Screening for Type 2 Diabetes

View online at http://pier.acponline.org/physicians/screening/s370/s370.html

Module Updated: 2012-03-16
CME Expiration: 2015-03-16

Author
Sonal Singh, MD

Table of Contents
1. Key Points .................................................................................................................. 2
2. Population at Risk ......................................................................................................... 3
3. Effectiveness/Harms of Screening Tests ........................................................................ 8
4. Effectiveness/Harms of Early Treatment ...................................................................... 12
5. Direct Evidence that Screening Reduces Adverse Outcomes ....................................... 18
6. Frequency .................................................................................................................... 20
7. Cost-Effectiveness ........................................................................................................ 21
8. Patient Counseling ....................................................................................................... 22
9. Referral/Consultation .................................................................................................. 23
References ........................................................................................................................ 24
Glossary ............................................................................................................................. 32
Tables ................................................................................................................................. 34

Quality Ratings: The preponderance of data supporting guidance statements are derived from:

- level 1 studies, which meet all of the evidence criteria for that study type;
- level 2 studies, which meet at least one of the evidence criteria for that study type; or
- level 3 studies, which meet none of the evidence criteria for that study type or are derived from expert opinion, commentary, or consensus.

Study types and criteria are defined at http://smartmedicine.acponline.org/criteria.html

Disclaimer: The information included herein should never be used as a substitute for clinical judgement and does not represent an official position of the American College of Physicians. Because all PIER modules are updated regularly, printed web pages or PDFs may rapidly become obsolete. Therefore, PIER users should compare the module updated date on the official web site with any printout to ensure that the information is the most current available.

CME Statement: The American College of Physicians is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing education for physicians. The American College of Physicians designates this enduring material for a maximum of 1 AMA PRA Category 1 Credit™. Physicians should claim only credit commensurate with the extent of their participation in the activity. Purpose: This activity has been developed for internists to facilitate the highest quality professional work in clinical applications, teaching, consultation, or research. Upon completion of the CME activity, participants should be able to demonstrate an increase in the skills and knowledge required to maintain competence, strengthen their habits of critical inquiry and balanced judgement, and to contribute to better patient care. Disclosures: Sonal Singh, MD, current author of this module, has no financial relationships with pharmaceutical companies, biomedical device manufacturers, or health-care related organizations. Deborah Korenstein, MD, FACP, Co-Editor, PIER, has no financial relationships with pharmaceutical companies, biomedical device manufacturers, or health-care related organizations. Richard B. Lynn, MD, FACP, Co-Editor, PIER, has no financial relationships with pharmaceutical companies, biomedical device manufacturers, or health-care related organizations.

PIER is copyrighted ©2014 by the American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106, USA.
1. Key Points

- Know that no direct evidence exists showing that screening for type 2 diabetes improves health outcomes or mortality rates.
- Screen all adults with CVD, hypertension, dyslipidemia, or other CVD risk factors for diabetes.
- Understand that there is insufficient evidence for diabetes screening in adults without CVD risk factors.
- Consider screening for diabetes in adults 18 years or older with risk factors for type 2 diabetes (family history, obesity, gestational diabetes, polycystic ovarian syndrome, high-risk ethnic group).
- Recognize that although there is no direct evidence about screening intervals, expert panels have recommended screening every 3 years.
- Use the FBG test to screen for diabetes because it is easier to administer, is less costly, and is more reproducible than the 75-g OGTT to detect diabetes; consider using HbA1c to screen for diabetes.
- Consider performing a 75-g OGTT in individuals with an FBG of 100 to 126 mg/dL (5.6 to 7.0 mmol/L), as diabetes cannot be adequately confirmed or excluded with FBG values within that range.
- Appreciate that the HbA1c test has good specificity but only moderate sensitivity to diagnose diabetes.
- Appreciate that intensive glycemic control in persons with type 2 diabetes reduces intermediate markers of microvascular complications, but it has not been convincingly shown to reduce end-organ complications or macrovascular disease.
- Be aware that treatment of overweight diabetes patients with metformin reduces CVD events, diabetes-related complications, and mortality rate.
- Recognize that treatment of hypertension and dyslipidemia in persons with diabetes reduces the risk of CVD events and mortality to a greater extent than in those without diabetes, partly due to their higher baseline risk for CVD, and because treatment is effective at lower levels of BP and LDL cholesterol in patients with diabetes.
- Recognize that ASA treatment reduces cardiovascular events in type 2 diabetes patients with CVD.
2. Population at Risk

2.1 Recognize that the natural history of diabetes includes an asymptomatic phase that would be detected only through screening or opportunistic testing and that complications can occur before clinical symptoms of diabetes are apparent.  

Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- Approximately one third of adults with prevalent diabetes have not been diagnosed (1).
- A total of 2.8% of the U.S. population has undiagnosed diabetes, and an additional 26% has impaired fasting glucose (1).
- The prevalence of retinopathy has been estimated between 10% and 37% at the time of clinical diagnosis of diabetes (2; 3).
- Approximately 10% of persons have nephropathy at the time of diabetes diagnosis (4).
- In newly diagnosed patients, 2% had had an MI, 3% had angina, and 1% had had a stroke (5).
- The preclinical phase of diabetes is estimated to be about 10 to 12 years (2; 6).
- A prospective study of screening using routine blood sugar in optometric practices in northern England found that 1.6% of 1909 previously undiagnosed adults were diagnosed with diabetes or prediabetes (7).

2.2 Recognize that the prevalence of diabetes increases significantly with age.  

Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- According to the International Diabetes Federation, the worldwide prevalence of diabetes in adults aged 20 to 79 years was 6.0% in 2007, and it is expected to increase to 7.3% by 2025.
- Prevalence of diabetes in the U.S. is 1% to 2% at ages 20 to 39 years, but it increases to 6% by ages 40 to 49 and to 15.8% by age 65 or older (8).
- The highest incidence of type 2 diabetes in persons aged 20 years or older is in the 40- to 59-year age group (9).
- Diabetes affects men and women equally (8).

2.3 Know that the risk of type 2 diabetes is significantly increased among patients with a first-degree family member with a history of diabetes.  

Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- A recent review of the literature found that the risk of type 2 diabetes is increased by 2 to 3.5 times in persons who have one parent with diabetes and by 2.5 to 6 times in those who have two parents with diabetes (10).
2.4 Know that nearly all minority groups in the U.S. have an increased risk of type 2 diabetes.

**Recommendations**
- See Comparative Guidelines: Screening for Diabetes.

**Evidence**
- The prevalence of diabetes among First Nations is approximately 2.2 times that for non-Hispanic whites, and an estimated 12.8% of Native Americans on reserves or settlements has diabetes (11; 12).
- The prevalence of impaired fasting glucose in the U.S. is 30.1% among Mexican-American populations and 16.8% among non-Hispanic blacks when compared to non-Hispanic whites. Diabetes risk is also increased among those of Asian and Pacific Islander origin, who are twice as likely to have diabetes compared to non-Hispanic whites (9).
- The increased prevalence of diabetes in minority groups is likely due to a combination of genetic and environmental factors. For example, in all U.S. minority groups for which data exist, the prevalence of diabetes is higher than residents in their countries of origin. Environmental factors such as “western” dietary changes, decreased activity, obesity, and lower socioeconomic status have all been shown to partly account for the higher diabetes rates among minority groups (12).

