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In the Clinic®

Type 2 Diabetes

Type 2 diabetes (T2D) is a prevalent disease that increases risk for vascular, renal, and neurologic complications. Prevention and treatment of T2D and its complications are paramount. Many advancements in T2D care have emerged over the past 5 years, including increased understanding of the importance of early intensive glycemic control, mental health, social determinants of health, healthy eating patterns, continuous glucose monitoring, and the benefits of some drugs for preventing cardiorenal disease. This review summarizes the evidence supporting T2D prevention and treatment, focusing on aspects that are commonly in the purview of primary care physicians.

Screening and Prevention

Diagnosis and Evaluation

Treatment

Practice Improvement

CME/MOC activity available at Annals.org.

Physician Writers
Allison L. Crawford, MD, MS
Neda Laiteerapong, MD, MS
The University of Chicago Medical Center, Chicago, Illinois (A.L.C.)
University of Chicago, Chicago, Illinois (N.L.)

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Type 2 diabetes (T2D) is among the most common diseases encountered by internal medicine physicians. Data from 2021 indicate that more than 38 million people in the United States have diabetes and about 90% to 95% of them have T2D. Incidence is expected to increase due to aging, the changing U.S. ethnic mix, and the increasing prevalence of obesity. An estimated 8.7 million people have undiagnosed diabetes, and 98 million (38% of U.S. adults) have prediabetes, defined as impaired fasting glucose level or impaired glucose tolerance (1). Diabetes is a leading cause of vision loss, amputation, and end-stage renal disease in the United States and is a substantial risk factor for atherosclerotic disease, the leading cause of morbidity, mortality, and expenditures in persons with T2D (2). Although population-based cardiovascular risk factor (CVRF) control has improved since 2000, only 1 in 5 U.S. adults achieve control of hemoglobin A_{1c} (HbA_{1c}), blood pressure (BP), and cholesterol, and control is lower among young adults and racial or ethnic minority populations (3).

Screening and Prevention

Whom should we screen for T2D?

Diabetes has a long asymptomatic phase during which some people develop early complications, such as retinopathy or microalbuminuria. Early treatment of T2D has been shown to improve outcomes (4). Because early intervention can delay development of T2D and/or its complications, screening is most likely to improve outcomes in adults with risk factors for cardiovascular disease (CVD) and adults for whom T2D confers a higher risk for complications (**Box:** Risk Factors for T2D). The 2024 American Diabetes Association (ADA) guidelines recommend that all adults be screened beginning at age 35 years (or before if they have risk factors, such as elevated body mass index [BMI]) and that clinicians should offer or refer patients with prediabetes to effective preventive interventions (5). Similarly, the U.S. Preventive Services Task Force (USPSTF) recommends screening in adults with overweight and obesity every 3 years, as well as adults at increased risk for diabetes (**Box:** Risk Factors for T2D) (2).

Strong evidence shows that intensive glycemic control in people newly diagnosed with T2D improves long-term outcomes (6–8), although some of these benefits may take at least a decade to appear (6–8). Moreover, the benefits of early intensive glycemic control seem to extend beyond the period of intensive control, a phenomenon called "legacy effects" or "metabolic memory" (4, 9, 10).

Risk Factors for T2D

- Age ≥35 years
- Black/African American, Hispanic/Latino, Asian, Pacific Islander, or Native American race/ethnicity
- First-degree relative with T2D
- Physical inactivity
- Smoking
- History of gestational diabetes or delivery of infant weighing ≥9 lb
- Overweight (BMI ≥25 kg/m^2 [≥23 kg/m^2 in Asian persons])
- Polycystic ovary syndrome
- HIV
- Prediabetes, impaired glucose tolerance, or impaired fasting glucose
- CVD, hypertension, dyslipidemia, or other features of metabolic syndrome
- Use of thiazide diuretics (chlorthalidone), first- and second-generation β-blockers (metoprolol, propranolol), high doses of calcium-channel blockers (nifedipine, diltiazem), high-potency statins (atorvastatin, rosuvastatin), glucocorticoids, HIV medications, atypical antipsychotics, oral contraceptives

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Can T2D be prevented?

T2D can be prevented through intensive changes in diet and exercise and treatment with metformin. The USPSTF recommends lifestyle interventions in patients with prediabetes because evidence suggests a moderate reduction in progression to T2D and improvements in other CVRFs (11). High-quality randomized controlled trials (RCTs) suggest diet and exercise can lead to modest weight loss (generally 5% to 7%) that mitigates progression to T2D among adults with overweight or obesity and prediabetes (12–14).

The Diabetes Prevention Program, an RCT of 3234 U.S. patients with prediabetes (mean age, 51 years; mean BMI, 34 kg/m^2), showed that an intensive lifestyle modification program aimed at a 7% weight loss reduced T2D incidence from 29% to 14% over 3 years (relative risk [RR], 0.42 [95% CI, 0.34 to 0.52]) versus placebo (12). A smaller reduction was noted in patients assigned to metformin (850 mg twice daily) (29% vs. 22%; RR, 0.69 [CI, 0.57 to 0.83]) versus placebo (12), although not among people aged 60 years or older. Both treatment groups regained some weight over time; incidence of T2D at 10 years was 34% and 18%, respectively (13).

Thus, clinicians should counsel patients to reduce caloric intake by 500 to 1000 kcal/d and engage in 150 minutes of moderate physical activity per week with a goal of achieving weight loss of 5% to 10% (15). If intensive lifestyle changes cannot be implemented, clinicians may consider adding metformin.

Screening and Prevention... Screening for T2D in patients with risk factors may lead to earlier treatment and fewer complications. In patients with prediabetes, intensive lifestyle programs aimed at weight loss that include reducing calories and increasing physical activity can prevent T2D; metformin may be considered.

CLINICAL BOTTOM LINE

Diagnosis and Evaluation

What are the diagnostic criteria for T2D in nonpregnant adults?

In patients with unequivocal symptoms of hyperglycemia (polyuria, polydipsia, weight loss), a single random plasma glucose level of 200 mg/dL (11.1 mmol/L) or higher is diagnostic. Per the ADA (5), diagnosis can also be based on 2 abnormal results from different tests on the same sample (for example, fasting plasma glucose and HbA_{1c}) or from different tests or the same test on different samples (for example, 2 HbA_{1c} tests). Thresholds for diagnostic tests (**Table 1**) include fasting plasma glucose level of 126 mg/dL (7.0 mmol/L) or higher, HbA_{1c} level of 6.5% or higher, or an oral glucose tolerance test with a 2-hour plasma glucose level of 200 mg/dL or higher. Point-of-care HbA_{1c} assays that are NGSP-certified and approved by the U.S. Food and Drug Administration (FDA) can also be used. If patients have conditions that change the relationship between HbA_{1c} and glycemia (such as pregnancy, hemoglobinopathies, glucose-6-phosphate dehydrogenase deficiency, HIV, hemodialysis, or recent blood loss), only plasma blood glucose should be used to diagnose T2D (5). In addition, for a given mean glucose value, Black patients may have HbA_{1c} values that are 0.33 percentage points higher than those in White patients, potentially leading to premature T2D diagnoses and overtreatment (16). An HbA_{1c} threshold of 6.5% or higher may also miss some T2D cases; a lower threshold of 6.03% had the highest sensitivity in one meta-analysis (17). Thus, if clinical suspicion is high but results are borderline, another test should be used.

