9. DIABETES MELLITUS\(^{1}\)

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Several recent reviews provided the core references in developing quality indicators for diabetes (Singer et al., in Eddy, 1991; Bergenstal, 1993; Gerich, 1989; Nathan, in Rubenstein and Federman, 1993; Garnick et al., 1994; Plotnick, in Oski, 1994; Golden and Gray, in McAnarney et al., 1992). Where these core references cited studies to support individual indicators, we have included the original references. We also performed narrow searches of the medical literature from 1985 to 1995 to supplement these references for particular indicators. Indicators of quality of care for gestational diabetes are covered in Chapter 16.

**IMPORTANCE**

Diabetes is a heterogeneous yet often serious and common chronic condition prevalent throughout the world. In 1992, the number of diabetics in the United States alone was estimated to be 7.2 million. The prevalence of insulin-dependent diabetes mellitus (IDDM) among children and adolescents varies somewhat from 1.2 to 1.9 per 1,000 population in the age group (Plotnick, in Oski, 1994). The incidence of diabetes among children reaches its highest rate of onset between 10 and 14 years (Golden and Gray, in McAnarney et al., 1992).

For children and adolescents, the failure to adequately treat (i.e., undertreatment, poor control) diabetes may contribute to delays in growth, skeletal maturation, and sexual maturation. On the other hand, high doses of insulin may result in weight gain, rebound hyperglycemia, ketosis, and growth retardation (Plotnick, in Oski, 1994). Adolescents with IDDM have comorbid hypertension more often than previously believed; treatment can prevent serious complications of cardiovascular disease and diabetic nephropathy. Cigarette smoking,

\(^{1}\)Originally written for the Women’s Quality of Care Panel. Some modifications have been made to reflect issues for children and adolescents.
which has been increasing among adolescents, is a risk factor for macrovascular complications (Golden and Gray, in McAnarney et al., 1992). Adolescents with IDDM are also at higher risk for other autoimmune diseases (Golden and Gray, in McAnarney et al., 1992). About half of insulin-dependent diabetics develop kidney failure (Bergenstal, 1993). All of these complications taken together result in much higher death rates among diabetics than the remainder of the population (Palumbo et al., 1976). Much of the benefit of high quality care will accrue years later from the prevention of morbidity and mortality from such complications. Death rates from diabetes itself increase with age ranging from 0.2 per 100,000 for those between 15 and 19 years of age to 14.6/100,000 for those between 50 and 54 years (National Center for Health Statistics [NCHS], 1994a).

The treatment of diabetes is resource intensive, with total costs estimated at $30-40 billion annually in 1992 (American Diabetes Association [ADA], 1993), or $1 of every $7 spent on health care in 1992 (Rubin et al., 1994). Diabetes was the eighth most common reason for a patient visiting a physician’s office in 1992 (NCHS, 1994b).

**Efficacy and/or Effectiveness of Interventions**

**Screening**

Indicators of the quality of screening diabetics for complications of diabetes are covered under diagnosis below. This section covers screening patients not known to be diabetic for the disease. Both the American College of Physicians (Singer et al., in Eddy, 1991) and the Canadian Task Force on Periodic Health Examination [CTF] (1979) recommended that asymptomatic patients need not undergo screening for diabetes. Children who develop IDDM are rarely asymptomatic. These recommendations turned on the poor evidence that treatment of patients so identified would prevent complications. Though many persons have asymptomatic hyperglycemia, most complications of diabetes occur late in the course of the disease, limiting the benefits of early identification. Since the publication of those recommendations, the Diabetes Control and Complications Trial (DCCT) (see below) has added evidence for the efficacy of tight control in known diabetics in
preventing complications (DCCT, 1993a). However, we have found no subsequent studies either directly evaluating the efficacy of screening asymptomatic patients in reducing morbidity or mortality from diabetes (Singer, 1988; CTF, 1979).