2.5 Recognize that women with gestational diabetes have a high risk of developing type 2 diabetes, with the highest incidence in the first 5 years after pregnancy.

**Recommendations**
- See Comparative Guidelines: Screening for Diabetes.

**Evidence**
- The 10-year incidence of type 2 diabetes is 20% to 50% following a pregnancy complicated by gestational diabetes (9).
- A systematic review of 28 studies examining the risk of type 2 diabetes among women with gestational diabetes found a cumulative incidence of diabetes of 2.6% to 70% from 6 weeks to 28 years postpartum. The highest incidence occurred in the first 5 years after the index pregnancy, and the risk appeared to plateau after 10 years (13).
- Rates of diabetes progression appear to be higher among Latin and Native American women with gestational diabetes, but follow-up lengths and retention rates vary widely between studies. Because no direct comparisons between populations have been made, it is uncertain whether risk of future diabetes is truly different based on ethnicity (13).
- A study found that in women with gestational diabetes followed prospectively for up to 11 years, those with autoantibodies to glutamic acid decarboxylase and/or insulinoma antigen-2, those who required insulin during gestation, those with BMI ≥30 kg/m², and those with a history of two or more prior pregnancies had hazard ratios of between 1.5 and 4.7 for development of type 2 diabetes. The highest risk at 8 years occurred in antibody-positive women (96%). In the group with none of the above attributes, the prospective incidence was 14% (14).
- According to a systematic review for the USPSTF on screening for gestational diabetes mellitus, there is limited evidence that gestational diabetes treatment after 24 weeks improves some maternal and neonatal outcomes. Evidence is even more sparse for screening before 24 weeks' gestation (15).

2.6 Recognize that women with polycystic ovarian syndrome have a higher prevalence of type 2 diabetes than women without the syndrome.
Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- Women with polycystic ovarian syndrome are two to three times more likely to have coexisting diabetes than women without the condition (16).

Comments

- Polycystic ovarian syndrome is defined as oligomenorrhea or amenorrhea with hyperandrogenism in the absence of other causes.

2.7 Note that the risk of diabetes significantly increases with increasing obesity, with the greatest risk in persons with abdominal fat accumulation.

Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- Based on a survey of over 195,000 U.S. adults, the adjusted odds ratio of self-reported diabetes was 1.59 (1.46 to 1.73) in overweight (BMI 25 to 29.9 kg/m²) persons, 3.44 (3.17 to 3.74) in moderately obese (BMI 30 to 39.9 kg/m²) persons, and 7.37 (6.39 to 8.50) in the severely obese (BMI ≥40 kg/m²). This association was consistent across sexes, races, educational levels, and smoking status (17).

- In a German cohort study of 5953 persons aged 35 to 74 years, the age-adjusted hazard ratio for incident diabetes doubled for every 4 kg/m² increase in BMI above normal (<25 kg/m²) (18).

- The risk of type 2 diabetes is greatest in persons with central or abdominal fat accumulation, a marker of insulin resistance and the metabolic syndrome. Increased waist circumference and waist-to-hip ratio are associated with an increase in diabetes incidence (RR 2 to 5), even after adjusting for BMI (19; 20; 21).

2.8 Note that persons with CVD, hypertension, dyslipidemia, and other features of the metabolic syndrome have an increased incidence of diabetes and that some medications place patients at risk for both metabolic syndrome and diabetes.

Recommendations

- See Comparative Guidelines: Screening for Diabetes.

Evidence

- Forty-eight percent to 67% of persons with previously undiagnosed diabetes have hypertension (22; 23). In a study of 12,550 U.S. adults aged 45 to 64, the incidence of diabetes in persons with hypertension was found to be over two times that of persons without hypertension (RR, 2.43 [CI, 2.16 to 2.73], absolute risk 29.1 vs. 12.0/1000 person-years) (24).

- Seventy-three percent of adults with diabetes have BP >130/80 mm Hg or are on treatment for hypertension (9).

- Sixty-two percent of persons with undiagnosed diabetes have LDL cholesterol concentrations of >130 mg/dL and 24% to 72% have high triglycerides (22; 23; 25). Hypertriglyceridemia is associated with an odds ratio of 2.29 for diabetes (25).

- Improved control of lipids can reduce CVD complications by 20% to 50% (9).

- For every 10-mm Hg reduction in systolic BP, the risk for any diabetes complication is reduced by 12% (9).
• Based on NHANES III data, U.S. adults aged 50 or older who meet the NCEP criteria for the metabolic syndrome are over eight times as likely to have diabetes as those without the metabolic syndrome (25).

• The features of the metabolic syndrome can be used to identify the risk of diabetes, but the predictive usefulness is due mainly to fasting plasma glucose. Among 1155 adults, the AROC was 0.76 for prediabetes, which was similar to that for random plasma glucose (0.72). Overall, to identify diabetes or prediabetes in blacks and whites with varying ages and BMIs, metabolic syndrome features are no better than random plasma glucose (26).

• A 1-year Japanese retrospective cohort study among 374 patients with schizophrenia treated with antipsychotics determined that the prevalence of new onset diabetes (glycated hemoglobin >6.4, or FBG >124 mg/dL, or random plasma glucose >179 mg/dL) was 8% and the prevalence of prediabetes (glycated hemoglobin 6.4%, fasting plasma glucose >110, or random blood glucose 140 to 179 mg/dL) was 17.4% (27).

Comments
• Criteria for the metabolic syndrome are at least three of the following: a waist circumference >40.2 in/102 cm in males or >34.6 in/88 cm in females; serum triglycerides ≥150 mg/dL; HDL cholesterol <40 mg/dL in males or <50 mg/dL in females; BP ≥130/85; and fasting glucose >110 mg/dL (6.1 mmol/L) (28).

2.9 Note that diabetes increases the risk of cardiovascular events, and that men over age 55 and women over age 60 with diabetes have at least a 10% risk of cardiovascular events over 10 years.

Recommendations
• See Comparative Guidelines: Screening for Diabetes.

Evidence
• Persons with asymptomatic prediabetic states of impaired glucose tolerance and impaired fasting glucose have an increased risk of CVD and death compared to those with normal glucose levels (8; 29; 30; 31; 32; 33; 34; 35; 36; 37; 38).

• Based on Framingham data, the risk of cardiovascular events in patients with diabetes is two to three times greater than in those without diabetes, and their absolute risk crosses the 10% threshold by age 55 in men and age 60 in women (39; 40).

