Management of the Older Adult with Type 2 Diabetes

Management of the Older Adult with Type 2 Diabetes is supported by an educational grant from Novo Nordisk Inc. It has been accredited by the American Association of Diabetes Educators (AADE) for nurses, dietitians, and pharmacists.
The following program is a taped presentation by Melinda D. Maryniuk.

As Director of Clinical Education Programs for Strategic Initiatives at the Joslin Diabetes Center in Boston, Massachusetts, Ms. Maryniuk is responsible for overseeing the support of the clinical, educational, and quality improvement activities for the over 40 Joslin affiliates. She also coordinates the education activities for the Healthcare Services Department, including several national diabetes education initiatives. Her areas of special interest include nutrition, patient education, behavior change, and increasing access to quality diabetes education services.

Ms. Maryniuk has worked in the field of diabetes education for over 30 years and has lectured and published extensively for both patient and professional audiences around the country and internationally. She is active within the American Diabetes Association, having served on the Board of Directors, as chair of the Education Recognition Program Committee and as an Associate Editor for ADA programs publications. Within the American Dietetic Association, Ms. Maryniuk served as Chair of the Diabetes Care and Education Practice Group as well as Chair of the Division of Clinical Diabetics and Research of the Council on Practice. She is the 2005 recipient of the Outstanding Educator in Diabetes for the American Diabetes Association and has received a Medallion Award from the American Dietetic Association.

Ms. Maryniuk has a BS from the University of Tennessee-Knoxville and a MEd from Tufts University. She completed a dietetic internship at the Frances Stern Nutrition Center in Boston.

We will now join Ms. Maryniuk.
Objectives

At the end of this program, participants should be able to:

- Discuss the rationale and process for establishing individualized glycemic goals in older adults with type 2 diabetes
- Explain the development and implementation of comprehensive care plans for older adults with type 2 diabetes
- Discuss how to optimize patient outcomes by using the most appropriate treatment regimens for older adults with type 2 diabetes
Why Focus on Older Adults?

- High prevalence of diabetes in older adults
- Increased rates of premature death, functional disability, and comorbidity
- Elevated risk for depression, polypharmacy, cognitive impairment, urinary incontinence, injurious falls, and persistent pain
- Increasing life expectancies make prevention or delay of diabetes–related complications an urgent issue
- Most older adults benefit from improved diabetes management, as do most younger persons

In this activity, unless otherwise specified, older adults are defined as persons 65 years of age or older.

There are many reasons for focusing on the management of older adults with diabetes. Diabetes is highly prevalent in this population. Older persons with diabetes have increased risks of premature death, functional disability, and comorbidity. Compared to older persons without diabetes, individuals with diabetes have an elevated risk for several geriatric syndromes, including depression, polypharmacy, cognitive impairment, urinary incontinence, injurious falls, and persistent pain.

The increasing life expectancies of older persons with diabetes make the prevention or delay of diabetes–related complications an urgent issue, both from a humanistic and an economic standpoint. Furthermore, it is important to focus on the management of type 2 diabetes in this population because most older adults benefit from improved diabetes management, as do most younger persons.
The incidence of diabetes among older adults in the US is alarming. In 2010, 390,000 new cases of diabetes were diagnosed in this population. Also in 2010, a total of 10.9 million older adults had diabetes. This represents 26.9% of the entire older adult population. Between 90% and 95% of these individuals had type 2 diabetes.

The median duration of diagnosed diabetes in adults between the ages of 65 and 79 was 9.6 years in 2009. Given the typically long latency period between the development of type 2 diabetes and its actual diagnosis, the actual mean duration of diabetes in older adults is probably much longer. This long disease duration suggests that many older adults with diabetes already have, or are at high risk for, macrovascular, microvascular, and neurologic complications associated with diabetes.

One third of current nursing home residents in the US have diabetes, and diabetes complications are a major reason for nursing home admission.
Older People Can Change

• Strong bias among health care providers that older adults cannot or are not willing to make lifestyle changes
• However, in DPP trial, lifestyle modification reduced development of type 2 diabetes by 71% among adults ≥60 years old

The Centers for Disease Control and Prevention estimate that 50% of older adults without diabetes had prediabetes in 2005–2008. Prompt and effective intervention is essential for these patients if diabetes is to be prevented.

A major obstacle to appropriate intervention is the pessimistic attitude of many health care providers. Research has shown that there is a strong bias among providers that older adults cannot or are not willing to make lifestyle changes, even if doing so could prevent the development of a serious chronic disease, such as type 2 diabetes.

However, the results of the Diabetes Prevention Program (DPP) trial challenge this bias. In this landmark study, lifestyle modification to decrease weight and increase physical activity reduced the development of type 2 diabetes by 71% over a 3-year period in high-risk adults aged 60 or older.
Body Mass Index

- Measure of body fat based on height and weight; applies to adult men and women
- Calculation: weight (kg)/height (m)^2
- BMI Categories
  - Underweight = <18.5
  - Normal weight = 18.5 – 24.9
  - Overweight = 25 – 29.9
  - Obesity = ≥30
- BMI calculator: http://www.nhlbisupport.com/bmi/
- BMI tables
  - Table 1 (BMI ≤35):
    http://www.nhlbi.nih.gov/guidelines/obesity/bmi_tbl.htm
  - Table 2 (BMI ≥36):
    http://www.nhlbi.nih.gov/guidelines/obesity/bmi_tbl2.htm
- Suggested BMI categories for Asians
  - Overweight = 23 – 24.9; Obesity = ≥25

Body mass index (BMI) is a measure of body fat based on height and weight. It applies to adult men and women. BMI is calculated by dividing the weight in kilograms by the height in meters squared. According to standard BMI categories, underweight is a BMI of less than 18.5, normal weight is a BMI ranging from 18.5 to 24.9, overweight is a BMI ranging from 25 to 29.9, and obesity is a BMI of 30 or greater.