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Table 1. **Diagnostic Criteria for Type 2 Diabetes***

Random Plasma Blood Glucose Level With Unequivocal Hyperglycemia Symptoms	*Two Abnormal Test Results From the Same or Different Samples*		
	Hemoglobin A_{1c} Level	*8-Hour Fasting Plasma Glucose Level*	*2-Hour Plasma Glucose Level During an Oral Glucose Tolerance Test*
≥200 mg/dL (≥11.1 mmol/L) with classic symptoms	≥6.5% (≥48 mmol/mol)	≥126 mg/dL (≥7.0 mmol/L)	≥200 mg/dL (≥11.1 mmol/L)

* *Data are from reference 2.*

What should initial evaluation of patients with newly diagnosed T2D include?

The goal of initial evaluation of patients with newly diagnosed T2D should be to identify CVRFs and diabetic complications that would guide management. The ADA recommends a detailed history that assesses risk factors for and poor control of T2D complications; reviews diet, body weight, physical activity, sleep, family history of T2D, social history, vaccine history, and fracture risk; and assesses for CVD, cerebrovascular disease, neuropathy, peripheral vascular disease, sleep apnea, bone health, erectile dysfunction, depression, anxiety, and disordered eating (18). The physical examination should include assessment of BMI and BP and inspection for possible T2D complications via CV, neurologic, skin, and foot examinations. Patients aged 65 years or older should be assessed for cognitive impairment.

Initial laboratory tests should assess glucose control (HbA_{1c} level), fasting lipid profile, nephropathy (urinary microalbumin–creatinine ratio and serum creatinine), and liver aminotransferases (to detect fatty liver disease). At diagnosis, patients should be referred to an optometrist or ophthalmologist for a dilated eye examination and comprehensive assessment to evaluate for retinopathy.

The ADA also recommends evaluating for symptoms of comorbid distress, depression, anxiety, and disordered eating (19). Social history should include assessment for food insecurity, housing instability, financial barriers, and social support (20), as social determinants of health influence T2D outcomes (20).

Diagnosis and Evaluation... Diagnosis of T2D is based on classic symptoms and a random blood glucose level of 200 mg/dL or higher, or 2 abnormal test results on the same or different samples. Initial evaluation includes a comprehensive history, physical examination, and laboratory testing to assess risk factors, comorbidities, and T2D complications.

CLINICAL BOTTOM LINE

Treatment

The goals of management are to decrease risk for diabetes-related complications by achieving normal glucose levels (especially in people who are newly diagnosed) while minimizing risk for hypoglycemia.

What nonpharmacologic interventions are effective in glycemic control for patients with T2D?

Because weight loss improves glycemic control in people with overweight or obesity, the ADA recommends intensive behavioral lifestyle interventions that include diet and exercise modifications (21) with a goal of achieving at least a 5% weight loss.

Various diets and eating patterns are recommended, including DASH (Dietary Approaches to Stop Hypertension), Mediterranean, high-fiber, low-fat, vegetarian, vegan, and low-carbohydrate

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diets. Whole-foods plant-based, DASH, and Mediterranean diets have been shown to confer cardioprotective benefits (22). Although a range of cardioprotective eating patterns exist, they share many principles. Recommended diets emphasize nonstarchy vegetables, fruits, and whole grains as well as low-fat dairy products, minimal added sugars, and minimally processed foods (**Appendix Table 1**, available at Annals.org). The ADA recommends nutrient-dense, high-fiber foods; carbohydrates from nonstarchy vegetables, fruits, and whole grains; dairy products with minimal added sugar (21); Mediterranean-style diets rich in monounsaturated and polyunsaturated fats as well as foods rich in omega-3 fatty acids, such as fatty fish, nuts, and seeds; and intake of water instead of sugar-sweetened beverages (including fruit juices). These eating patterns have been associated with improved insulin resistance (23).

Patients with elevated BMI (≥25 kg/m^2 [≥23 kg/m^2 for Asian persons]) should be advised to reduce caloric intake by 500 to 1000 kcal/d by focusing on foods with low caloric density, such as lean protein, fruits, and nonstarchy vegetables, as well as limited added sugar and refined carbohydrates. Many structured diets that allow lower caloric intake have been shown to improve weight loss; thus, counseling should focus on strategies that individual patients can adhere to. Additional information about effective eating plans to produce weight loss are available in the In the Clinic on obesity (15).

The ADA recommends at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week and at least 2 days of resistance training per week, which have been shown to reduce HbA_{1c} level, decrease weight, and improve CVRFs (21). Ideally, aerobic physical activity and resistance training should be distributed across the week.

What is the target HbA_{1c} level?

HbA_{1c} is the main measure of glycemic control, and the target level should be individualized to the patient. Major RCTs confirm that lowering HbA_{1c} level decreases risk for microvascular complications in patients with newly diagnosed (6, 7) and established (24, 25) diabetes, although the reduction in macrovascular complications appears to take decades to accrue (8) and may not apply to patients with established diabetes (26–28).

In the UKPDS (United Kingdom Prospective Diabetes Study), patients with newly diagnosed diabetes who were randomly assigned to intensive control (mean achieved HbA_{1c} level of 7.0%) had lower rates of early, asymptomatic microvascular outcomes (8.6 vs. 11.4 per 1000 patient-years) but not clear benefits for CV outcomes versus those in the control group (mean achieved HbA_{1c} level of 7.9%) (7). In a 20-year follow-up study, the group initially assigned to intensive control had lower rates of myocardial infarction (MI) (16.8 vs. 19.6 per 1000 patient-years) and death (26.8 vs. 30.3 per 1000 patient-years), even though differences in glycemic control were not maintained between groups (8).

Subsequent trials in patients with established diabetes affirmed benefits of glycemic control for microvascular complications (24, 25) but not for macrovascular outcomes (26–28); 1 trial showed increased risk for death (29).

In ADVANCE (Action in Diabetes and Vascular Disease: Preterax and Diamicron-MR Controlled Evaluation), 11 140 patients with T2D (mean age, 66 years; mean T2D duration, 8 years; 32% with prior CV event) who were randomly assigned to intensive control (mean HbA_{1c} level of 6.5% vs. 7.3% in the control group) (30) had reduced nephropathy (4.1% vs. 5.2%; P = 0.006) but no change in CV events or mortality after a median of 5 years. In posttrial follow-up, the intensive control group had lower rates of end-stage renal disease but no change

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in CV events or all-cause mortality (24, 31).