• More recent data from a 45- to 64-year-old Finnish cohort suggest that the risk of MI in diabetes patients with no history of previous MI is comparable to the risk of nondiabetes patients who have had a previous MI (19% vs. 20% 7-year absolute risk, respectively) (41). The 7-year risk of recurrent MI in persons with diabetes and CVD is 45%, compared with 20% in those with CVD but no diabetes (41). This finding is the rationale for the view of diabetes as a cardiovascular disease risk equivalent.

• Another study of Scotland residents, aged 45 to 64 years, compared the 8-year risk of MI between diabetes patients without CVD and nondiabetes patients who had had an MI within the previous 8 years. The risk of MI was higher in the patients with a recent MI than those with diabetes, which contradicts the Finnish study. One explanation is that the Finnish study excluded patients with diet-controlled diabetes, resulting in a population with more advanced disease than in the Scottish study. However, the diabetes patients still had an almost 10% absolute risk of a first MI within 8 years, a risk cutpoint considered worthy of primary intervention (42).

• The benefits of screening for type 2 diabetes depend largely on baseline CVD risk, and the benefits may be greatest in patients with a baseline 10-year CVD risk of >8% (43).
3. Effectiveness/Harms of Screening Tests

3.1 Know that a 2-hour PG value of ≥200 mg/dL (11.1 mmol/L) after a 75-g OGTT is considered the gold standard for diagnosing diabetes mellitus.\(^8\)

Evidence
- A 2-hour PG value of ≥200 mg/dL (11.1 mmol/L) was shown to reflect a threshold separating subjects at increased risk of retinopathy (\(^{44, 45}\)).
- A 2-hour PG value of ≥200 mg/dL (11.1 mmol/L) is associated with an increased risk of CAD and all-cause mortality (\(^{46}\)).
- The 2-hour PG is not as reliable as the FBG value. Intra-individual coefficients of variation when repeated 2 to 6 weeks apart were 16.7% for the 2-hour PG value vs. 6.4% for the FBG (\(^{47}\)).

3.2 Recognize that the ADA criterion for diabetes of an FBG of ≥126 mg/dL (7.0 mmol/L) is more reproducible than the 2-hour PG and has excellent specificity for diagnosing diabetes, but its sensitivity is only approximately 50%.\(^9\)

Recommendations
- See table Operating Characteristics for Various Tests in Screening for Diabetes.
- See table Posttest Probability of Type 2 Diabetes After Screening Tests.

Evidence
- The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended diagnosing diabetes in patients with an HbA\(_1c\) level ≥6.5%, a fasting plasma glucose level ≥126 mg/dL (7.0 mmol/L), an oral glucose tolerance test with a 2-hour plasma glucose level of ≥200 mg/dL (11.1 mmol/L), or classic symptoms of diabetes with a random plasma glucose level ≥200 mg/dL (11.1 mmol/L). The guideline did not differentiate diagnostic criteria for type 1 and type 2 diabetes (\(^{48}\)).
- An FBG ≥126 mg/dL (7.0 mmol/L) is associated with an increased prevalence of retinopathy (\(^{45, 49, 50}\)).
- An FBG ≥126 mg/dL (7.0 mmol/L) is associated with an increased risk of CAD and all-cause mortality (\(^{46}\)).
- An FBG of ≥126 mg/dL (7.0 mmol/L) has a specificity of 96% to 99% to detect a 2-hour PG of ≥200 mg/dL (11.1 mmol/L) but is only 31% to 79% sensitive, depending on the population (most studies report sensitivities of approximately 50%) (\(^{51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63}\)).
- The FBG is more reliable than the 2-hour PG. Intra-individual coefficients of variation when repeated 2 to 6 weeks apart were 16.7% for the 2-hour PG value vs. 6.4% for the FBG (\(^{47}\)).

3.3 Know that lowering the threshold FBG value increases the sensitivity but decreases the specificity for a diagnosis of diabetes; therefore, although the optimal threshold FBG value to exclude diabetes may be <100 mg/dL (5.6 mmol/L), a 2-hour PG would be required to confirm diabetes in patients with an FBG ≥100 mg/dL (5.6 mmol/L).\(^9\)

Recommendations
- See table Operating Characteristics for Various Tests in Screening for Diabetes.
- See table Posttest Probability of Type 2 Diabetes After Screening Tests.
Evidence

- The ADA published Standards of Medical Care in Diabetes in 2007 (64).
- In a study of 935 Canadian subjects of European, South Asian, and Chinese origin, an FBG of ≥103 mg/dL (5.7 mmol/L) had a sensitivity of 83.3% (73.9 to 92.8) and a specificity of 88.0% (85.9 to 90.2) to diagnose diabetes (65).

3.4 Recognize that the HbA1c test has good specificity but only moderate sensitivity for detecting undiagnosed diabetes, and its performance varies depending on the population and cutpoint used.

Recommendations

- See table Operating Characteristics for Various Tests in Screening for Diabetes.
- See table Posttest Probability of Type 2 Diabetes After Screening Tests.

Evidence

- A population-based study of the accuracy of HbA1c compared with OGTT for the diagnosis of diabetes in a screening population of non-Hispanic adults found that HbA1c > 6.5 had a low sensitivity (30%) but high specificity (99%) for diabetes, with positive likelihood ratio of 48 (66).
- A population-based study in the Netherlands compared HbA1c to OGTT and found that HbA1c ≥ 7% ruled in diabetes (specificity, 100%), and that a HbA1c < 5.5% was moderately effective in ruling out diabetes (sensitivity, 91%) (67).
- In a community-based population of 11,092 nondiabetic adults in the Atherosclerosis Risk in Community study, glycated hemoglobin values were associated with diagnosed diabetes with multivariable adjusted hazard ratios (glycated hemoglobin < 5%, HR 0.52 (CI, 0.40 to 0.69); 5% to < 5.5%, HR, 1.00 (reference); 5.5% to < 6%, HR, 1.86 (CI, 1.67 to 2.08); 6% to < 6.5%, HR, 4.48 (CI, 3.92 to 5.13); and 6.5% or greater, HR, 16.47 (CI, 14.22 to 19.08) (68).
- Results from NHANES III, a survey that included 7832 U.S. adults who underwent testing for diabetes, found that an HbA1c value of ≥ 5.6% (1 SD above the mean) was 83.4% sensitive and 84.4% specific for detecting undiagnosed diabetes. This specificity increased to 97.4% and the sensitivity decreased to 63.2% for an HbA1c value of ≥ 6.1% (2 SD above the mean) (69).
- In a study of 936 Canadians of European, South Asian, and Chinese origin, an HbA1c value of ≥ 5.9% had a sensitivity of 75.0% and a specificity of 79.1% for detection of diabetes. The specificity increased to 95% but the sensitivity decreased to 71.7% when this was combined with an FBG of ≥ 103 mg/dL (5.7 mmol/L) (65).

Comments

- International variability in HbA1c assays had previously precluded its validation for diagnosis of diabetes, but the National Glycohemoglobin Standardization Program has now made the measurement of HbA1c more precise for use in studies and clinical practice (70).