A useful BMI calculator is available at The National Heart Lung and Blood Institute (NHLBI) “Aim for a Healthy Weight” website. Also available at this website are 2 BMI tables, one for individuals with a BMI of 35 or less and a second for those with a BMI of 36 or greater.

It is increasingly recognized that the standard BMI categories developed for use in the general US population do not reflect risk patterns in some ethnic groups, such as Asian Americans. According to suggested modifications for Asian Americans, a BMI of 23 to 24.9 kg/m^2 indicates that a person is overweight and a BMI greater than or equal to 25 kg/m^2 indicates that a person is obese.
Aging and Weight Change

• Lean body mass decreases, body fat and visceral fat increase during aging
• Among US adults ≥60 years old:
  – 78% of men and 69% of women have BMI ≥25 kg/m²
  – 37% of men and 34% of women have BMI ≥30 kg/m²
• Weight gain, obesity, and visceral fat associated with increased risk of type 2 diabetes
• Increased visceral fat also associated with reduced insulin sensitivity, decreased glucose uptake, and increased glucose production
• Unintended weight loss, a common problem in older adults, an independent risk factor for increased mortality

During aging, lean body mass typically decreases, whereas proportions of body fat and visceral fat increase. Many adults gain weight as they age. Among US adults aged 60 or older, 78% of men and 69% of women have a BMI of at least 25 kg/m², while 37% of men and 34% of women have a BMI of at least 30 kg/m². Weight gain, obesity, and increased visceral fat are all associated with an elevated risk of developing type 2 diabetes. Increased visceral fat is also associated with reduced insulin sensitivity in skeletal muscle tissue (i.e., insulin resistance), decreased glucose uptake due to impaired insulin action, and reduced hepatic insulin sensitivity, which can result in increased hepatic glucose production. These metabolic changes lead to an imbalance in the glucose homeostasis mechanism. In response, pancreatic beta cells initially produce more insulin. Eventually, however, increased demand leads to a deterioration in beta-cell function. Type 2 diabetes arises when pancreatic insulin production no longer meets metabolic demands.

Although it has received far less attention than weight gain, unintended weight loss is also a common problem in older adults, and is an independent risk factor for increased mortality.
Delayed Diagnosis in Older Adults

- Symptoms may resemble common age–related changes (weakness, fatigue, vision problems, slow wound healing, GI changes)
- Classic symptoms (polydipsia, polyuria) often absent or unrecognized
- Diagnosis may follow presentation with diabetic complication (eg, retinopathy, renal impairment)
- Hyperglycemia may be detected as part of routine physical examination

Crandall JP. Type 2 Diabetes: Principles and Practice. 2nd ed. 2008:491–500.

Diagnosing diabetes in older adults is often difficult, resulting in treatment delays. Presenting symptoms may be nonspecific and similar to common age-related changes, such as weakness, fatigue, vision problems, slow wound healing, and GI changes. Classic symptoms of diabetes, such as polydipsia and polyuria, may be absent or mistakenly attributed to another disorder or to a medication the patient is taking.

Sometimes diabetes is not diagnosed until the patient presents with a diabetic complication, such as retinopathy or renal impairment. In other cases, diabetes is detected when blood tests are conducted as part of a routine physical examination.
The American Diabetes Association (ADA) has established the following criteria for testing for diabetes in asymptomatic adults, including older adults. Testing should be considered in all adults who are overweight (BMI ≥25 kg/m²) and have additional risk factors. These risk factors are shown on the next slide. In the absence of the above criteria, testing for diabetes should begin at age 45, since age is a major risk factor for diabetes.

ADA categories of increased risk for diabetes—also called prediabetes—are the following:

- Fasting plasma glucose (FPG) of 100 to 125 mg/dL, a condition called impaired fasting glucose (IFG)
- 2-hour plasma glucose in the 75-gram oral glucose tolerance test of 140 to 199 mg/dL, a condition called impaired glucose tolerance (IGT)
- A1C of 5.7% to 6.4%

For all 3 of these tests, risk is continuous, extending below the lower limit of the range and becoming disproportionately greater at higher ends of the range.

If results are normal, testing should be repeated at least at 3-year intervals, with consideration of more frequent testing depending on initial results and the patient’s risk status. Although additional prospective studies are needed, many experts believe that it is more appropriate to use a BMI cutoff of ≥23 kg/m² rather than ≥25 kg/m² for people of Asian descent.
In addition to having a BMI greater than or equal to 25 kg/m², the ADA has defined additional risk factors for type 2 diabetes. They are:
• Physical inactivity
• First-degree relative with diabetes
• High-risk race/ethnicity (eg, African American, Latino, Native American, Asian American, or Pacific Islander)
• Women who delivered a baby weighing >9 lb or were diagnosed with gestational diabetes mellitus (GDM)
• Hypertension (≥140/90 mmHg or on therapy for hypertension)
• HDL-C level <35 mg/dL and/or triglyceride level >250 mg/dL
• Women with PCOS
• A1C ≥5.7%, IGT, or IFG on previous testing
• Other clinical conditions associated with insulin resistance, such as severe obesity or acanthosis nigricans
• History of cardiovascular disease (CVD)

IGT is defined as a 2-hour plasma glucose value in the oral glucose tolerance test (OGTT) of 140 to 199 mg/dL. IFG is defined as a fasting plasma glucose value in the OGTT of 100 to 125 mg/dL.
Diabetes Comprehensive Care Plan