In the VADT (Veterans Affairs Diabetes Trial) of 1791 older veterans with long-standing diabetes (mean diabetes duration, 11.5 years; 40% with a prior CV event) (26), intensive control did not have a greater effect on the primary composite outcome (CV events, heart failure, vascular surgery, and amputation; mortality; or microvascular events) despite achieving greater HbA_{1c} reduction (mean, 6.9% vs. 8.4%) after a median of 5.6 years. However, there was a reduction in albuminuria (26). After 15 years of follow-up, mortality (hazard ratio [HR], 1.02 [CI, 0.88 to 1.18]) and CVD risk (HR, 0.91 [CI, 0.78 to 1.06]) did not differ between groups (27).

ACCORD (Action to Control Cardiovascular Risk in Diabetes), an RCT of 10 251 U.S. patients with T2D (mean age, 62.2 years; median T2D duration, 10 years; 35% with a prior CV event) (29), was stopped early because of a 22% increase in mortality in the intensive control group (5.0% vs. 4.0%; $P = 0.04$). The primary end point (nonfatal MI, nonfatal stroke, and CV death) did not differ between groups. Long-term follow-up suggested an ongoing greater risk for CV events (28) but lower rates of retinopathy with intensive control (25).

Given the overall evidence, the target HbA_{1c} level should be individualized depending on duration of T2D, prior diabetic complications, age, life expectancy, risk for hypoglycemia, overall health, and patient preferences. The ADA recommends an HbA_{1c} target of less than 7.0% for many nonpregnant adults if it is achievable without significant hypoglycemia (5); lower HbA_{1c} goals may be reasonable based on patient preference and clinician judgment if they are achievable without significant hypoglycemia, and higher HbA_{1c} targets may be reasonable when harms of treatment outweigh potential benefits and for patients with short life expectancy. In contrast, in its 2017 guidance statement, the American College of Physicians (ACP) recommended that most people with T2D have an HbA_{1c} level of 7% to 8%, as lower targets were not found to reduce mortality or macrovascular benefit but did result in significant harms in addition to hypoglycemia. However, for those with a life expectancy longer than 15 years, ACP acknowledged that a lower target may be reasonable (32).

When should treatment include pharmacotherapy?

Once an HbA_{1c} goal has been established, pharmacologic management should be instituted if lifestyle changes alone do not achieve the goal within approximately 6 to 8 weeks. Patients with severe hyperglycemia (random blood glucose level consistently ≥180 mg/dL [≥10.0 mmol/L]) or symptoms (polydipsia, polyuria, weight loss) require immediate pharmacologic intervention.

How should physicians select noninsulin glucose-lowering pharmacotherapies?

There are many noninsulin pharmacologic options, making selection of a glucose-lowering medication challenging. Selection should consider the patient's level of glycemic control; the agent's efficacy in achieving glycemic control and its other therapeutic benefits; the patient's risk for atherosclerotic cardiovascular disease (ASCVD), heart failure, renal protection, and obesity; drug costs; and the patient's preferences.

Table 2 provides an overview of the major classes of noninsulin agents available to treat T2D, their relative efficacy, and clinical considerations based on the 2024 ADA guidelines (33). Biguanides, sodium–glucose cotransporter-2 inhibitors (SGLT2-Is), and glucagon-like peptide-1 receptor agonists (GLP-1RAs) are most often considered first-line treatment depending on patients' underlying ASCVD risk and comorbidities.

Biguanides, such as metformin, decrease gluconeogenesis in the liver, thereby reducing blood glucose. SGLT2-Is (dapagliflozin, empagliflozin)

Table 2. **Major Noninsulin Medications Available in the United States for Type 2 Diabetes***

Drug Class	Indication	Name	HbA_{1c} Efficacy	Weight Loss	Other Benefits	Initial Dose	Maximum Dose	Usual Dose	Considerations
Biguanides†	Patients without ASCVD, HF, CKD, high risk for ASCVD, or overweight or obesity based on BMI	Metformin	High	Neutral	–	500 mg twice daily or 850 mg/d	2550 mg/d	500–1000 mg twice daily	GI tolerance may be improved with slow titration or using extended-release; monitor for vitamin B deficiency
		Metformin extended-release				500 mg/d	2000 mg/d	1500–2000 mg/d	
SGLT2-Is†	Patients with ASCVD, HF, CKD, high risk for ASCVD, or overweight or obesity based on BMI‡	Canagliflozin	Intermediate or high	Intermediate	↓CV death, nonfatal MI, nonfatal stroke ↓HF hospitalization ↓End-stage renal disease	100 mg/d	300 mg/d	100–300 mg/d	Increased risk for genital mycotic infections (rare reports of perineum necrotizing fasciitis); affects volume status
		Empagliflozin			↓CV death ↓HF hospitalization ↓Death ↓End-stage renal disease	10 mg/d	25 mg/d	10–25 mg/d	
		Dapagliflozin			↓CV death ↓HF hospitalization	5 mg/d	10 mg/d	5–10 mg/d	
		Ertugliflozin			–	5 mg/d	15 mg/d	5–15 mg/d	
GLP-1RAs†§	Patients with ASCVD, HF, CKD, high risk for ASCVD, or overweight or obesity based on BMI‡	Semaglutide	High or very high	Very high	↓CV death, nonfatal MI, nonfatal stroke ↓Nephropathy	0.25 mg/wk	1 mg/wk	0.5 mg/wk	All injectable, and semaglutide also available as oral; ↑risk for thyroid c-cell tumors in rodents; possible ↑risk for pancreatitis, gallbladder disease; GI tolerance may improve with dietary modifications
		Dulaglutide		High	↓CV death, nonfatal MI, nonfatal stroke ↓Nephropathy	0.75 mg/wk	1.5 mg/wk	0.75–1.5 mg/wk	
		Liraglutide		High	↓CV death, nonfatal MI, nonfatal stroke	0.6 mg/d	1.8 mg/d	1.2 mg/d	
		Exenatide		Intermediate	–	5 mcg twice daily (≤60 min before meals)	10 mcg twice daily	5–10 mcg/d	
		Exenatide extended-release		Intermediate	–	2 mg once per week	2 mg once per week	2 mg once per week	
		Lixisenatide		Intermediate	–	10 mcg/d	20 mcg/d	20 mcg/d	
GLP-1/GIP receptor agonist†§ (injection)	Patients with overweight or obesity based on BMI and without ASCVD, HF, CKD, or high risk for ASCVD	Tirzepatide	Very high	Very high	–	2.5 mg weekly for 4 wk, then 5 mg weekly; increase by 2.5 mg/wk every 4 wk	15 mg/wk	–	Same as GLP-1RAs
DPP-4Is§	–	Sitagliptin	Intermediate	Neutral	–	100 mg/d	100 mg/d	100 mg/d	Possible ↑risk for pancreatitis, joint pain, bullous pemphigoid; evaluate for gallbladder disease
		Saxagliptin				2.5 mg/d	5 mg/d	5 mg/d	
		Linagliptin				5 mg/d	5 mg/d	5 mg/d	
		Alogliptin				25 mg/d	25 mg/d	25 mg/d	
Thiazolidinediones	–	Pioglitazone	High	Neutral to mild weight gain	–	15–30 mg/d	45 mg/d	15–45 mg/d	↑risk for heart failure, fluid retention, fracture; benefits in nonalcoholic fatty liver disease
		Rosiglitazone				4 mg/d (or twice daily)	8 mg/d	4–8 mg/d (or twice daily)	
Sulfonylureas (second generation)	–	Glimepiride	High	Mild weight gain	–	1–2 mg/d	8 mg/d	4 mg/d	Increases hypoglycemia
		Glipizide				2.5–5 mg/d	40 mg/d	10–20 mg/d (or twice daily)	
		Glipizide sustained-release				5 mg/d	20 mg/d	5–20 mg/d (or twice daily)	
		Glyburide†				2.5–5 mg/d	20 mg/d	5–20 mg/d (or twice daily)	
		Glyburide micronized†				0.75–3 mg/d	12 mg/d	3–12 mg/d (or twice daily)	