**Diagnosis**

The initial diagnosis of diabetes depends upon the measurement of a fasting blood sugar greater than 140/mg/dl or a postprandial blood sugar of greater than 200/mg/dl. If a recorded blood sugar meets the above criteria, we recommend looking for notation of the diagnosis of diabetes in the progress notes or problem list. Most experts also recommend a complete history and physical examination, dietary evaluation, urinalysis for protein, measurement of blood creatinine, and a lipid panel at the time of initial diagnosis (ADA, 1989). We do not propose any of these as quality indicators for the initial diagnosis because of the small number of incident cases in our sample and the difficulty of defining the time of initial diagnosis.

We instead concentrate on the routine diagnostic tests that known diabetics should undergo regardless of their clinical status and stage of disease. The first of these is the measurement of glycosylated hemoglobin to monitor glycemic control. Based on a randomized controlled trial of 240 patients, it was found that measuring hemoglobin A1c every three months leads to changes in diabetic treatment and improvement in metabolic control, indicated by a lowering of average hemoglobin A1c values (Larsen et al., 1990). The landmark DCCT followed 1,441 insulin-dependent diabetics (about 14 percent of whom were adolescents) for 9 years and found that tight glycemic control and lower hemoglobin A1c values decreased rates of diabetic complications (DCCT, 1993a). Despite recommendations from a number of specialty and generalist physician societies, there is great variation in the use of this test (ADA, 1993; Bergenstal et al., 1993; Garnick et al., 1994; Goldstein et al., 1994). We suggest looking for a hemoglobin A1c test for all diabetics at 6-month intervals, the longest recommended interval.
Home blood glucose monitoring has been shown to aid glycemic control in diabetics treated with insulin. The DCCT employed home blood glucose monitoring for its population of insulin-dependent diabetics rather than the more easily tolerated urine glucose monitoring to achieve tight control because moderate hyperglycemia (180 mg/dl) may not cause glycosuria. At least one small randomized trial (n=23) has shown home blood glucose monitoring to improve glycemic control in obese insulin-dependent diabetics (Allen et al., 1990). The optimal frequency of monitoring has not yet been determined, though some studies have questioned patients ability to comply with frequent measurement (Bergenstal et al., 1993; Health and Public Policy Committee, 1983; Muchmore et al., 1994; Gordon, 1991). Observational data has failed to find any strong relationship between home blood glucose monitoring and glycemic control in noninsulin-dependent diabetics (Patrick, 1994; Allen et al., 1990). Specialty societies recommend that patients on insulin be offered training and equipment for home glucose monitoring, and we propose this as another indicator of diagnostic quality (ADA, 1993).

Because of the frequency of vision, cardiovascular, and renal complications among diabetics, many of which may be asymptomatic, the ADA (1989) has recommended several screening tests in children: yearly eye exam in children age 12-18 who have had a diagnosis of diabetes for at least 5 years; tests of triglycerides, total cholesterol, and HDL cholesterol every 2 years; routine urinalysis test yearly, and, after 5 years duration of diabetes or after puberty, a test of total urinary protein excretion. An annual eye and vision exam conducted by an ophthalmologist after five years of disease duration has also been recommended by the American College of Physicians (ACP), the ADA, and the American Academy of Ophthalmology (AAO) (ACP, ADA and AAO, 1992). Retinal examination by generalists has been shown to be much less effective in detecting retinopathy at an early treatable stage (Reenders et al., 1992). The routine evaluation of the other screening recommendations has never been tested in controlled trials, but the conditions screened for (hyperlipidemia p.396 and nephropathy p.398-9 ESRD) are both more common in diabetics and amenable to intervention (The Carter Center, 1985). Compliance with ADA screening
recommendations has been estimated to vary from 20 to 50 percent (Garnick et al., 1994; Brechner et al., 1993).

Other common treatable complications of diabetes include hypertension, cellulitis, and osteomyelitis. The ADA recommends blood pressure measurement and examination of the feet at every visit to detect these complications early in their course as well as a careful history to elicit signs and symptoms of hypoglycemia and hyperglycemia. No controlled trials have examined the efficacy of a regular history and physical examination.

