood glucose values, which are defined as <126 mg/dL and A1C $<7\%$.³⁶

Obesity Prevention

Obesity is the most prevalent risk factor for type 2 diabetes and yet no long-term effective strategies are in place to prevent or reduce the incidence of obesity in children or adults.

Older Adults: Frail vs. Functional

Although there is a decline in function with age that can be more severe in people with diabetes, too often diabetes therapy in this population fails to meet target goals. While important to acknowledge that the frail elderly may need more relaxed glucose goals, the functional elderly must be treated to the standard of care.

Summary

Type 2 diabetes is a major problem affecting all ages. With the incidence and prevalence of this disease rising to epidemic proportions, the healthcare professional must address the factors that contribute to development of diabetes as well as those that contribute to the development of diabetic complications. Obesity, genes, and family history are the prime risk factors; however, attention to interpersonal, intrapersonal, community, and societal issues can help promote healthy lifestyles for those with diabetes.

- ◆ To prevent type 2 diabetes, interventions at the individual, family, and community levels are crucial to reduce the levels of obesity in Western society.

- ◆ Important steps to improve diabetes care include these: community awareness of lifestyle modifications necessary to reduce risk, appropriate screening for diabetes among those at highest risk, and promotion and adherence to diabetes standards of care.
- ◆ To be effective, education and medical management must be tailored to the individual, taking into consideration age, socioeconomic status, and cultural and religious affiliations.

By recognizing the needs of individuals with type 2 diabetes throughout the life span, the health professional is better prepared to offer appropriate treatment and guidance.

Focus on Education: Pearls for Practice

Teaching Strategies

- **Be sensitive to issues of age and culture.** Type 2 and LADA affect a wide range of age groups. Give simple, clear information and messages, in a step-wise approach. Tailor content to the age group. Seek out questions that need to be answered first. Establish rapport, then begin to offer information and handouts.
- **Create a milieu.** Think about a wide range of ages, previous experience with diabetes in the family or with friends, and how to deliver content with more than a single approach. For example, teens and adults who drink soft drinks benefit from actually measuring teaspoons of sugar found in a “real” soft drink. This gives a visual of calorie and glycemic value of a commonly used beverage. Adults and teens also respond to seeing test tubes filled with fat that equal the fat in food products such as hamburger, steak, and chicken.
- **Identify polypharmacy problems.** Polypharmacy may be a problem, particularly in older adults. Routinely review all medications the person is taking, including over-the-counter products and dietary supplements. Discuss use and misuse (for example, use in combination with other medicines and street drugs).
- **Recognize psychological concerns.** Changes in self-esteem, for example, are a concern to all age groups. Accepting diabetes as a chronic disease may be especially difficult for younger individuals, but belief in the chronicity and care needed is of concern to all age groups. As an elderly person’s medical and mental status changes, the person may be placed at risk for adverse events. Family involvement is advised for support.

Messages for Patients

- **Screening visits protect health longer.** Schedule health visits for screening and then schedule follow-up appointments without delay. Doing so helps individuals with diabetes know what they are most at risk for, helps avoid and delay complications related to having diabetes, and improves the chances for effective treatment.
 - **Physical activity helps at every age.** All age groups engage in fitness. Although competitive sports may be culturally encouraged, fitness and endurance are true primary focus. Walking and workout programs are examples.
 - **Involve family.** Involving family and/or significant others at all levels of education from basic information to participation in exercise is encouraged.
-