ASCVD = atherosclerotic cardiovascular disease; BMI = body mass index; CKD = chronic kidney disease; CV = cardiovascular; DPP-4I = dipeptidyl peptidase-4 inhibitor; GI = gastrointestinal; GIP = glucose-dependent insulinotropic polypeptide; GLP-1RA = glucagon-like peptide-1 receptor agonist; HbA_{1c} = hemoglobin A_{1c}; HF = heart failure; MI = myocardial infarction; SGLT2-I = sodium–glucose cotransporter-2 inhibitor.

** Data are from reference 33.*

† Not recommended in pregnant persons.

‡ Effects of GLP-1RAs and SGLT2-Is in patients with ASCVD, HF, and CKD and at high risk for ASCVD differ within each class. See "Other Benefits" for details.

§ GLP-1RAs and DPP-4Is should not be combined.

reduce reabsorption of renally filtered glucose, which promotes renal excretion of glucose. GLP-1RAs (linagliptin, liraglutide, semaglutide), GLP-1/glucose-dependent insulinotropic polypeptide (GIP) receptor agonists (tirzepatide), and dipeptidyl peptidase-4 inhibitors (DPP-4Is) (alogliptin, linagliptin, saxagliptin, sitagliptin) all work through mechanisms that promote insulin release, which enhances insulin sensitivity, and also decrease glucagon. GLP-1RAs differ from DPP-4Is in also increasing satiety and slowing gastric emptying. Thiazolidinediones work by increasing insulin sensitivity and glucose utilization. Sulfonylureas work by stimulating pancreatic β cells to secrete insulin.

In patients with or at high risk for ASCVD (such as those aged ≥55 years with 2 CVRFs), strong evidence suggests and the 2024 ADA guideline recommends that GLP-1RAs and/or SGLT2-Is are the preferred initial choice depending on the underlying comorbidity (33).

The EMPA-REG trial (n = 7020) found that patients with T2D and high CV risk randomly assigned to the SGLT2-I empagliflozin had a reduction in a composite CV outcome (death from CV causes, nonfatal MI, or nonfatal stroke) (10.5% vs. 12.1% in the placebo group; HR, 0.86 [CI, 0.74 to 0.99]) (34). The empagliflozin group also had lower all-cause mortality (5.7% vs. 8.3%; HR, 0.68 [CI, 0.57 to 0.82]), driven largely by a difference in CV mortality, and had better renal outcomes (lower rates of doubling of serum creatinine level and initiation of renal replacement therapy) (35).

Subsequent clinical trials suggest that the ASCVD benefits associated with SGLT2-Is and GLP-1RAs seem to be class effects; however, other benefits are medication-specific. For example, among SGLT2-Is, RCTs show that canagliflozin, dapagliflozin, and empagliflozin improve CV outcomes (34, 36, 37), but only canagliflozin and empagliflozin also improved renal outcomes (35, 36). Similarly, the GLP-1RAs dulaglutide, liraglutide, and semaglutide reduced CV events in RCTs (38–40), but only dulaglutide and semaglutide reduced nephropathy (38, 41).

In an RCT of once-weekly semaglutide versus placebo among 3297 patients with T2D and high CV risk (83.0% with prior CV or chronic kidney disease [CKD]), patients who received semaglutide had lower risk for the composite CV end point of the first occurrence of CV death, nonfatal MI, or nonfatal stroke (6.6% vs. 8.9%; HR, 0.74 [CI, 0.58 to 0.95]) but not lower mortality (38). Semaglutide also reduced incident nephropathy (3.8% vs. 6.1%; HR, 0.64 [CI, 0.46 to 0.88]) but resulted in higher rates of worsening retinopathy requiring treatment (3.0% vs. 1.8%; HR, 1.76 [CI, 1.11 to 2.78]).

The reductions in CV outcomes associated with SGLT2-Is and GLP-1RAs have primarily been shown in patients with preexisting CVD or high ASCVD risk and may not be generalizable to patients with lower baseline risk.

The DECLARE–TIMI 58 (Dapagliflozin Effect on Cardiovascular Events–Thrombolysis in Myocardial Infarction 58) trial, which randomly assigned 17 160 patients with T2D (10 186 without baseline CV disease), found no difference in the primary composite outcome of CV death, MI, or stroke but found a reduction in hospitalization for heart failure (HR, 0.73 [CI, 0.61 to 0.88]) and renal end points (HR, 0.76 [CI, 0.67 to 0.87]) with dapagliflozin compared with placebo (37).

RCTs also demonstrate that GLP-1RAs such as liraglutide and semaglutide produce clinically important weight loss and are FDA-approved for treatment of obesity; thus, these drugs might be a reasonable first choice for patients with obesity and related CVD comorbidities according to the ADA (42).

In patients without ASCVD risk or the aforementioned indications for SGLT2-Is or GLP-1RAs, metformin is recommended as first-line therapy and a lower-cost alternative (33, 43). Although

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metformin is not as efficacious as GLP-1RAs in promoting weight loss, the UKPDS trial showed that in patients whose body weight was 20% higher than ideal, metformin was superior to sulfonylureas and insulin in reducing mortality despite identical levels of glycemic control (6). Metformin should not be used in persons with severe renal insufficiency (glomerular filtration rate [GFR] <30 mL/min/1.73 m^2), acute decompensated heart failure, or severe liver disease because of its drug metabolism. Patients taking metformin for more than 4 years should be screened for vitamin B_{12} deficiency because metformin reduces vitamin B_{12} levels (44). The periodicity of screening is unknown, although the ADA recommends annual screening.