• Every patient with diabetes should have a comprehensive care plan, which considers the patient’s unique medical history, behaviors and risk factors, ethnocultural background, and environment
• Health care providers should move beyond a narrow focus on glycemic management
• An organized multidisciplinary team is the best way to deliver diabetes care
• All patients should receive comprehensive DSME at diagnosis and subsequently as appropriate

According to an expert committee of the American Association of Clinical Endocrinologists (AACE), every patient with diabetes, including each older adult with diabetes, requires a comprehensive care plan, which takes into account the patient’s unique medical history, behaviors and risk factors, ethnocultural background, and environment. This comprehensive approach is based on the assumption that clinicians should move beyond a narrow focus on glycemic management. It is grounded on the evidence that although glycemic control parameters have an impact on cardiovascular disease risk, mortality, and quality of life, other factors also affect clinical outcomes in persons with diabetes.

Ideally, patients with diabetes should receive care from an organized multidisciplinary team. Members of such a team would typically include a primary care physician, endocrinologist, geriatrician, physician assistant, nurse practitioner, registered nurse, certified diabetes educator (CDE), dietitian, exercise specialist, and mental health professional.

Persons with diabetes should receive comprehensive diabetes self-management education (DSME) at the time of diagnosis and subsequently as appropriate.

The elements of the diabetes comprehensive care plan are described in the AACE Medical Guidelines for Clinical Practice for Developing a Diabetes Mellitus Comprehensive Care Plan, which was published in 2011.
Elements of the DSME Plan for Older Adults

- Comprehensive assessment of patient’s knowledge, skills, attitudes, beliefs, and psychosocial and physical status
- Assisting patients and their family to develop and prioritize self-care goals
- Formulating an assessment-based plan that is individualized, proactive, and designed to maximize the person’s and family’s ability to manage diabetes
- A complete evaluation that includes reassessment and revision of the plan based on the reassessment

The diabetes self-management education (DSME) plan typically includes the following elements:

- A comprehensive assessment of the patient’s knowledge, skills, attitudes, beliefs, and psychosocial and physical status
- Assisting patients and their family to develop and prioritize self-care goals
- Formulating an assessment-based plan that is individualized, proactive, and designed to maximize the patient’s and family’s ability to manage diabetes
- A complete evaluation that includes reassessment and revision of the plan based on the reassessment

Educational assessment of the older adult with diabetes does not differ substantially from assessment of the middle-aged adult, except that there is greater emphasis on understanding the effects of the aging process in general and in the context of diabetes. Furthermore, because the health status of older adults can deteriorate rapidly, assessment is an ongoing process that often involves family members, caregivers, and other health care providers.

During the process of setting self-care goals, the educator’s role is to guide the patient to set goals that are specific, realistic, and measurable.

Key content areas for the educational plan include glucose monitoring, medications, physical activity, meal planning and nutrition, preventing and detecting complications, coping with diabetes, problem-solving skills, and maximizing quality of life.

Medicare coverage for diabetes education includes diabetes self-management training (DSMT). When prescribed by a physician or nurse practitioner, Medicare covers 10 hours of DSMT during the first year after the diagnosis of diabetes and 2 hours of follow-up training each subsequent year.

Medicare also covers medical nutrition therapy (MNT). When prescribed by a physician, Medicare covers 3 hours of training during the first year after diagnosis and 2 hours of follow-up education in each subsequent year.
This slide shows ADA and AACE glycemic goals for the general population of persons with diabetes.

Older adults should be treated using the same principles of glucose management used for younger patients. However, individualized treatment programs are essential due to the heterogeneity of the older adult population. Many older adults benefit from intensive, long-term diabetes management and should be treated to target. These include individuals who are expected to live long enough to benefit from long-term intensive diabetes management (approximately 10 years) and who are physically active, cognitively intact, and willing and able to perform self-management.

Short-term management goals often focus on patient safety issues, such as avoiding hypoglycemia. However, treatment of hyperglycemia can minimize polyuria and prevent nighttime falls. For example, older men who have had surgical prostate treatment may struggle with incontinence. Similarly, many older women have stress incontinence. Managing hyperglycemia can help with the management of incontinence, as well.
The optimal A1C level for achieving the best balance between a low risk for diabetes complications and a low risk for mortality is an unresolved question, both for older adults and for younger people with type 2 diabetes. The Diabetes and Aging Study was a retrospective cohort study, conducted between 2004 and 2008, that included more than 71,000 patients 60 years of age or older. To identify the range of A1C levels associated with the lowest rates of complications and mortality, the investigators determined each participant’s most recent A1C. Hazard ratios (HRs) were generated for baseline glycemic control, using participants whose A1C was less than 6% as the reference group. For all comparisons, this group had a HR of 1.

The study showed that there was a stepwise relationship between A1C and both chronic microvascular and chronic cardiovascular events. Compared to the reference group, there was a significantly higher risk of microvascular events beginning in the group with an A1C range of 7.0 to 7.9%, and a significantly higher risk of cardiovascular events beginning in the group with an A1C range of 6.0% to 6.9%. In contrast to complications, mortality had a U-shaped relationship with baseline A1C. Relative to A1C levels below 6.0%, the risk of mortality was significantly lower for A1C levels between 6.0% and 7.9% and significantly higher for A1C levels of 10% or higher.

The investigators concluded that A1C in older adults should be maintained below 8% to prevent both complications and mortality, with the caution that A1C levels below 6% were associated with an increased mortality risk.
When Are Less Stringent Glycemic Goals Appropriate?