3.5 Recognize that consideration of age, BMI, and race/ethnicity in screening to detect diabetes and pre-diabetes may be less important than evaluation of random plasma glucose.

Recommendations

- See table Operating Characteristics for Various Tests in Screening for Diabetes.

Evidence

- One study of 1471 U.S. adults found that a random CBG level of ≥ 121 mg/dL (6.7 mmol/L) was 78% sensitive and 86% specific for a diagnosis of diabetes (based on a 2-hour PG of ≥ 200 mg/dL [11.1 mmol/L]) (71).
In SIGT-5, among 1129 individuals without diabetes the AROC for random plasma glucose alone as a screen for diabetes (0.81) and dysglycemia (0.72) were highly significant ($P<0.001$) and significantly higher than both the age >45 years plus BMI >25 kg/m$^2$ cutoffs (both 0.63) and the age plus BMI plus black race cutoffs (0.63 and 0.58), $P<0.0001$ (72).

In SIGT-2, another cross-sectional study of 990 adults without diabetes, the AROC was 0.80 (CI, 0.74 to 0.86) for random plasma glucose to identify diabetes and 0.72 (CI, 0.68 to 0.75) to identify any glucose intolerance, both highly significant ($P<0.001$) (73).

### 3.6 Know that risk assessment questionnaires developed to screen for diabetes have inadequate sensitivity and specificity in identifying persons with undiagnosed diabetes.

**Recommendations**
- See table Operating Characteristics for Various Tests in Screening for Diabetes.

**Evidence**
- The questionnaire, “Take the Test, Know the Score,” developed by the ADA, which provides a score based on a family history of diabetes, a history of a macrosomic infant, BMI, age, and physical inactivity, was associated with a sensitivity of 78% and a specificity of 50% for the detection of undiagnosed diabetes in 1471 U.S. adults (71).
- The Finnish Diabetes Risk Score, which incorporates data on BMI, age, hypertension, diet, and physical activity, found that a score $\geq 9$ had a sensitivity of 76% to 77% and a specificity of 66% to 68% for identifying persons with previously undiagnosed diabetes in two cohorts of 4435 Finnish subjects aged 35 to 64 years (74).
- A questionnaire incorporating age, obesity, physical inactivity, family history of diabetes, hypertension, and BMI was tested in a cohort of 2364 Dutch subjects aged 50 to 74 years, and it was found to be 72% to 78% sensitive and 55% specific for detecting undiagnosed diabetes (75).

### 3.7 Know that there is limited evidence regarding the harms of screening for diabetes; however, screening tests appear to be safe and have minimal effect on quality of life.

**Evidence**
- Immediate harms associated with screening tests are limited to the inconvenience and time commitment associated with testing and the discomfort and risks of venipuncture and oral glucose ingestion.
- One study of 1253 U.S. outpatients aged 45 to 64 years with no history of diabetes found that quality of life was not decreased after 1 year in patients diagnosed with diabetes through screening (76).
- There is little objective evidence regarding the psychological and social harm of screening programs. However, experts have suggested that potential adverse effects include excessive overall awareness of health, consequences of being labeled as “sick” or “at risk,” compromise of insurance opportunities, stigmatization and, in the case of a false-negative test result, false assurance of disease-free status (77; 78).
- A systematic review found that false-positive diagnoses may cause unnecessary treatment and difficulty obtaining life or health insurance (79).
- A systematic review of the harms of screening found that most studies are anecdotal. The most consistent finding was that false-negative results might have legal consequences due to loss of public confidence and concerns regarding delay in diagnosis (80).
• Use of the Diabetes Risk Calculator, which includes questions on age, waist circumference, gestational diabetes, height, race/ethnicity, hypertension, family history, and exercise, had a sensitivity and specificity of 88% and 75%, respectively, for detecting undiagnosed diabetes in NHANES III. This tool was validated against the NHANES 1999-2004 dataset (81).
4. Effectiveness/Harms of Early Treatment

4.1 Recognize that although tight glycemic control in persons clinically diagnosed with type 2 diabetes may reduce intermediate markers of diabetes complications, it has not been convincingly shown to lead to significant reductions in end-organ complications and may increase mortality.

Evidence

- The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended a goal HbA1c level <7.0% for most patients, noting that a lower goal HbA1c level (<6.5%) is reasonable in select patients without hypoglycemia and a higher goal HbA1c level (<8%) is reasonable for patients with a history of severe hypoglycemia, a limited life expectancy, multiple comorbid conditions, and other factors (48).

- A 2011 systematic review and meta-analysis of studies of intensive vs. standard glycemic control found that intensive control did not have an impact on all-cause or cardiovascular mortality, but did lead to a reduction in microvascular complications (RR, 0.88 [CI, 0.79 to 0.97]), and an increase in severe hypoglycemia (RR, 2.39 [CI, 1.17 to 3.34]) (82).

- The ACCORD trial was a large, randomized trial of tight glucose control (goal HbA1c <6%) compared with standard control (goal HbA1c 7% to 7.9%). The study found no difference in cardiovascular events between groups, but an increased rate of all-cause mortality in the tight control group with NNT, 117 (83).

- Five randomized controlled trials have compared health outcomes in groups of patients with type 2 diabetes that differ with respect to glycemic control (84; 85; 86; 87; 88; 89; 90; 91; 92; 93; 94). Four of these studies were small and lacked power to detect clinically important differences between groups (86; 87; 88; 89; 90; 91; 92; 93; 94).

- Two of these smaller studies found reductions in progression of albuminuria and retinopathy with tight glycemic control (92; 94), and one study that included tight glycemic control as part of a multifactorial intervention found a significant reduction in severe visual impairment (90).

- The UKPDS was the longest and largest study, with 3867 UK residents with newly diagnosed type 2 diabetes randomly assigned to intensive vs. conventional glycemic control (84; 85).

- After 10 years of follow-up in the UKPDS, there was a significant reduction in microvascular complications with tight glycemic control (average HbA1c 7.0% vs. 7.9%), primarily due to a reduction in need for retinal photocoagulation, a trend toward reduction in MI (relative risk, 0.84 [CI, 0.71 to 1.0], P = 0.052), and no benefit on mortality rates, progression to renal failure, loss of vision, amputation, stroke, or quality of life (84).

- It should be noted that all of these studies were conducted in patients with clinically diagnosed diabetes; for example, only 31.2% of patients in the UKPDS were diagnosed at an asymptomatic stage (through opportunistic testing) (95).

4.2 Note that metformin treatment in overweight patients with newly diagnosed diabetes is associated with reductions in mortality rates, MI, and diabetes complications.

Evidence

- The 2009 NICE guidelines for the care of patients with type 2 diabetes included a helpful treatment algorithm, which recommended metformin as the first-line agent in most patients with diabetes (96).
• A 2012 clinical practice guideline from the American College of Physicians recommended metformin as first-line therapy in patients with type 2 diabetes in whom lifestyle interventions do not achieve treatment goals (97).