**Treatment**

Recent debate in the area of diabetic treatment hinges on the utility of tight glycemic control. The goal of tight control and prevention of long-term complications through aggressive treatment is supported by the DCCT (1993a). The DCCT randomized 1,441 insulin-dependent diabetics into conventional therapy or intensive therapy that included daily adjustments of insulin dosage, frequent home glucose monitoring and nutritional advice. Under the optimal circumstances present in the DCCT trial, 44 percent of the intervention group achieved glycosylated hemoglobin values under the goal of 6.05 mg/dl percent at least once, but only 5 percent maintained average values in that range. The intervention group developed 76 percent less retinopathy, 57 percent less albuminuria, and 60 percent less clinical neuropathy, but this reduction in diabetic complication may come at the expense of quality of life (Nerenz et al., 1992). For example, the tight control group in DCCT experienced a two- to three-fold increase in hypoglycemic episodes. The efficiency of such methods in general practice has not received adequate evaluation. Nonetheless, the ADA recommends that all diabetics over the age of seven be offered similar aggressive therapy.

The DCCT investigators suggest, however, that the risk-benefit ratio for children under 13 may be less favorable. In Type I diabetes (IDDM), emphasis is placed on avoidance of diabetic ketoacidosis and tight control of blood sugar levels through the judicious use of insulin.
Adherence to ADA diet decreases insulin and oral hypoglycemic requirements and serum lipids (Bantle, 1988). The DCCT (1993b) relied on dietitians and revealed that greater adherence to dietary instructions resulted in better control. Exercise improves glucose tolerance and may reduce or eliminate the need for drug therapy (Raz et al., 1994). The ADA and the American Board of Family Practice recommend dietary and exercise counseling at both the initial diagnosis and before starting oral hypoglycemics or insulin (ADA, 1989; Bergenstal et al., 1993). We recommend evaluating the medical record for evidence that all diabetics have received dietary and exercise counseling.

Insulin treatment is essential for Type I diabetics. The literature contains varied recommendations as to the optimal timing and content of insulin injections (Gregerman, 1991, in Barker et al., 1991; Knatterud, 1978), and no one regimen has emerged as superior. It has been suggested that, for children and adolescents, two injections per day of short- and intermediate-acting insulin are generally necessary to achieve reasonable control (Plotkin in Oski, 1994). The ADA recommends that all diabetics taking insulin receive formal instruction in the technique of injection (ADA, 1989; Bergenstal et al., 1993). We recommend evaluating the medical record for evidence that this has taken place.

Though quality indicators for treatment of hypertension are covered elsewhere, the intersection of diabetes and hypertension poses special treatment challenges. Control of hypertension is perhaps the most crucial step in preventing diabetic nephropathy. In particular, ACE inhibitors and possibly calcium channel blockers have been shown to reduce hyperalbuminuria and delay the progression to diabetic nephropathy (Lederle, 1992; Anderson, 1990). Beta blockers on the other hand may block the symptoms of hypoglycemia, and thus may be contraindicated in treated diabetics (Hamilton, 1990).

**Follow-up**

A study of internists and family practitioners using patient vignettes found wide variation in recommended follow-up intervals for diabetics (Petitti and Grumbach, 1993). The ADA (1989) guidelines
recommend that regular visits be scheduled every three months for insulin-dependent diabetics. As a minimum standard of care for patients with diabetes, we suggest a visit every six months.
**RECOMMENDED QUALITY INDICATORS FOR DIABETES MELLITUS**

The following criteria apply to children with diabetes aged 5-18.