- Higher A1C and BG goals acceptable for:
  - Frail older adults
  - Persons whose life expectancy is <5 years
  - Patients with pronounced risk of severe hypoglycemia
  - Individuals with advanced comorbidities

- Chronically ill, institutionalized patients with short life expectancy require adequate, but not aggressive BG control

According to current treatment guidelines, higher A1C and BG goals are acceptable for frail older adults, persons with a life expectancy of less than 5 years, patients in whom the risk of severe hypoglycemia is pronounced, and individuals with advanced comorbidities. Health care providers should adopt therapeutic goals that enhance patients’ quality of life, effectively treat symptoms associated with diabetes and related conditions, and address common geriatric syndromes, such as depression, polypharmacy, cognitive impairment, urinary incontinence, injurious falls, and pain. An A1C below 8% may be appropriate for many of these patients, but individualization of BG goals is of paramount importance.

Chronically ill, institutionalized patients with a short life expectancy do not require aggressive glucose control. However, maintaining adequate control is necessary to facilitate healing and prevent dehydration, symptoms of hyperglycemia or hypoglycemia, and weight loss. Again, individualization of the treatment plan is essential.
Factors That May Compromise Glycemic Control

- Comorbidities
- Polypharmacy
- Economic constraints
- Social changes
- Difficulty preparing or eating food
- Depression, cognitive impairment
- Reduced visual acuity
- Limited manual dexterity
- Impaired renal or hepatic function
- Decreased physical activity or mobility

Many factors can compromise glycemic control in older adults. These individuals frequently present with more than one chronic disease. Because they often take multiple medications, sometimes obtained from more than one pharmacy, they are at risk for drug-drug, drug-food, and drug-disease interactions. Many older individuals live on a fixed income and do not have private health insurance to supplement Medicare or Medicaid. Thus, the cost of therapy, particularly newer glucose-lowering drugs, can be problematic. Common social changes, such as moving to a different neighborhood or a relative’s home, may result in isolation and less access to medical care.

Clinical depression and/or cognitive impairment are common in older adults. These conditions complicate self-care and sometimes make it impossible. Although the changes associated with mild depression and cognitive impairment may be difficult for patients, family members, and friends to detect, even these subtle changes can result in self-care deficits and reduced glycemic control. Older adults with reduced visual acuity and manual dexterity may have difficulty opening medication bottles or drawing up insulin doses. Patients may have impaired renal or hepatic function, placing them at risk for the accumulation of some drugs and an increased incidence of adverse drug reactions. Older adults may also experience physical and physiological changes that result in decreased physical activity or mobility.
Adherence to therapy, such as following a meal and activity plan and taking medications exactly as prescribed, is often limited in the overall population of adults with diabetes, and is also a problem in older adults.

A study in older adults enrolled in a managed care plan found that increased medication adherence was associated with decreased health care costs, and that insulin injections administered with a vial and syringe were associated with reduced adherence to drug treatment.

In another study that included both older and younger adults, insulin delivery systems other than a vial and syringe were shown to increase adherence and reduce health care costs.

Several studies have shown that difficulty in paying for medications may compromise adherence to therapy.

Thus, health care providers should be mindful of adherence when prescribing treatments for their patients and monitoring their progress. They may increase adherence by ensuring that their patients are using an appropriate insulin delivery system, helping their patients overcome economic obstacles to effective treatment, and prescribing therapies that their patients can afford.
An accurate statement about type 2 diabetes in older adults is that __________.

a. approximately 5 million older adults have diabetes
b. in individuals with no risk factors, diabetes screening should begin at age 55
c. in the Diabetes and Aging Study, an A1C of <6% was associated with the lowest mortality risk
d. the A1C target might be less stringent for an individual whose life expectancy is <1 year
Answer to Checkpoint 1

The correct answer is d.

An accurate statement about type 2 diabetes in older adults is that the A1C target might be less stringent for an individual whose life expectancy is <1 year.

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An accurate statement about type 2 diabetes in older adults is that the A1C target might be less stringent for an individual whose life expectancy is <1 year.
Comprehensive Monitoring

- SMBG (if appropriate)
- Routine medical visits
  - Screening for depression and cognitive impairment
  - A1C
  - BP, lipid levels
  - Dilated eye exam
  - Foot exam (also performed daily at home)
  - Test for urine albumin excretion with spot urine albumin/creatinine ratio
  - Nutritional status (food shopping; meal preparation; CHO, fat, and fiber intake; weight history; dentition; alcohol consumption; dietary supplement use)

Self-monitoring of blood glucose (SMBG) is an effective means of assessing daily control of hyperglycemia and minimizing the risk for hypoglycemia. The health care provider should teach newly diagnosed patients to use a BG meter, if appropriate, and periodically assess every patient’s ability to perform SMBG.

Routine medical visits are essential for managing diabetes in all patients, including older adults. These visits often include:

- Annual screening for depression and cognitive impairment
- A1C testing for assessment of BG control. This should be done at least every 6 months or more frequently as needed
- Management of cardiovascular risk factors, such as hypertension and dyslipidemia
- An annual dilated eye examination
- An annual foot exam, which includes assessment of protective sensation, foot structure, vascular status, and skin integrity. The patient should also be encouraged to perform daily foot exams at home
- Test for urine albumin excretion with spot urine albumin/creatinine ratio. Testing should be performed upon diagnosis of diabetes and then at least annually
- Nutritional status, which should be assessed at each visit. Items to be assessed include ability to shop for and prepare meals; intake of carbohydrates, fats, and fiber; weight history; dentition; alcohol consumption; and use of dietary supplements
Other Important Areas for Assessment

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Several important areas are sometimes overlooked when assessing the older adult with diabetes. One key area is the patient’s attitudes towards diabetes self-care. How high a priority does the patient give to diabetes self-care? Which self-care domains are most important to the patient? For example, how important is physical activity in relation to taking glucose-lowering medication?