• The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended metformin as the preferred first agent for most patients with type 2 diabetes (48).

• A 2011 systematic review of the comparative effectiveness and safety of oral medication for type 2 diabetes found limited evidence of long-term benefits and no demonstrated differences among most agents. Metformin decreased HbA1c more than DPP-4 inhibitors and had benefits including weight loss and improvements in the lipid profile (98).

• A systematic review and meta-analysis of oral medications in type 2 diabetes found that metformin reduced the risk of cardiovascular mortality (RRR, 25% [CI, 10% to 36%]); no other oral hypoglycemic agents reduced cardiovascular mortality. Metformin did not reduce overall mortality (99).

• A subgroup of over 700 overweight subjects in the UKPDS were treated with metformin as their intervention. Metformin treatment was associated with significant reductions in all-cause mortality (RRR, 0.33; NNT, 14), diabetes-related mortality (RRR, 0.42; NNT, 19), MI (RRR, 0.36; NNT, 14), and diabetes-related outcomes (RRR, 0.32; NNT, 10) (85).

4.3 Appreciate that very tight BP control in patients with diabetes is associated with reductions in stroke but not other cardiovascular outcomes or death, but that moderate BP control may reduce mortality as compared with loose BP control.

Evidence

• A 2014 guideline from the JNC 8 panel members recommended a target blood pressure <140/80 mm Hg for patients aged 60 years or younger, and <150/90 mm Hg for patients aged 60 years or older, regardless of the presence of diabetes. The guideline recommended using ACE inhibitors, angiotensin-receptor blockers, calcium-channel blockers, or thiazide diuretics as first-line agents in diabetic and nondiabetic, nonblack populations, and recommended calcium-channel blockers and thiazide diuretics as first-line agents in diabetic and nondiabetic black patients (100).

• A 2013 science advisory from the American Heart Association, American College of Cardiology, and the Centers for Disease Control and Prevention on effective control of high blood pressure recommended a goal blood pressure of <140 mm Hg and <90 mm Hg diastolic for most patients, noting that lower targets may be appropriate for some populations. The guideline noted that appropriate drugs for patients with diabetes include ACE inhibitors, angiotensin-receptor blockers, thiazide diuretics, calcium-channel blockers, and β-blockers (101).

• The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended a goal BP <140/80 mm Hg in most patients with diabetes and to use ACE inhibitors or angiotensin-receptor blockers as first-line medical therapy in diabetic patients with hypertension (48).

• A 2008 NICE guideline on the management of type 2 diabetes recommended that patients with diabetes and hypertension be offered lifestyle advice and to begin medical management if blood pressure remains above 140/80 mm Hg in the absence of end-organ damage or 130/80 mm Hg in the presence of end-organ damage. The guideline recommended that patients who are not of African or Caribbean descent be started on an ACE inhibitor as initial therapy, and that those of African or Caribbean descent be started on both an ACE inhibitor and either a thiazide diuretic or calcium-channel blocker.

• The ACCORD study randomized patients with type 2 diabetes at high cardiovascular risk to tight blood pressure control (systolic BP <120 mm Hg) vs. standard blood pressure control (systolic BP
<140 mm Hg). The study found that tight BP control reduced stroke (NNT, 95) but did not reduce other cardiovascular events or mortality (102).

- The HOT trial found that persons with diabetes randomly assigned to a target diastolic BP of 80 mm Hg had a 51% reduction in cardiovascular events (NNT, 8) and a 67% reduction in cardiovascular death (NNT, 14) after 5 years when compared with those assigned to a target of 90 mm Hg. Interestingly, lowering the diastolic BP target from 90 mm Hg to 80 mm Hg was not found to be beneficial in subjects without diabetes (103).

- In the UKPDS, newly diagnosed patients with type 2 diabetes and hypertension randomly assigned to tight BP control (≤150/85 mm Hg) for 10 years had a significant reduction in diabetes-related deaths (RR, 0.68 [CI, 0.49 to 0.94]), as well as a reduction in stroke (RR, 0.56 [CI, 0.35 to 0.89]), any diabetes-related endpoint (RR, 0.76 [CI 0.62 to 0.92]), and risk of microvascular complications. The NNT to prevent any diabetes complication was 6.1 (2.6 to 9.5), and to prevent a diabetes-related death, 15.0 (12.1 to 17.9) (104).

- Two other small randomized controlled trials have shown significant reductions in all-cause mortality (105) and in strokes (106) in patients with diabetes given intensive BP therapy.

Comments

- All of these studies were conducted predominantly in persons with clinically diagnosed diabetes rather than through screening.

4.4 Know that treatment of type 2 diabetes patients with microalbuminuria and overt nephropathy using ACE inhibitors and angiotensin-receptor blocking agents reduces the risk of nephropathy progression.

Evidence

- The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended ACE inhibitors and angiotensin-receptor blockers (but not both) for patients with nephropathy and suggested following urinary albumin excretion (48).

- A meta-analysis of various antihypertensive agents in diabetic nephropathy found that both ACE inhibitors and angiotensin-receptor blockers reduce progression from micro- to macroalbuminuria, but that only ACE inhibitors prevent all-cause mortality in patients with diabetic nephropathy (RR, 0.79 [CI, 0.63 to 0.99]) (107).

- ACE inhibitor treatment of normotensive and hypertensive type 2 diabetes patients with microalbuminuria decreases progression of proteinuria when compared to placebo or other antihypertensive agents (108; 109; 110).

- ACE inhibitor treatment has also been shown to preserve renal function to a greater extent than calcium-channel blocker or β-blocker treatment in type 2 diabetes patients with hypertension and overt nephropathy (urinary protein excretion >300 mg/d) (111; 112).

- Two large randomized controlled trials have shown that angiotensin-receptor blocking treatment can reduce the progression of renal function decline in hypertensive patients with type 2 diabetes and overt nephropathy when compared to placebo (113; 114).

- There are no studies that have directly compared ACE inhibitor to angiotensin-receptor blocking therapy.

4.5 Patients with diabetes and hypertension but without nephropathy should be treated with an ACE inhibitor as the first-line agent.

Evidence

- A meta-analysis of antihypertensive agents found that in patients with diabetes but no diabetic nephropathy, ACE inhibitors prevented microalbuminuria as compared with placebo (RR, 0.60 [CI,
0.43 to 0.84)) as compared with calcium-channel blockers (RR, 0.58 [CI, 0.40 to 0.84]) but did not prevent death or other complications in this population (107).