References

- American Diabetes Association. Standards of medical care in diabetes (position statement). *Diabetes Care*. 2006;29 Suppl 1: S4-42.
- Kahn SE. The relative contributions of insulin resistance and beta cell dysfunction to the pathophysiology of type 2 diabetes. *Diabetologia*. 2003; 46:3-19.
- Nathan DM. Insulin treatment of type 2 diabetes mellitus. In: *The Diabetes Mellitus Manual: A Primary Care Companion to Ellenberg and Rifkin's*, 6th ed. Inzucchi S, ed. New York: McGraw-Hill; 2005:138-49.
- American Diabetes Association. Diabetes population statistics. In: *Diabetes 4-1-1: Facts, Figures and Statistics at a Glance*. Alexandria, Va: American Diabetes Association; 2005:34-46.
- Centers for Disease Control and Prevention. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2005. Atlanta, Ga: US Department of Health and Human Services, Centers for Disease Control and Prevention, 2005. On the Internet: www.diabetes.org/diabetes-statistics.jsp. Accessed 1 Feb 2006.
- Inzucchi SE, Sherwin RS. The prevention of type 2 diabetes mellitus. *Endocrin Metab Clin North Am*. 2005;34(1):199-219.
- Healthy People 2010 Consortium. Diabetes. In: *Healthy People 2010 (vol 1)*, 2nd ed: Objectives for Improving Health. US Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Nov 2000.
- American Diabetes Association. Classification and diagnosis of diabetes mellitus. *Diabetes Care*. 2004;27 Suppl 1: S9.
- Danish RK, West BB. Rapid progression from prediabetes to severely ill diabetes while under "expert care": suggestions for improving screening for disease progression. *Diabetes Spectrum*. 2005;18(4):229-39.
- American Diabetes Association. Diabetes mortality rates. In: *Diabetes 4-1-1: Facts, Figures and Statistics at a Glance*. Alexandria, Va: American Diabetes Association; 2005:75-7.
- American Diabetes Association. Clinical practice recommendations. *Diabetes Care*. 2006;29 Suppl 1:
- The DCCT Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977-86.
- UK Prospective Diabetes Study Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk complications in patients with type 2 diabetes (UKPD 33). *Lancet*. 1998;352:837-53.
- Centers for Disease Control and Prevention, National Center for Health Statistics, Division of Health Interview Statistics, data from the National Health Interview Survey. Centers for Disease Control and Prevention, Atlanta, Ga. On the Internet: Prevalence of Diagnosed Diabetes by Age, US, 1980-2004; from the National Diabetes Surveillance System of the National Center for Chronic Disease Prevention and Health Promotion. Accessed 6 Feb 2006.
- Harris MI, Flegal KM, Cowie CC, et al. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in US adults: the Third National Health and Nutrition Examination Survey 1988-1994. *Diabetes Care*. 1998;21:518-25.
- The DECODE Study Group. Is fasting glucose sufficient to define diabetes? epidemiological data from 20 European studies. *Diabetologia*, 1999;42:647-54.
- Meneilly GS, Tessier D. Diabetes in elderly adults. *J Gerontol Med Sci*. 2001;56A:M5-13.
- Ahmann AJ, Riddle MC. Oral pharmacological agents. In: *Medical Management of Diabetes Mellitus*. Leahy JL, Clark NG, Cefalu WT, eds. New York: Marcel Dekker, Inc; 2000:267-83.
- Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ*. 2000;321(7258):405-12.
- Bertoni AG, Krop JS, Anderson GF, Brancati FL. Diabetes-related morbidity and mortality in a national sample of US elders. *Diabetes Care*. 2002;25(3): 471-5.
- Songer TJ. Disability in diabetes. In: *Diabetes in America*, 2nd ed. Harris MI, Cowie CC, Stern MP, Boyko EJ, Bennet PH, eds. Bethesda, Md: National Institute of Diabetes and Digestive and Kidney Diseases; 1995:259-83.
- Chau D, Edelman SV. Clinical management of diabetes in the elderly. *Clin Diabetes*. 2001; 19(4):172-5.
- Sommerfield AJ, Deary IF, Grier BM. Acute hyperglycemia alters mood and impairs cognitive performance

- in people with type 2 diabetes. *Diabetes Care*. 2004;27:2335-40.
24. Sinclair AJ, Girling AJ, Bayer A. Cognitive dysfunction in older subjects with diabetes mellitus: impact on diabetes self-management and use of care services. *Diabetes Res Linc Pract*. 2000;50:203-12.
 25. American Diabetes Association. Type 2 diabetes in children and adolescents (consensus statement). *Diabetes Care*. 2000;23(3):381-9.
 26. Sinha R, Fisch G, Teague B, et al. Prevalence of glucose tolerance among children and adolescents with marked obesity. *N Engl J Med*. 2002;346:802-10.
 27. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, Kaufman F, Silink M. Type 2 diabetes in the young: the evolving epidemic. *Diabetes Care*. 2004;27:1798-1811.
 28. Phillips DI. Birthweight and the future development of diabetes: a review of the evidence. *Diabetes Care*. 1998;21 Suppl 2:B150-55.
 29. Silverman BL, Metzger BE, Cho NH, Loeb CA. Impaired glucose tolerance in adolescent offspring of diabetic mothers: relationship of fetal hyperinsulinism. *Diabetes Care*. 1995;18:611-17.
 30. Pettit DJ, Nelson RG, Saad MF, Bennett PH, Knowler WC. Diabetes and obesity in the offspring of Pima Indian women with diabetes during pregnancy. *Diabetes Care*. 1993;16:310-4.
 31. Schreiner B. Promoting lifestyle and behavior change in overweight children and adolescents with type 2 diabetes. *Diabetes Spectrum*. 2005;18(1):9-12.
 32. Copeland KC, Becker D, Gottschalk M, Hale D. Type 2 diabetes in children and adolescents: risk factors, diagnosis and treatment. *Clin Diabetes*. 2005;23(4):181-5.
 33. Jones KL, Arslanian S, Peterokova VA, et al. Effect of metformin in pediatric patients with type 2 diabetes: a randomized controlled trial. *Diabetes Care*. 2002;25:89-94.
 34. Amiel SA, Sherwin RS, Simonson DC, Lauritano AA, Tamborlane WV. Impaired insulin action in puberty, a contributing factor to poor glycemic control in adolescents with diabetes. *N Engl J Med*. 1986;315:215-9.
 35. American College of Endocrinologists. ACE consensus development conference on guidelines for glycemic control. *Endocrine Practice Supplement*. 2001.
 36. American Diabetes Association. Standards of medical care in diabetes, 2006. *Diabetes Care*. 2006;29 Suppl 1:S4-S42.