Another essential area is the status of the patient’s knowledge about self-care and her/his actual self-care behaviors. Does the patient understand current recommendations for self-care and why they are important in the overall context of diabetes management? What self-care practices does the patient currently perform?

Assessing the patient’s level of family and social support is also essential. What is the status of the patient’s relationships with family and friends? Are these relationships antagonistic or supportive? How much support does the patient want and how much does she/he actually receive from the family, friends, and community?

Assessment of the patient’s literacy is sometimes avoided because patients may become defensive. Nevertheless, it is important to determine whether the patient has functional literacy skills and if so, in what language. Determining the patient’s health literacy level is also desirable and can be done quickly using a standardized instrument such as the Test of Functional Health Literacy in Adults (TOFHLA).
**Other Important Areas for Assessment**

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Intact cognitive function that enables complex behaviors is particularly important for people with diabetes, since increasingly sophisticated regimens are now used for glycemic management. However, older adults with diabetes are at greater risk for cognitive dysfunction than older adults without diabetes. Therefore, the health care provider should perform an annual assessment of cognition and the ability to perform activities of daily living (ADLs) and instrumental ADLs (IADLs).

Many useful standardized tests can be performed in the clinical setting. The Mini Mental Status Examination (MMSE) includes specific questions related to attention, orientation, memory, calculation, and language. The clock-drawing test (CDT) is a validated screen for cognitive dysfunction. The Mendez method of scoring the CDT most accurately predicts cognitive deficits and correlates with the MMSE. The clock-in-a-box (CIB) test is a modified CDT that serves as a fast and reliable index of executive function. The Geriatric Depression Scale (GDS) is a well-validated, 15-item tool often used to screen for depressive symptoms in older adults. Informant-based ADL questionnaires measure an individual’s functionality in bathing, toileting, grooming, dressing, and eating, whereas IADL questionnaires measure functionality in traveling, shopping, housework, managing finances, using the telephone, and taking medications. The annual cognition and ADL assessment should also include an assessment of the patient’s gait and balance.
The AADE 7™ Self-Care Behaviors are applicable throughout the lifespan of persons with diabetes. Each behavior is critical for attaining self-sufficiency in diabetes management, and each behavior must reflect the particular needs, physical and cognitive capabilities, and self-care responsibilities of the individual with diabetes. The ways in which the first four AADE 7™ self-care behaviors—healthy eating, being active, monitoring, and taking medication—apply to older adults with diabetes are addressed in other parts of this activity.

Diabetes is a complex disease with unpredictable manifestations, and individuals with diabetes often need to make rapid, informed decisions about eating, physical activity, and medication management. As individuals age, they often lose some of the flexibility and reasoning needed to solve complex, unfamiliar problems. However, appropriate educational interventions can help many older adults to refine their problem-solving skills and anticipate the types of problems they are likely to encounter.

Risk reduction is especially important for older adults with diabetes, who are at an increased risk for hypoglycemia, drug interactions, injurious falls, and other potentially severe conditions and situations related to diabetes. Diabetes educators and other health care providers can help older adults to learn about standards of care and preventive services to reduce these risks.

Coping with diabetes often seems overwhelming to many adults with diabetes, and the challenges of diabetes may seem especially difficult for older adults, who may also be dealing with other health problems, the death of a spouse or close friends, and financial issues. As noted earlier, rates of depression are elevated in older adults with diabetes. Health care providers can assist older adults with diabetes to differentiate between healthy and unhealthy coping mechanisms and adopt healthy coping strategies.
Healthy Eating: 
Basic MNT Principles

• Older adults should receive MNT from registered dietitian
• Dietary and physical activity patterns should be assessed
• Meal plans should minimize complexity, spread carbohydrates throughout day, and incorporate moderate caloric restriction for obese patients
• Interdisciplinary team should oversee MNT for hospital inpatients
• In LTC facilities, interdisciplinary team should integrate MNT into overall patient management

The ADA recommends that all older adults with diabetes receive medical nutrition therapy (MNT) from a registered dietitian. MNT, which is covered by Medicare and many private insurance plans, includes an assessment of the patient’s nutritional status and physical activity patterns, personal and cultural food preferences, and an identification of factors that might impact the nutritional care plan, such as dentition, food intolerance, allergies, and altered taste perception. MNT also includes the identification of lifestyle or social factors that might limit the patient’s adherence to the meal plan, such as cognitive dysfunction or limited finances.

In addition, MNT entails the development of a customized meal plan, reflecting the fact that the energy needs of an older adult may be lower than those of a younger person of the same weight. The plan should minimize complexity and ensure that carbohydrates are spread throughout the day to avoid large BG fluctuations. The plan for an obese patient should generally incorporate moderate caloric restriction. A daily multivitamin supplement may be appropriate, especially for patients with reduced energy intake.

An interdisciplinary team should oversee MNT for hospitalized patients, focusing on meals with a consistent carbohydrate content and a discharge plan that includes a diabetes-specific meal plan prescription. In long-term care facilities, an interdisciplinary team should integrate MNT into overall patient management.
Regular physical activity has many benefits for older adults with diabetes. Exercise promotes improved glucose tolerance and increased insulin sensitivity, reduces blood pressure (BP), and improves circulation. It increases joint flexibility, promotes a sense of well-being, and increases lean body mass and muscle. Exercise may also reduce all-cause mortality and decrease the risk for falls in older adults.