- The American Diabetes Association recommends the use of ACE inhibitors as first-line therapy in diabetic patients with hypertension (115).
- For diabetes patients without nephropathy, five studies have suggested that ACE inhibitors and angiotensin-receptor blocking agents may provide better protection than other agents against cardiovascular events (116; 117; 118; 119) and death (119; 120) and that this effect is at least partly independent of BP reduction.
- However, three large studies have failed to confirm an added benefit of ACE inhibitors over calcium-channel blockers or β-blockers in both hypertensive (121; 122) and normotensive (106) patients with diabetes. ALLHAT, which was a 4- to 8-year study of high-risk hypertensive patients, including over 12,000 with diabetes, found that lisinopril treatment was equivalent to diuretic treatment (chlorthalidone) in preventing cardiovascular events (122). In addition, diuretic treatment was associated with lower 6-year rates of CVD, stroke, and heart failure when compared to lisinopril therapy. Finally, a large meta-analysis of predominantly nondiabetic persons did not find that ACE inhibitors provided cardiovascular benefit over other types of drugs (mostly diuretics and β-blockers) for hypertension treatment (123).

4.6 Recognize that patients with diabetes derive substantial benefit through primary and secondary prevention of cardiovascular events and death with lipid-lowering treatment, even with near-normal baseline lipid levels.  

Evidence

- A Cochrane review of statins for primary prevention of cardiovascular disease found that statin therapy reduced all-cause mortality (RR=0.83). This study included patients with diabetes but was not specific to that population (124).
- A systematic review of patients with both type 1 and 2 diabetes and without diabetes included in randomized trials of statins showed that diabetic patients on statins had similar benefit to non-diabetic patients in terms of cardiovascular outcomes, with trends toward reduction in cardiovascular and all-cause mortality (125).
- A secondary analysis of two secondary prevention statin treatment studies found that only diabetes patients, and not those without diabetes, with LDL cholesterol levels <124 mg/dL (3.2 mmol/L) benefited from treatment (126).
- The MRC/BHF Heart Protection Study, a large trial of persons with CVD or at high risk for CVD, including 5963 patients with diabetes (both with and without previous CVD), found that treatment with simvastatin was associated with a significant decrease in cardiovascular deaths and overall mortality after 5 years (RR, 0.83 [CI, 0.75 to 0.91]) (127).
- A subgroup analysis of the diabetes patients in the MRC/BHF Heart Protection Study found that the cardiovascular mortality risk reduction with simvastatin was about 25, regardless of age, sex, or treatment for hypertension, and that the risk reduction remained significant even for those with LDL cholesterol levels <115.8 mg/dL (3.0 mmol/L). Furthermore, major cardiovascular events were reduced by 30% (NNT, 32; P = 0.05) even among the 1343 diabetes patients without known CVD whose LDL cholesterol was <115.8 mg/dL (3.0 mmol/L) at baseline (128).
- The National Cholesterol Education Program final report on treatment of high blood cholesterol in adults (ATPIII) recommends that type 2 diabetes be considered a coronary heart disease equivalent (goal LDL <100 mg/dL) (129).

Comments
Persons with diabetes have a two to three times higher baseline risk of CVD and may therefore derive even greater absolute benefit with lipid-lowering therapy than those without diabetes. The LDL cholesterol target recommended for persons with diabetes is <100 mg/dL (5.6 mmol/L).

4.7 **Note that patients with diabetes have similar relative benefits on CVD protection with ASA treatment as those without diabetes, but their absolute benefit may be greater due to their greater baseline risk of CVD.**

**Evidence**
- A meta-analysis of 145 randomized controlled trials of antiplatelet therapy for secondary prevention of cardiovascular events found that participants with diabetes had an equivalent 25% reduction in cardiovascular events as did those without diabetes (130).
- The Early Treatment Diabetic Retinopathy Study of type 1 and type 2 diabetes patients, 52% of whom had no previous CVD, found that ASA treatment significantly reduced the risk of MI by 28% over 5 years (131).
- For primary prevention of cardiovascular events, aspirin treatment was associated with a 15% cardiovascular event reduction (NNT, 63) in the HOT trial (103), and a 44% reduction in MI rates in participants over age 50 in the Physicians' Health Study (NNT, 54) (132). Both of these studies included over 1500 patients with diabetes.

**Comments**
- The baseline risk of CVD is two to three times higher in persons with diabetes compared to those without diabetes.

4.8 **Recognize that there is no evidence that initiation of foot care programs during the preclinical phase of diabetes provides additional benefit.**

**Evidence**
- Foot care programs have been shown to decrease the risk of amputation in persons with long-standing diabetes (133; 134; 135).
- No study has shown a benefit of initiating foot care programs in the preclinical phase of diabetes.
- The risk for amputation in the first 10 years after a clinical diabetes diagnosis is low (136).

4.9 **Know that there is no evidence that early aggressive therapy in patients with screen-detected diabetes leads to reductions in end-organ damage and limited evidence regarding the harms of early treatment, but the recommended treatments have been shown to be safe in those diagnosed clinically.**

**Evidence**
- A cluster-randomized trial in which 343 European general practices were randomly assigned to screening of non-diabetic adults (mean age, 60.3) followed by routine care of diabetes or screening followed by intensive treatment of multiple risk factors showed that the intervention to promote early intensive management among patients newly diagnosed with type 2 diabetes did not lead to a significant reduction in the incidence of first cardiovascular events within 5 years (hazard ratio, 0.83 [CI, 0.65 to 1.05]) (137).
- Treatment of hyperglycemia with oral hypoglycemic agents or insulin may lead to hypoglycemia; however, episodes of severe hypoglycemia are infrequent (2.3% of patients on insulin and 0.6% of patients on oral agents) (84).
• ACE inhibitors have fewer side effects than most antihypertensive agents and are associated with high rates of adherence. The most common dose-related side effect, a reversible cough, occurs in 5% to 20% of patients (138).

• Statins and fibrates also have low rates of serious adverse effects (139; 140).

• There is little evidence regarding the nonmedical harms of early diabetes treatment except one study that showed no effect on quality of life in diabetes patients 1 year after they were diagnosed through screening (76).
5. Direct Evidence that Screening Reduces Adverse Outcomes

5.1 Know that there is no direct evidence that screening for diabetes reduces adverse outcomes, and limited evidence that screening does not reduce overall mortality.\[36\]

Evidence
- The Ely cohort study of men and women age 40 to 65 evaluated the long-term impact on overall mortality of invitation to screen for type 2 diabetes. Invitation to screening was associated with trend toward reduction in the adjusted hazard of mortality (HR, 0.79 [CI, 0.63 to 1.00]) among those who had been invited to screen between 1990 and 1999 with no reduction in the cohort who had been invited to screen between 2000 and 2008 (141).