If metformin is contraindicated or not tolerated, the next choice of agent should be dictated by patient factors, including BMI, preferences for method of delivery (oral vs. injectable), adverse effects, and cost. As described previously, SGLT2-Is may provide greater benefit in CV and renal outcomes. In addition, for patients with overweight or obesity, GLP-1RAs and dual-acting GLP-1/GIP receptor agonists may be reasonable options because of their weight loss benefits. One RCT showed that subcutaneous semaglutide and tirzepatide led to significant weight loss (−5.7 and −7.6 to −11.2 kg, respectively) (45). The GLP-1RA semaglutide also comes in oral form, which has also been shown to improve glycemic control and weight (46) and was noninferior to subcutaneous liraglutide for weight loss (47). DPP-4Is are a reasonable choice for patients who prefer oral agents, are unable to receive oral semaglutide due to insurance, and cannot take a GLP-1RA. ACP recommends metformin and lifestyle changes for all people with T2D; in those with inadequate glycemic control, ACP recommends adding SGLT2-Is to reduce risk for all-cause mortality, major adverse cardiovascular events, progression of CKD, and hospitalization due to congestive heart failure or GLP-1RAs to reduce risk for all-cause mortality, major adverse cardiovascular events, and stroke. In its updated 2024 guideline, ACP also recommended against using DPP-4Is for treatment of T2D (43).

The newer dual-acting GLP-1/GIP receptor agonist tirzepatide was superior in reducing HbA_{1c} compared with a 1-mg dose of semaglutide (−2 to −2.3 vs. −1.86 percentage points) (45) and insulin glargine (−2.43 and −2.58 vs. 1.44 percentage points) (48) in RCTs, so this drug may be preferred in patients who need large improvements in their HbA_{1c} and are trying to avoid insulin; however, no studies have directly compared tirzepatide with a 2-mg dose of semaglutide.

Other noninsulin options, including sulfonylureas, thiazolidinediones, and α-glucosidase inhibitors, are not preferred because of their adverse effect profiles. Sulfonylureas can cause hypoglycemia and weight gain and are unlikely to provide CV benefits beyond glucose control. Thiazolidinediones can increase risk for heart failure and fracture, although they probably do not increase total CV events (49). Short-acting agents, such as α-glucosidase inhibitors (acarbose, miglitol) and nonsulfonylurea insulin secretagogues (nateglinide, repaglinide), improve postprandial hyperglycemia and may be useful in persons with inconsistent mealtimes.

Most patients with T2D have worsening glycemic control over time. Increasing the dose of existing agents is generally the first step to maintain control, but response may be limited. Patients often require additional agents. Several combination formulations of oral agents are available and may provide advantages in convenience or cost.

For women who are interested in becoming pregnant or are already pregnant, preconception counseling is recommended with referral to an endocrinologist to manage medications. Several medications, including metformin, glyburide, GLP-1RAs, and SGLT2-Is, are not recommended because they

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cross the placenta (50, 51). Insulin therapy is considered first-line treatment (50).

When should physicians consider insulin therapy?

Insulin therapy may be necessary for patients who have severe hyperglycemia (weight loss, polyuria, polydipsia) and to achieve glycemic control (usually in combination with noninsulin therapy). Insulin is also first-line therapy for women who are interested in becoming or are already pregnant. Except for women who are or are planning to become pregnant, most patients with severe hyperglycemia should be started on a GLP-1–based therapy before starting insulin (33). Fixed-dose combinations, such as basal insulin and GLP-1RAs, are also available.

The many available insulin formulations differ in their onset of action and duration (**Appendix Table 2**, available at Annals.org). No particular regimen is clearly superior, as most patients have a 1% to 2% decrease in HbA_{1c} level after starting therapy. Patients receiving insulin therapy are at high risk for hypoglycemia and often gain weight. Therefore, patients receiving insulin should be prescribed home glucose monitoring and should be educated about recognizing and self-managing hypoglycemia.

Initially, most patients can be treated with a single bedtime dose of neutral protamine Hagedorn (NPH) or basal analogue insulin combined with metformin and a GLP-1RA. A basal analogue may be the first choice, although they are considerably more expensive than NPH insulin. Evidence suggests lower rates of hypoglycemia with basal analogues, particularly newer, long-acting analogues, such as degludec. Typical starting doses of insulin are 0.1 to 0.2 units per kilogram of body weight.

Some patients need twice-daily insulin to achieve glycemic targets, and more frequent injections (such as preprandial injections) may be necessary for others. If HbA_{1c} levels remain elevated despite normal fasting glucose levels, prandial insulin may be considered, usually starting with a dose before the largest meal of the day. For those needing high doses of insulin, higher concentrations of insulin are available, including U-200, U-300, and U-500 formulations.

What is the role of home glucose monitoring?

Home glucose monitoring in the form of standard blood glucose meters or continuous glucose monitors (CGMs) should be recommended when patients are prescribed insulin therapy, with advice to check glucose levels with each insulin injection per the ADA (52). It is considered standard of care for persons receiving insulin therapy to allow sensible dose adjustments, particularly with shorter-acting preparations. For some people not taking insulin, home glucose monitoring may help them make behavioral lifestyle changes; however, evidence for improving glycemic control in people who are not receiving insulin therapy is limited. Home glucose monitoring allows patients and clinicians to assess glucose control longitudinally, can provide real-time feedback on the effects of diabetes self-management and treatments, and should be used if symptoms of hyperglycemia or hypoglycemia are present.

Patients using standard blood glucose meters are generally advised to measure fasting glucose once daily if using long-acting insulin. After they achieve normal fasting levels, preprandial and postprandial measurement may be helpful if HbA_{1c} levels remain elevated.

Medicare expanded CGM coverage to people with diabetes who take any type of insulin and those who do not take insulin but have a history of hypoglycemia. RCT data suggest that HbA_{1c} improves with CGM use in patients with T2D taking basal insulin (52), older adults taking basal insulin (53), and patients with multiple insulin injections (54). Continuous blood glucose monitors are recommended especially for patients receiving multiple daily injections and those who require continuous insulin infusions and are not able

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to monitor with other devices (55). Cost-effectiveness studies have found that CGMs are likely to be cost-effective compared with standard blood glucose meters (56).

What other clinical interventions reduce and manage diabetes-related complications?