Before embarking on an exercise program, the patient should be evaluated for risk factors, such as microvascular disease and loss of sensation in the feet. The patient’s ability to perform different types of exercise should also be assessed. For example, individuals with retinopathy should not lift weights. Patients should be taught about the importance of performing SMBG before and after exercise and the appropriate actions to take in response to test results. Exercise-induced hypoglycemia and late-onset postexercise hypoglycemia, which can occur 24 or more hours after activity, are important concerns. The patient should remain adequately hydrated and wear easily visible medical identification during exercise.
The Office of Disease Prevention and Health Promotion of the US Department of Health and Human Services issued physical activity guidelines for Americans in 2008. The following are key guidelines for adults:

- All adults should avoid inactivity
- For substantial health benefits, adults should do at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes. Preferably, it should be spread throughout the week
- For additional and more extensive benefits, these periods of physical activity should be doubled or increased even further
- Adults should also do moderate- to high-intensity muscle-strengthening activities on at least 2 days per week, as these activities provide additional health benefits

The following are key guidelines for older adults:

- Older adults should follow regular adult guidelines if possible. If unable to do 150 minutes of moderate-intensity aerobic activity per week because of chronic conditions, they should be as physically active as their abilities and conditions allow
- Older adults should do exercises that maintain or improve balance if they are at risk of falling
- Older adults should determine their level of effort for physical activity relative to their level of fitness
- Older adults with chronic conditions should understand whether and how their conditions affect their ability to do regular physical activity safely.
Monitoring: SMBG

- Allows patients to evaluate individual response to therapy and assess whether glycemic goals are being achieved
- Frequency and timing should be dictated by individual’s needs, goals, and capabilities
- Age should not be primary criterion for deciding whether to use SMBG
- Monitoring technique should be assessed regularly
- Monitors are available for patients with physical limitations

SMBG allows patients to evaluate their individual response to therapy and assess whether their glycemic targets are being achieved. Results of SMBG can be useful in preventing hypoglycemia and adjusting medications, MNT, and physical activity. The frequency and timing of SMBG should be dictated by the particular needs, goals, and capabilities of the particular patient.

Age should not be the primary criterion for deciding whether to use SMBG, because many older individuals perform SMBG more accurately and consistently than younger adults. The individual’s monitoring technique should be assessed at regular intervals, since cognitive and physical abilities may deteriorate over time.

Special BG monitors are available for patients with impaired manual dexterity, and “talking” monitors and monitors with large numerical displays and backlights are available for persons with visual limitations. Current information about specialized BG monitors is available in the annual consumer guide published in *Diabetes Forecast*. 
Medicare Coverage for SMBG Supplies

- Medicare Part B covers BG monitors, test strips, lancet devices, lancets, and glucose control solutions for checking accuracy of testing equipment and strips
- Quantity of supplies covered
  - Patients using insulin: 100 test strips and lancets every month, 1 lancet device every 6 months
  - Patients not using insulin: 100 test strips and lancets every 3 months, 1 lancet device every 6 months
  - Additional test strips and lancets allowed if physician documents that they are medically necessary


Medicare Part B covers BG monitors, test strips, lancet devices, lancets, and glucose control solutions for checking the accuracy of testing equipment and test strips.

The quantity of SMBG supplies varies, depending on whether a person uses insulin. Patients using insulin are eligible for 100 test strips and lancets every month, as well as 1 lancet device every 6 months. Patients who do not use insulin are eligible for 100 test strips and lancets every 3 months and one lancet device every 6 months. If the patient’s physician provides documentation that it is medically necessary, Medicare will allow additional test strips and lancets. Similarly, Medicare will provide coverage for a special type of BG monitor, such as one designed for a patient with limited vision, if the physician documents that it is medically necessary.

To qualify for coverage, patients must have a physician’s prescription for SMBG supplies and obtain the supplies from a pharmacy or supplier enrolled in Medicare.
Many oral and injectable glucose-lowering agents are currently available. Several questions are relevant when selecting one of these medications for an older adult. The ways in which the drug is metabolized and eliminated are important because hepatic and renal function typically decreases with advancing age. Therefore, extra precautions should be taken with drugs metabolized by the liver or excreted by the kidney. Medications for the older adult should often be started at the lowest possible dose and slowly titrated upwards. Due to the potential for drug interactions, other medications the patient is taking may need to be changed or their dosage reduced.

Because older adults are more vulnerable to adverse drug reactions, it is important to know the history of the drug’s use in older persons. The health care provider should consider the risk versus the benefit of using each drug. Furthermore, the likelihood that the patient will be able to adhere to the medication regimen must be determined. Simplified regimens, such as combination products, and pillboxes or timers can assist patients with diminished cognitive abilities. It is also important to determine whether the patient has an insurance plan with prescription drug coverage, and what types of antidiabetes medications are covered by the plan. If the drug is not covered by insurance, the health care provider should determine whether the patient has the financial resources to pay for the drug.

The 2009 consensus algorithm of the American Diabetes Association and European Association for the Study of Diabetes (ADA/EASD 2009 algorithm) provides useful guidance on the initiation and adjustment of drug therapy in patients with type 2 diabetes.
## Drugs That Can Alter BG Levels

### Lower BG
- Alcohol (acute use)
- ACE inhibitors
- Salicylates (>4 g/day)
- Beta blockers (nonselective)
- Pentamidine

### Raise BG
- Alcohol (chronic use)
- Glucocorticoids
- Atypical antipsychotics
- Diuretics
- Sympathomimetics
- Phenytoin
- Diazoxide
- Beta blockers (nonselective)

Many widely used drugs can lower BG levels. For example, acute ingestion of alcohol impairs gluconeogenesis and enhances the response to insulin. ACE inhibitors are associated with hypoglycemia. Salicylate doses greater than 4 grams per day may alter the pharmacokinetics of sulfonylureas (SUs), increase utilization of glucose by peripheral tissues, reduce gluconeogenesis, and potentiate insulin secretion. Nonspecific beta blockers such as propranolol can inhibit gluconeogenesis and glycogenolysis, thereby masking the signs of hypoglycemia. Pentamidine can damage pancreatic beta cells, resulting in hypoglycemia.