5.2 Understand that there is fair evidence that detecting diabetes in persons with CVD, hypertension, dyslipidemia, and other CVD risk factors improves estimates of CVD risk and may increase their risk to a level worthy of interventions that have been shown to reduce CVD events in diabetes patients.\[7\]

Evidence
- Based on Framingham data, the risk of cardiovascular events in patients with diabetes is two to three times greater than in those without diabetes, and that risk crosses the 10% threshold by age 55 in men and age 60 in women (39; 40).
- The benefits of screening for type 2 diabetes depend largely on baseline CVD risk, and the benefits may be greatest in those with a baseline 10-year CVD risk of >8% (43).
- Treatment of adults with aspirin reduces primary and secondary CVD risk by 15% to 44% (103; 130; 131; 132) (see information on ASA treatment), and statin therapy reduces primary and secondary CVD risk by 25% to 30% (127; 128; 142; 143; 144; 145; 146; 147) (see information on lipid-lowering treatment).
- Aggressive BP control of hypertensive patients reduces CVD events by 32% to 51% (103; 104) and CVD mortality by 67% (103) in diabetes patients only (see information on BP control).
- If 90% of screened hypertensive persons with diabetes received tight BP control for 5 years, the estimated number needed to screen to prevent one CVD event would be 500 (79).
- A review of the evidence for the USPSTF on screening for type 2 diabetes found that there is a lack of direct evidence on the health benefits for screening of type 2 diabetes by either targeted or mass screening, and indirect evidence also fails to show health benefits for screening general populations. However, persons with hypertension probably benefit from screening, because blood pressure targets for persons with diabetes are lower than those for persons without diabetes (148).

5.3 Know that there is insufficient evidence that screening for diabetes in persons at low risk for CVD reduces adverse outcomes.\[8\]

Evidence
- The benefits of screening for type 2 diabetes on CVD events depend largely on baseline CVD risk, and the benefits may be greatest in patients with a baseline 10-year CVD risk of >8% (43).
- There is insufficient evidence that interventions such as tight glycemic control aimed at reducing non-CVD events such as microvascular disease provide benefit when initiated at an asymptomatic
screening stage (84; 85; 86; 87; 88; 89; 90; 91; 92; 93; 94) (see information on glycemic control).

- If 90% of screened patients with diabetes received tight glycemic control for 5 years, the estimated number needed to screen to prevent one case of blindness would be 4300 (79).
6. Frequency

6.1 Repeat screening for diabetes in at-risk adults 18 years or older every 3 years or more frequently if clinically indicated.

Evidence

- The 2014 Standards of Medical Care in Diabetes from the American Diabetes Association recommended screening all patients over age 45 and younger patients who are overweight or obese and have one additional risk factor every 3 years (48).
- The prevalence of diabetes increases by about 6% to 8% per decade, and it plateaus above the age of 75 years (8).
- There is no good evidence regarding frequency of diabetes screening; a recommended 3-year interval is based on an expert panel (149).
7. Cost-Effectiveness

7.1 Recognize that one-time screening with an FBG test for type 2 diabetes in all adults aged 25 or older may reduce the lifetime incidence of diabetes complications and result in gains in both QALY and life-years.

Evidence

- A high-quality cost-effectiveness analysis estimated the cost-effectiveness of universal and targeted (only patients with hypertension) screening for type 2 diabetes. The analysis found that targeted screening was more cost-effective, with cost per QALY less than $50,000 for targeted screening of patients at age 45, 55, 65, or 75. Screening of patients at age 65 was most cost-effective, at $31,228 per QALY. Universal screening was only cost-effective at a threshold of $50,000 per QALY at age 75 ($48,146 per QALY) (150).

- A second cost-effectiveness analysis estimated that compared to no screening, nearly all simulated screening strategies in the U.S. population were cost effective at standard thresholds, including strategies of screening beginning at age 30, 45, and 60 at intervals of 1 to 5 years and targeted screening of patients with hypertension. The overall most cost-effective strategy was screening patients with hypertension every 3 years ($6287 per QALY) and the most cost-effective population-based strategy was screening every 3 years beginning at age 45 ($9731 per QALY). The study was limited by the fact that it did not use many standard cost-effectiveness analysis techniques (151).

- A cost-effectiveness analysis of treatment for type 2 diabetes found that the cost-effectiveness ratio of intensive glycemic control was $41,384 per QALY, and was $51,889 per QALY for lipid-lowering treatment. Intensive hypertension control reduced costs and improved health outcomes with a ratio of -$1,959 per QALY (152).

7.2 Appreciate that the benefits of screening for type 2 diabetes depend largely on the baseline CVD risk and that the benefits may outweigh the harms for persons with a 10-year CVD risk of over 8% to 10%.

Evidence

- A decision analysis found that screening for type 2 diabetes in patients between the ages of 45 to 60 years using an FBG test was associated with a savings of 10 QALYs for every 10,000 individuals screened, with a gain of 4 QALYs from postponed microvascular complications and 17 QALYs from avoided CVD events. Furthermore, the benefit of screening depended largely on the baseline CVD risk, with the benefits outweighing the harms of screening for patients with a 10-year risk over 8% (43).
8. Patient Counseling

8.1 Recognize that no evidence exists that patient education strategies improve screening strategies for diabetes.  

Evidence
- No studies have examined whether patient education strategies have increased screening strategies for diabetes.

8.2 Appreciate that patient lifestyle counseling programs aimed at dietary and exercise modification initiated in overweight persons with the prediabetic state of impaired glucose tolerance can prevent the progression to diabetes.  

Evidence
- Three randomized controlled trials have examined the effect of intensive lifestyle interventions in overweight persons with impaired glucose tolerance on the incidence of diabetes, the largest of which was conducted in the U.S. (the Diabetes Prevention Program). These studies all found that programs providing regular individual counseling sessions on dietary and exercise advice aimed at reducing and maintaining a 5% to 7% weight loss resulted in a 42% to 58% reduction in progression to diabetes over 3 to 6 years (153; 154; 155).

Comments
- Impaired glucose tolerance is an asymptomatic condition that can only be detected through screening.

8.3 Know that diabetes education strategies involving patient collaboration have been shown to improve glycemic control, weight loss, and lipid profiles in patients with type 2 diabetes.  

Evidence
- A systematic review of the literature identified 72 randomized controlled trials of patient self-management training strategies for type 2 diabetes patients. These trials included education on self-care, dietary modifications, and increased physical activity. Interventions using regular reinforcement throughout follow-up and those involving patient collaboration were most effective at improving glycemic control and weight and lipid profiles (156).
- A meta-analysis of 31 randomized controlled trials of self-management education for type 2 diabetes patients found that education strategies immediately reduce HbA1c by a mean 0.76% (0.34% to 1.18%), and by a mean of 0.26% (0.05% to 0.48%) after 4 months or more. The benefits of diabetes education are related to the amount of contact time between patient and educator, with an estimated 1% decrease in HbA1c for every 23.6 hours of contact (157).
9. Referral/Consultation

9.1 Refer all patients with evidence of type 1 diabetes for consultation with an endocrinologist or diabetes specialist.

Evidence
- A prospective study of type 1 diabetes patients found that those who received specialist care for their diabetes had significantly lower HbA1c levels than those who did not (9.7% vs. 10.3%; \( P = 0.0006 \)). These patients were also more likely to have received diabetes education, to have an HbA1c test in the previous 6 months, to self-monitor their glucose levels, and to inject insulin more than twice daily than those who did not receive specialist care (158).
- Specialist care may also be protective against the development of complications in this population, with a trend towards decreased nephropathy, neuropathy, and CVD (159).