Besides glycemic control, optimal care of patients with T2D includes clinical interventions to reduce CV and/or ASCVD risk, screening for and management of other diabetes-related complications and comorbidities, including nephropathy, retinopathy, and neuropathy; and treatment of mental health conditions (Table 3).

CV risk reduction

CV risk reduction includes smoking cessation, hypertension control, use of lipid-lowering agents, aspirin use for secondary prevention, and weight management (Table 3). Evidence-based strategies to manage tobacco dependence are reviewed in the In the Clinic on smoking cessation (57).

Hypertension is a major risk factor for diabetes complications. Current guidelines from the ADA, the American College of Cardiology, and the American Heart Association suggest a BP target of less than 130/80 mm Hg for patients with T2D (58). ACP recommends a systolic BP target of less than 140 mm Hg for adults aged 60 years or older with T2D (59). In addition to lifestyle changes, several drug classes are effective for BP control, including angiotensin receptor blockers (ARBs), angiotensin-converting enzyme inhibitors (ACEIs), dihydropyridine calcium-channel blockers, and thiazide diuretics. ARBs and ACEIs are often the initial agent because of their beneficial renal effects, although they are highly recommended only for patients with nephropathy. Because of the risk for angioedema and the overall safety profile of ACEIs, ARBs may be preferred (60). Multiple BP agents may be needed to achieve control, as the average effect is about −10/5 mm Hg per drug class (61). Additional information on the management of hypertension is available in the In the Clinic on hypertension (62).

ADA guidelines suggest using a risk-based approach to select patients for lipid-lowering therapy for primary prevention (58). Patients with T2D who are older than 40 years are likely to benefit from and should be treated with at least moderate-intensity statin therapy, regardless of their initial low-density lipoprotein cholesterol (LDL-C) level (63). High-intensity statin therapy is recommended in patients with multiple ASCVD risk factors or a history of ASCVD. The ADA recommends a target LDL-C reduction of at least 50% from baseline and a target LDL-C level below 70 mg/dL (1.8 mmol/L) for primary prevention and below 55 mg/dL (1.4 mmol/L) for secondary prevention with statin treatment and, if necessary, ezetimibe or a proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitor (58). For people with T2D aged 20 to 39 years, statin therapy may be reasonable if they have additional ASCVD risk factors (58). In 2024, the ADA updated its recommendations to include treatment with bempedoic acid or a PCSK9 inhibitor in people who cannot tolerate statins (58). Long-term adherence to statin therapy is low (64), so annual measurement may be helpful to improve adherence in those receiving therapy. For patients with T2D who are younger than 40 years, measurement of cholesterol is recommended at least every 5 years to assess risk (58). Detailed information on cholesterol management is reviewed in the In the Clinic on dyslipidemia (65).

Patients with T2D and overweight or obesity should be evaluated and treated. Intensive lifestyle modification is the cornerstone for weight management; however, if weight loss goals are not met through diet and exercise modifications alone, pharmacologic options, including GLP-1RAs and GIP-1 agonists, and surgical options should be offered in medically eligible patients as part of a comprehensive weight management treatment plan. Management of obesity is reviewed in the In the Clinic on obesity (15).

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Table 3. **Other Clinical Interventions to Reduce Diabetic Complications**

Clinical Intervention	*Approaches*
Cardiovascular risk reduction	
Smoking cessation (57)	Counsel using evidence-based approaches Consider referral to smoking cessation resources (e.g., counselors, state-run programs)
Hypertension control (58–62)	Goal of <130/80 or <140/90 mm Hg ARBs and ACEIs highly recommended for patients with nephropathy
Lipid-lowering agents (58, 63–65)	High-intensity statin recommended for secondary prevention of ASCVD and in populations at high ASCVD risk to target LDL-C level <55 mg/dL (<1.4 mmol/L); add ezetimibe or PCSK9 inhibitor if necessary At least moderate-intensity statin recommended for most other patients with T2D (age >40 y) to target LDL-C reduction of ≥50% from baseline and level <70 mg/dL (<1.8 mmol/L) for primary prevention Consider bempedoic acid or PCSK9 inhibitor if unable to tolerate statins Consider annual measurement of lipid panel to improve low long-term prescription adherence
Weight management (15)	Screen for and treat overweight or obesity (based on BMI) Treatment includes intensive lifestyle modification as cornerstone Consider pharmacologic therapy in patients with BMI >27.5 kg/m^2 (>25 kg/m^2 in Asian patients) and/or surgical weight loss options in medically eligible patients (BMI >35 kg/m^2 [>30 kg/m^2 in Asian patients] or BMI >30 kg/m^2 [>27.5 kg/m^2 in Asian patients] with poor glycemic control) Consider referral to lifestyle medicine and obesity medicine specialists
Aspirin therapy (66, 67)	Recommended for secondary prevention for heart disease (75–325 mg/d) Shared decision-making conversation recommended for primary prevention (75–162 mg/d)
Screening for diabetic complications and comorbidity	
Heart failure screening (58)	Screen for heart failure at least once in asymptomatic people with T2D by measuring natriuretic peptide level
Peripheral artery disease screening (58)	Screen using ankle–brachial index at least once for people with T2D aged ≥50 y with T2D duration ≥10 y, microvascular disease, end-organ damage from T2D, or foot complications
Nephropathy measurement (18)	Urinary microalbumin–creatinine ratio and estimated glomerular filtration rate at least annually
Retinal examination (18)	Dilated and comprehensive eye examination by ophthalmologist/optometrist or via retinal photography at least every 1–2 y depending on underlying risk
Diabetic foot examinations (18)	At least annually
Mental health screening and treatment (18)	Screening for depression, anxiety, and disordered eating at least annually Cognitive behavioral therapy, mindfulness-based therapies, and collaborative care; antidepressant therapy

ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; ASCVD = atherosclerotic cardiovascular disease; BMI = body mass index; LDL-C = low-density lipoprotein cholesterol; PCSK9 = proprotein convertase subtilisin/kexin type 9; T2D = type 2 diabetes.

Aspirin therapy (75 to 162 mg/d) for primary prevention of CVD may not benefit all patients with T2D. An RCT of aspirin in patients with T2D found an absolute reduction in serious vascular events of 1.1% but an increase in bleeding risk of 0.9% (66). Thus, shared decision making is recommended when considering aspirin for primary prevention (67). In contrast, 75 to 325 mg of aspirin per day should be recommended for patients with a history of heart disease.

The ADA also recommends screening for heart failure in asymptomatic people with T2D by measuring natriuretic peptide at least once. In addition, the ADA recommends screening for asymptomatic peripheral artery disease at least once using an ankle–brachial index in people with T2D who are aged 50 years or older or have T2D duration of at least 10 years, microvascular disease, end-organ damage from T2D, or foot complications (58).