On the other hand, a number of commonly used drugs can raise BG levels. For example, chronic alcohol consumption may cause hyperglycemia. Glucocorticoids, such as prednisone, increase gluconeogenesis and depress insulin action. Atypical antipsychotic therapy may lead to hyperglycemia and the development of type 2 diabetes through multiple mechanisms. Diuretics can inhibit insulin secretion indirectly, by depleting potassium levels. Sympathomimetics, such as epinephrine, increase glycogenolysis and gluconeogenesis. Both phenytoin and diazoxide can inhibit insulin secretion. Nonselective beta-blockers can block glucose— or glucagon—mediated beta-adrenergic stimulation that normally promotes pancreatic insulin secretion.
Many classes of oral glucose-lowering drugs are approved for use in the US. Metformin, the only biguanide available in most parts of the world, improves the effectiveness of insulin in suppressing excess hepatic glucose production. The \( \alpha \)-glucosidase inhibitors (AGIs) acarbose and miglitol reduce the rate of polysaccharide digestion in the proximal small intestine. The bile acid sequestrant colesvelam is a lipid-lowering polymer that binds bile acids in the intestine, impeding their absorption. Although colesvelam is mainly used to treat hypercholesterolemia, it is also indicated as an adjunct to diet and exercise to improve glycemic control in adults with type 2 diabetes. The mechanism by which colesvelam lowers BG levels is unknown.

The dipeptidyl peptidase-4 (DPP-4) inhibitors, including sitagliptin, saxagliptin, and linagliptin, increase GLP-1 levels by inhibiting DPP-4. DPP-4 is a ubiquitous enzyme that degrades glucagon-like peptide 1 (GLP-1), an incretin hormone released from the GI tract during food ingestion that increases insulin secretion from pancreatic beta cells in a glucose-dependent manner. The glinides, including repaglinide and nateglinide, are insulin secretagogues that stimulate primarily the first phase of insulin secretion after food ingestion. The SUs, such as glimepiride, glipizide, and glyburide, are insulin secretagogues that enhance the second phase of insulin secretion, with little effect on first-phase secretion. The thiazolidinediones (TZDs), including pioglitazone and rosiglitazone, increase the sensitivity of muscle, fat, and liver to endogenous and exogenous insulin.
### Injected Glucose-Lowering Drugs

<table>
<thead>
<tr>
<th>Class (Examples)</th>
<th>Main Mechanism of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amylin agonist (pramlintide)</td>
<td>Synthetic analog of beta-cell hormone amylin that delays gastric emptying, inhibits glucagon production in glucose-dependent manner, and decreases postprandial glucose excursions</td>
</tr>
<tr>
<td>Glucagon-like peptide 1 (GLP-1) agonists (exenatide, liraglutide)</td>
<td>Agents that are structurally similar to native GLP-1; increase insulin release and decrease glucagon secretion in glucose-dependent manner</td>
</tr>
<tr>
<td>Insulin (regular, intermediate-acting [NPH], premixed)</td>
<td>Polypeptide hormone structurally identical to natural human insulin and produced by recombinant DNA (rDNA) technology</td>
</tr>
<tr>
<td>Insulin analogs (rapid-acting, long-acting, premixed)</td>
<td>Structurally modified insulin products manufactured by rDNA technology</td>
</tr>
</tbody>
</table>

Among the injected glucose-lowering drugs is the amylin agonist pramlintide, a synthetic analog of the beta-cell hormone amylin. Pramlintide delays gastric emptying, inhibits glucagon production in a glucose-dependent manner, and decreases postprandial glucose excursions.

The GLP-1 agonists, including exenatide and liraglutide, are agents that are structurally similar to native GLP-1, but have a much longer duration of action. They increase insulin release and decrease glucagon secretion in a glucose-dependent manner.

Manufactured human insulin is a polypeptide hormone that is structurally identical to natural human insulin and produced by recombinant DNA (rDNA) technology. These products provide major improvements in purity over insulin obtained from animal sources. Human insulin products include regular, intermediate-acting (NPH), and premixed insulins.

Insulin analogs are structurally modified insulin products manufactured by rDNA technology. (Recall that an analog is an agent whose function is generally similar to that of another agent—in this case, insulin—but whose origin and structure are different.) Insulin analogs differ from human insulins by the substitution or transposition of one or more amino acids. Available products include rapid-acting, long-acting, and premixed insulin analogs.
The different classes of glucose-lowering drugs are variably effective at decreasing A1C levels. This table shows the expected range of the A1C reduction when an agent is given as monotherapy or, in the case of colesevelam, in combination with one or more additional glucose-lowering drugs.

Insulin and insulin analogs are the most effective agents for lowering BG levels. The expected A1C reduction with insulin is 1.5 to 3.5%. However, when used in adequate doses, insulin can reduce any level of elevated A1C to, or close to, the therapeutic goal. Unlike other glucose-lowering drugs, there is no maximum insulin dose beyond which a therapeutic effect will not occur.