9.2 Refer all diabetic pregnant patients for prenatal care from a diabetes specialist and an obstetrician specializing in high-risk patients.

Evidence
- Programs focusing on strict prenatal glycemic control and antepartum fetal surveillance have been associated with a reduction in perinatal deaths and congenital malformations among offspring of women with diabetes (160).

9.3 Refer all patients with diabetes who are planning a pregnancy for preconception counseling.

Evidence
- A meta-analysis of 14 cohort studies of preconception care for women with diabetes found that the offspring of women who had preconception counseling had significantly lower rates of major and minor congenital anomalies (161).

9.4 Patients with evidence of severe or rapidly progressive diabetes complications should be referred to a diabetes specialist for more intensive treatment.

Evidence
- There are no studies that have specifically examined the benefits of specialist care for persons with severe complications of diabetes.
- There is some evidence that foot ulcer and avoidable hospitalization rates are reduced for patients with diabetes who were cared for by specialists (162; 163).
References


42. Evans JM, Wang J, Morris AD. Comparison of cardiovascular risk between patients with type 2 diabetes and those who had had a myocardial infarction: cross sectional and cohort studies. BMJ. 2002;324:939-42. (PMID: 11964337)


Screening for Type 2 Diabetes


New


Screening for Type 2 Diabetes


77. Feldman W. How serious are the adverse effects of screening? J Gen Intern Med. 1990;5:S50-3. (PMID: 2231065)


new


Screening for Type 2 Diabetes


new


new


new


new


new


163. Greenfield S, Rogers W, Mangotich M, Carney MF, Tarlov AR. Outcomes of patients with hypertension and non-insulin dependent diabetes mellitus treated by different systems and specialties. Results from the medical outcomes study. JAMA. 1995;274:1436-44. (PMID: 7474189)
Glossary

ACE
angiotensin-converting enzyme

ASA
acetylsalicylic acid

AROC
area under receiver operator curves

BMI
body mass index

BP
blood pressure

CAD
coronary artery disease

CBG
capillary blood glucose

CI
confidence interval

CVD
cardiovascular disease

FBG
fasting blood glucose

HDL
high-density lipoprotein

HMG-CoA
3-hydroxy-3-methylglutaryl coenzyme A

HbA1c
glycosylated hemoglobin

LDL
low-density lipoprotein

MI
myocardial infarction

NNT
number needed to treat

OGTT
oral glucose tolerance test

PG
postglucose

QALY
quality-adjusted life-year

RR
risk ratio

RRR
relative risk ratio

SD
standard deviation
Screening for Type 2 Diabetes

Acronyms

ADA
American Diabetes Association

ALLHAT
Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial

ASCOT
Anglo-Scandinavian Cardiac Outcomes Trial

CTF
Canadian Task Force on Preventive Medicine

HOT
Hypertension Optimal Treatment trial

JNC 8
Eighth Joint National Committee

MRC/BHF
Medical Research Council/British Heart Foundation

NCEP
National Cholesterol Education Program

NHANES III
Third National Health and Nutrition Examination Survey

SIGT
Screening for Glucose Tolerance Study

UKPDS
United Kingdom Prospective Diabetic Study

USPSTF
U.S. Preventive Services Task Force
### Operating Characteristics for Various Tests in Screening for Diabetes

<table>
<thead>
<tr>
<th>Disease/Condition</th>
<th>Gold Standard</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Likelihood Ratio Positive</th>
<th>Likelihood Ratio Negative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBG* ≥126 mg/dL</td>
<td>2-hour PG* ≥200 mg/dL after 75-g OGTT</td>
<td>31-79</td>
<td>96-99</td>
<td>19.8-31.0</td>
<td>0.22-0.70</td>
<td>Performance varies depending on the population</td>
</tr>
<tr>
<td>Other thresholds of FBG*: ≥110 mg/dL ≥103 mg/dL</td>
<td>2-hour PG* ≥200 mg/dL after 75-g OGTT</td>
<td>65-95</td>
<td>90-96</td>
<td>9.5-16.5</td>
<td>0.06-0.34</td>
<td>0.19</td>
</tr>
<tr>
<td>HbA1c: ≥5.6% 5.9% ≥6.1% ≥4 SD above mean</td>
<td>2-hour PG* ≥200 mg/dL after 75-g OGTT</td>
<td>83</td>
<td>84</td>
<td>5.2</td>
<td>0.20</td>
<td>0.32</td>
</tr>
<tr>
<td>CBG* ≥121 mg/dL</td>
<td>2-hour PG* ≥200 mg/dL after 75-g OGTT</td>
<td>78</td>
<td>86</td>
<td>5.6</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Questionnaires</td>
<td>2-hour PG* ≥200 mg/dL after 75-g OGTT</td>
<td>72-78</td>
<td>50-68</td>
<td>1.6-2.3</td>
<td>0.41-0.44</td>
<td></td>
</tr>
</tbody>
</table>

CBG = capillary blood glucose; FBG = fasting blood glucose; OGTT = oral glucose tolerance test; PG = postglucose; SD = standard deviation.

*Divide by 18 to obtain SI values (mmol/L).
## Posttest Probability of Type 2 Diabetes After Screening Tests

<table>
<thead>
<tr>
<th>Disease(s)</th>
<th>Posttest Probabilities of Disease if Pretest Clinical Probability is Low (&lt;10%)</th>
<th>Posttest Probabilities of Disease if Pretest Clinical Probability is Intermediate (10%-30%)</th>
<th>Posttest Probabilities of Disease if Pretest Clinical Probability ColHdC::is High (&gt;30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBG ≥126 mg/dL (7.0 mmol/L)</td>
<td>30%-70%</td>
<td>70%-90%</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>FBG ≥110 mg/dL (6.1 mmol/L)</td>
<td>25%-60%</td>
<td>60%-80%</td>
<td>&gt;80%</td>
</tr>
<tr>
<td>FBG ≥103 mg/dL (5.7 mmol/L)</td>
<td>5%-40%</td>
<td>40%-70%</td>
<td>70%-90%</td>
</tr>
<tr>
<td>HbA1c ≥5.6%</td>
<td>5%-30%</td>
<td>30%-70%</td>
<td>70%-95%</td>
</tr>
<tr>
<td>HbA1c ≥5.9%</td>
<td>2%-20%</td>
<td>20%-50%</td>
<td>50%-90%</td>
</tr>
<tr>
<td>HbA1c ≥6.1%</td>
<td>30%-70%</td>
<td>70%-90%</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>CBG ≥121 mg/dL (6.7 mmol/L)</td>
<td>5%-30%</td>
<td>30%-70%</td>
<td>70%-95%</td>
</tr>
</tbody>
</table>

CBG = capillary blood glucose; FBG = fasting blood glucose.