Management of other diabetic complications and comorbidities

Optimal care also includes screening for and management of nephropathy, retinopathy, and neuropathy and foot care. Detection of early diabetic nephropathy includes annual measurement of the urinary microalbumin–creatinine ratio (for example, random urine albumin–creatinine ratio) and estimated GFR. Albuminuria is a risk factor for CVD, and RCTs have shown that treatment of albuminuria with ARBs

or ACEIs reduces progression to end-stage renal disease (68, 69). As discussed, some GLP-1RAs (39, 42) and SGLT2-Is (36, 37) improve renal disease outcomes and are recommended for macroalbuminuria by the ADA. In addition, among patients with T2D and CKD, an RCT has identified that finerenone reduced risk for CKD progression and CV events compared with placebo (70). Retinal examination and treatment reduces incidence of vision loss in patients with T2D (18). Neuropathy screening and foot care are essential in reducing risk for amputation (18). Painful neuropathy can be treated with various agents, including antiepileptic agents (carbamazepine, gabapentin, pregabalin), duloxetine, capsaicin cream, and tricyclic antidepressants.

Patients with T2D have higher rates of mental health problems (18). The ADA recommends annual screening for depression, anxiety, and disordered eating in patients with T2D (18). The USPSTF also recommends routine screening for depression in patients aged 12 years or older (71). In addition to antidepressant pharmacologic therapy, evidence suggests cognitive behavioral therapy and mindfulness-based therapies can benefit patients with T2D. In particular, integrating primary care and behavioral health in a collaborative care model has been shown to improve depression symptoms and glycemic control (72). Screening and management of depression are also discussed in the In the Clinic on depression (73).

How frequently should physicians see patients with T2D, and what should be included in follow-up visits?

The ADA recommends physicians see patients with T2D at least once a year to review diabetes self-management, assess HbA_{1c} and CVRFs, and manage and prevent diabetic complications (18). Experts consider quarterly visits and monitoring of HbA_{1c} levels reasonable (18). For healthy patients with stable disease, this can be reduced to every 6 to 12 months (18). The National Committee for Quality Assurance (NCQA) recommends at least 1 HbA_{1c} test each year as a quality measure benchmark (**Appendix Table 3**, available at Annals.org).

When should a specialist be consulted?

Several specialists could be consulted to help optimize T2D management. Referral for formal diabetes self-management education and support programs is recommended for all patients with newly diagnosed T2D, as well as periodically for reinforcement; these programs are covered by most insurance but are underused (74).

Consultation with an endocrinologist is helpful when diagnostic issues arise or to assist with glucose management (for example, in patients with highly labile blood glucose levels), including during and in preparation for pregnancy, as poor glycemic control is associated with adverse fetal outcomes (50).

Referral to lifestyle medicine and obesity medicine specialists may be helpful in patients with comorbid overweight and obesity. Referral for bariatric surgery may be appropriate for medically eligible patients (75).

A dilated and comprehensive eye examination by an ophthalmologist or optometrist or via retinal photography should be done every 1 to 2 years. Nephrologic evaluation is required for patients with a GFR below 30 mL/min/1.73 m^2. Earlier referral can be considered, especially if the origin of renal insufficiency is unclear. Podiatric evaluation is helpful for management of lesions, such as calluses or deformities, which require intervention to reduce risk for foot ulcers and amputation.

Referral to mental health specialists (therapists, counselors, psychologists, psychiatrists) may be helpful for patients with comorbid mental health problems, which can negatively affect self-management and medication adherence and increase risk for diabetic complications if untreated.

When should patients with T2D be hospitalized?

Patients with severe, symptomatic hyperglycemia may require hospitalization. Hyperglycemic and normoglycemic diabetic ketoacidosis (defined by presence of metabolic acidosis, ketones in serum or urine, and hyperglycemia) and hyperosmolar coma require hospitalization. Diabetes complications may require hospitalization; for example, hypoglycemia, cellulitis, or osteomyelitis may require medication adjustments, intravenous antibiotics, or surgery, respectively. Detailed evaluation and management of hyperglycemia in hospitalized patients will be reviewed in an upcoming In the Clinic on inpatient management of hyperglycemia.

Can T2D go into remission?

T2D is a heterogeneous disease that results from variable expressions of genetic and environmental factors and can remit under certain circumstances. A consensus report published in 2021 on behalf of the Endocrine Society, the European Association for the Study of Diabetes, Diabetes UK, and the ADA proposed standardized parameters

in which patients with an HbA_{1c} level below 6.5% (<48 mmol/mol) can be considered to be in "remission." For patients using glucose-lowering pharmacotherapy, remission is defined as an HbA_{1c} level below 6.5% at least 3 months after cessation of glucose-lowering pharmacotherapy (or ≥3 months after surgery and cessation of pharmacotherapy for those who have had bariatric surgery) (76). Patients who have not been using pharmacotherapy for 3 months and have decreased HbA_{1c} through lifestyle changes can be considered to be in remission after at least 6 months of lifestyle change.

Treatment... The goal of treating T2D is to achieve individualized glycemic targets based on underlying risk, life expectancy, and patient preferences. Patients should achieve at least moderate control (HbA_{1c} level <8.0% in most cases) to minimize hypoglycemia and because microvascular risk increases exponentially above this level. More aggressive targets (such as <7.0%) should be reserved for patients with a long life expectancy because reductions in advanced diabetes complications take 15 to 20 years to accrue.

CLINICAL BOTTOM LINE

Practice Improvement

What measures do U.S. stakeholders use to evaluate the quality of care for patients with T2D?

The NCQA, through the Healthcare Effectiveness Data and Information Set program, recommends several measures of diabetes care (**Appendix Table 3**). In 2022, these were separated and became standalone measures. It is important to note that these recommendations do not align perfectly with clinical targets.

What do professional organizations recommend regarding care of patients with T2D?

Several professional associations publish guidelines on various aspects of diabetes care, and these vary slightly. The ADA continually updates its standards of diabetes care, which are comprehensive and encompass most relevant areas of screening, prevention, and management (3, 18, 21, 33, 50, 55, 58, 75). Our recommendations are generally consistent with the ADA diabetes screening guideline (3). Where applicable, we have discussed or referenced the ADA and other relevant guidelines throughout this review. ACP conducts systematic evidence reviews to inform guidelines on glucose management in patients with T2D (32, 43) and BP control, which differ from the ADA in some respects (59). The American Association of Clinical Endocrinology updated its guidelines in 2023 (77). The USPSTF recommendation on screening for elevated blood glucose (not specifically diabetes) is similar to the ADA guidelines (2, 4).