**Diagnosis**

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<tr>
<th>Indicator</th>
<th>Quality of evidence</th>
<th>Literature</th>
<th>Benefits</th>
<th>Comments</th>
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<tr>
<td>1. Patients with the diagnosis of diabetes should have the following routine monitoring tests:</td>
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<td>a. glycosylated hemoglobin every 6 months</td>
<td>I</td>
<td>Larsen et al., 1990</td>
<td>Prevent diabetic complications.*</td>
<td>Randomized controlled trial of 240 patients indicated a significant decrease in hemoglobin A1c among those whose hemoglobin A1c was monitored. Time interval is that used in most clinical trials.</td>
</tr>
<tr>
<td>b. Eye and visual exam if more than 5 years since diagnosis</td>
<td>III</td>
<td>ACP, ADA and AAO, 1992; ADA, 1989</td>
<td>Prevent retinopathy.</td>
<td>Eye and visual exam shown to detect retinopathy at an earlier treatable stage.</td>
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<tr>
<td>c. Triglycerides at least once a year</td>
<td>III</td>
<td>ACP, ADA and AAO, 1992; ADA, 1989</td>
<td>Prevent hyperlipidemia and atherosclerotic complications.</td>
<td>Recommendations based on expert opinion, though studies have shown conditions they screen for to be more common in diabetics and all are susceptible to treatment with improved outcomes resulting from earlier detection.</td>
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<tr>
<td>d. Total cholesterol at least once a year</td>
<td>III</td>
<td>ACP, ADA and AAO, 1992; ADA, 1989</td>
<td>Prevent hyperlipidemia and atherosclerotic complications.</td>
<td>Recommendations based on expert opinion, though studies have shown conditions they screen for to be more common in diabetics and all are susceptible to treatment with improved outcomes resulting from earlier detection.</td>
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<tr>
<td>e. HDL cholesterol at least once a year</td>
<td>III</td>
<td>ACP, ADA and AAO, 1992; ADA, 1989</td>
<td>Prevent hyperlipidemia and atherosclerotic complications.</td>
<td>Recommendations based on expert opinion, though studies have shown conditions they screen for to be more common in diabetics and all are susceptible to treatment with improved outcomes resulting from earlier detection.</td>
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<tr>
<td>f. Urinalysis at least once a year</td>
<td>III</td>
<td>ADA, 1989</td>
<td>Prevent renal disease.</td>
<td>Recommendations based on expert opinion, though studies have shown conditions they screen for to be more common in diabetics and all are susceptible to treatment with improved outcomes resulting from earlier detection.</td>
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<td>g. Examination of feet at every visit</td>
<td>III</td>
<td>ADA, 1989</td>
<td>Prevent lower extremity amputation, reduced morbidity from foot infections.</td>
<td>ADA recommendation. Earlier detection of treatable disease reduces probability of developing serious complications. Exam provides an opportunity for patient education.</td>
</tr>
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h. Measurement of blood pressure at every visit  III  ADA, 1989

2. All patients taking insulin should monitor their glucose at home daily.  III  ADA, 1993  Prevent hypoglycemic episodes. Prevent diabetic complications.*  A small RCT found that home glucose monitoring increases glycemic control in insulin dependent diabetics. Another study found no difference in control by frequency of monitoring. Recommended by the ADA.

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<td>3. All diabetics should receive dietary and exercise counseling.</td>
<td>II</td>
<td>Raz et al., 1994; Delahanty and Halford, 1993; ADA, 1989; Bergenstal et al., 1993</td>
<td>Reduce diabetic complications.*</td>
<td>Adherence to ADA diet decreases insulin and oral hypoglycemic requirements and serum lipids. Exercise improves glucose tolerance and may reduce or eliminate need for drug therapy. DCCT used dieticians and found that adherence to diet improved control and the ADA and the ABFP recommend their use. No study has found that dietary counseling reduces diabetic complications.</td>
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Follow-up

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<td>4. All patients with diabetes should have a follow-up visit at least every 6 months.</td>
<td>III</td>
<td>Bergenstal et al., 1993; ADA, 1989</td>
<td>Reduce probability of severe diabetic complications.*</td>
<td>Visits for diabetic patients in control should be every 3-6 months (per ABFP). Routine monitoring facilitates early detection and treatment of complications.</td>
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* Diabetic complications include visual loss and dysfunction of the heart, peripheral vasculature, peripheral nerves and kidneys.

Quality of Evidence Codes:

I: RCT
II-1: Nonrandomized controlled trials
II-2: Cohort or case analysis
II-3: Multiple time series
III: Opinions or descriptive studies
REFERENCES - DIABETES MELLITUS


The Diabetes Control and Complications Trial Research Group. 30 September 1993. The effect of intensive treatment of diabetes on