In the Clinic
Tool Kit

Type 2 Diabetes

Patient Information

https://medlineplus.gov/diabetestype2.html
https://medlineplus.gov/languages/diabetestype2.html
Information on type 2 diabetes in English and other languages from the National Institutes of Health's MedlinePlus.

www.niddk.nih.gov/health-information/diabetes/overview
www.niddk.nih.gov/health-information/informacion-de-la-salud/diabetes/informacion-general
Overview of diabetes in English and Spanish from the National Institute of Diabetes and Digestive and Kidney Diseases.

https://professional.diabetes.org/clinical-support/patient-education-library
Patient education library in English and other languages from the American Diabetes Association.

Information for Health Professionals

www.acpjournals.org/doi/10.7326/M23-2788
American College of Physicians clinical guideline on newer pharmacologic treatments in adults with type 2 diabetes.

https://diabetesjournals.org/care/issue/47/Supplement_1
Standards of Care in Diabetes–2024 from the American Diabetes Association.

http://diabetes.acponline.org
The latest information on type 2 diabetes from ACP Diabetes Monthly.

www.niddk.nih.gov/health-information/communication-programs/ndep/health-professionals
Information on diabetes from the National Institute of Diabetes and Digestive and Kidney Diseases.

WHAT YOU SHOULD KNOW ABOUT TYPE 2 DIABETES

What Is Type 2 Diabetes?

Diabetes is a common condition where there is too much glucose (sugar) in your blood. Insulin is a hormone that turns sugar into energy. Most people with diabetes make some insulin, but it does not work as well to keep the blood sugar under control. This is called type 2 diabetes. High sugar levels in your blood over time may lead to:

- Vision loss
- Kidney damage
- Nerve damage
- Foot ulcers
- Heart disease
- Possible amputation from infections

What Are the Signs and Symptoms?

- Extreme thirst and/or hunger
- Fatigue
- Frequent need to urinate
- Unusual weight loss
- Blurred vision
- Tingling or numbness in the hands or feet

Most people with diabetes may not have symptoms at first and will not know they have the disease.

What Are Other Risk Factors?

- Age 45 years or older
- African American, Hispanic, Asian, Pacific Islander, or Native American race or ethnicity
- Overweight or obesity
- Having a close relative with type 2 diabetes
- A history of diabetes in pregnancy

Can I Prevent It?

A healthy diet and regular exercise may prevent type 2 diabetes. Even a small amount of weight loss and 30 minutes of exercise a day can reduce your risk for developing diabetes.

How Is It Diagnosed?

- Your doctor will ask you about your medical history, including your current diet and exercise regimen, and do a physical examination.
- Diabetes is diagnosed by measuring the level of glucose in your blood. You may need to fast before some diabetes tests.
- Your hemoglobin A_{1c} (HbA_{1c}) level can be checked via a simple blood test that measures your average blood sugar over the past 3 months and does not require fasting.

- Your doctor will check your blood pressure, cholesterol levels, and kidney function.
- You will need an eye examination to check for any problems.

How Is It Treated?

- People with diabetes need to improve blood glucose control in their bodies.
- Lifestyle changes, such as losing weight and exercising regularly, improve glucose control without medication.
- If lifestyle changes do not improve glucose control, you may need medicine.
- There are many different types of medicines for type 2 diabetes, including several new oral and injectable medicines. Not all people with type 2 diabetes need to take injections or check their blood sugar at home.
- Talk to your doctor about the treatment plan that is best for you and what your average blood sugar target (HbA_{1c} level) should be.
- Make sure your blood pressure and cholesterol are controlled to help prevent complications of diabetes.
- The best treatment plan for you is one that you can afford and will stick with. Talk about the cost and convenience of treatment plans with your doctor.

Questions for My Doctor

- Do I need to change my diet and start exercising?
- What is an optimal blood sugar target (HbA_{1c} level) for me?
- Do I have to check my blood sugar? When and how often?
- What are the symptoms of low blood sugar? What should I do when I have those symptoms?
- How should I care for my feet?
- How often should I have follow-up visits?
- Do I need to see other medical specialists?

For More Information

ACP℠
American College of Physicians
Leading Internal Medicine, Improving Lives

American Diabetes Association
www.diabetes.org/diabetes/type-2

Patient Information

Appendix Table 1. **Recommended Foods and Diets for Type 2 Diabetes**

Foods
Nonstarchy vegetables
Fruits
Whole grains
Low-fat dairy products
High-fiber foods
Lean proteins (avoid red and processed meats)
Fatty fish
Nuts and seeds
Minimal added sugars
Minimally processed foods
Diets
DASH (Dietary Approaches to Stop Hypertension)
Mediterranean diet
High-fiber
Low-fat
Low-carbohydrate
Whole-foods plant-based
Vegetarian
Vegan

Appendix Table 2. **Onset and Mechanisms of Action of Various Types of Insulin***

Class	*Name*	*Peak of Action*	*Duration of Action*	*Dosage Forms/Product*
Rapid-acting (analogues)	Lispro Aspart Glulisine Inhaled insulin	0.5–3 h	3–5 h	U-100, U-200 Prefilled pen, cartridge, vial
Short-acting (human)	Regular U-100	2–5 h	Up to 12 h	U-100 Prefilled pen, vial
Intermediate-acting (human)	NPH	4–12 h	Up to 24 h	U-100 Prefilled pen, vial
Concentrated human regular	Regular U-500	6–8 h	Up to 24 h	U-500 Prefilled pen, vial
Long-acting (analogue)	Glargine Detemir Degludec	Relatively peakless	Up to 24–42 h	U-100, U-200 Prefilled pen, vial
Ultra-long-acting	Glargine U-300	Relatively peakless	Up to 5 d to steady state	U-300 Prefilled pen
Human insulin mixtures	70% NPH/30% regular 50% NPH/50% regular	2–12 h 2–5 h	Up to 24 h	U-100 Prefilled pen, vial
Analogue mixtures	75% lispro protamine/25% lispro 50% lispro protamine/50% lispro 70% aspart protamine/30% aspart	1–2 h 1–2 h 1–4 h	Up to 24 h	U-100 Prefilled pen, vial

NPH = neutral protamine Hagedorn.
** Data are from reference 33.*

Appendix Table 3. **Quality Measures for Diabetes**

HbA_{1c} management
Percentage of patients who have had ≥1 HbA_{1c} test in the measurement year
HbA_{1c} management control
Percentage of patients whose most recent HbA_{1c} level was >9.0% (poor control)
Percentage of patients whose most recent HbA_{1c} level was <8.0% (control)
Blood pressure management
Percentage of patients whose most recent blood pressure was <140/90 mm Hg
Eye examination
Percentage of patients who received a retinal or dilated eye examination by an eye care professional (optometrist or ophthalmologist) in the measurement year or had a negative retinopathy screening result in the prior year
Medical attention for nephropathy
Percentage of patients with screening for albuminuria, use of an ACEI/ARB, or documentation of medical attention for kidney disease in the measurement year

ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; HbA_{1c} = hemoglobin A_{1c}.