<table>
<thead>
<tr>
<th>Class</th>
<th>Expected A1C Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-Glucosidase inhibitors</td>
<td>0.5–0.8</td>
</tr>
<tr>
<td>Biguanide (metformin)</td>
<td>1.0–2.0</td>
</tr>
<tr>
<td>Bile acid sequestrant (colesevelam)</td>
<td>0.3–0.4†</td>
</tr>
<tr>
<td>DPP-4 inhibitors</td>
<td>0.5–0.8</td>
</tr>
<tr>
<td>Glinides</td>
<td>0.5–1.5‡</td>
</tr>
<tr>
<td>Sulfonylureas</td>
<td>1.0–2.0</td>
</tr>
<tr>
<td>TZDs</td>
<td>0.5–1.4</td>
</tr>
<tr>
<td>Amylin agonist (pramlintide)</td>
<td>0.5–1.0</td>
</tr>
<tr>
<td>GLP-1 agonists</td>
<td>0.5–1.1</td>
</tr>
<tr>
<td>Insulin and insulin analogs</td>
<td>1.5–3.5</td>
</tr>
</tbody>
</table>

*When administered as monotherapy.
†When given in combination with one or more glucose-lowering drugs.
‡Repaglinide more effective than nateglinide.

The α-glucosidase inhibitors (AGIs) include acarbose (Precose®) and miglitol (Glyset®). AGIs should be taken 3 times daily, with the first bite of each major meal. They are most effective when the diet contains large amounts of complex carbohydrates, as is typical of many Asian diets.

The main side effects of the AGIs are gastrointestinal and include increased intestinal gas formation, abdominal discomfort, and diarrhea. They have a neutral effect on weight.

AGI use is contraindicated in patients with severe intestinal disease. Miglitol is also contraindicated in individuals with cirrhosis. AGI therapy is not recommended for patients with severe renal impairment. During clinical trials, no important differences in safety or efficacy were observed in older and younger adults.

Hypoglycemia is rare during monotherapy, but may occur when an AGI is administered with an insulin secretagogue or insulin. If hypoglycemia does occur, it must be treated with glucose, since the AGIs inhibit the digestion and absorption of sucrose and complex carbohydrates.

The AGIs are not widely used due to their GI side effect profile.
Biguanide: Metformin

- First-line therapy in 2009 ADA/EASD and AACE/ACE consensus algorithms
- Available in immediate- and extended-release formulations and as part of many combination products
- Best tolerated when taken with meals
- GI side effects, which are usually transient, can be minimized by initiating treatment at 500 mg/day
- Low risk of hypoglycemia; modest weight loss may occur
- Lactic acidosis a very rare but life-threatening adverse effect
- Treatment should not be initiated in patients ≥80 years unless measurement of creatinine clearance shows that renal function is not reduced
- Contraindicated in patients with renal dysfunction or other lactic acid risk factors

The biguanide metformin is positioned as first line therapy in the 2009 consensus algorithms of the ADA/EASD and the AACE/American College of Endocrinology (ACE). Metformin is available in immediate- and extended-release (ER) formulations, and also as a component of several combination products. The maximal recommended dose is 2500 mg/day, although little additional benefit is seen with doses greater than 2000 mg/day. Metformin is best tolerated when taken with meals. The most common adverse effects involve the GI system and include metallic taste, anorexia, nausea, abdominal pain, and diarrhea. These effects are usually transient and can be minimized by initiating treatment at 500 mg/day. There is a low risk for hypoglycemia and modest weight loss may occur. Lactic acidosis is a rare but life-threatening adverse event. Its estimated incidence is 0.03 cases per 1000 patient-years, with 0.015 fatal cases per 1000 patient-years. Lactic acidosis occurs most often in older adults with marked renal insufficiency. Therefore, treatment should not be initiated in patients aged 80 or older unless measurement of creatinine clearance shows that renal function is not reduced.

Metformin is contraindicated in patients with renal disease or renal dysfunction, as suggested by abnormal creatinine clearance or by serum creatinine levels ≥1.5 mg/dL in men or ≥1.4 mg/dL in women. Metformin treatment should not be initiated or should be promptly discontinued in patients with other risk factors for lactic acidosis, including congestive heart failure, liver disease, and chronic alcohol abuse. Since radiographic contrast materials can impair renal function, metformin therapy should be discontinued at the time of studies involving intravascular iodinated contrast materials, withheld for 48 hours after the procedure, and not reinstated until renal function has been reevaluated and found to be normal.
Bile Acid Sequestrant: Colesevelam

- Available in tablet and powder formulations (as Welchol®)
- Major adverse effect is constipation; should not be used in patients with GI motility disorders or those at risk for bowel obstruction
- May increase triglyceride levels; contraindicated in patients with triglyceride levels >500 mg/dL and those with history of hypertriglyceridemia-induced pancreatitis
- May decrease absorption of fat-soluble vitamins, especially vitamin B12

Although the bile acid sequestrant colesevelam is used primarily to treat hypercholesterolemia, either as monotherapy or in combination with a statin, it also reduces the BG levels of patients with type 2 diabetes. In clinical trials, add-on colesevelam therapy resulted in modest glycemic reductions in individuals whose BG was inadequately controlled with metformin, a sulfonylurea, or insulin.

Colesevelam, which has the trade name Welchol®, is available both as a tablet and as a powder for oral suspension. The powder formulation, which comes in single-use packets, should be taken with 4 to 8 ounces of water, fruit juice, or diet soft drink. This formulation is well suited to older adults who find it difficult to swallow tablets.

Because its major adverse effect is constipation, colesevelam should not be used in patients with gastroparesis or other GI motility disorders, in individuals who have just undergone major GI surgical procedures, and in others at risk for bowel obstruction. Other adverse effects include malabsorption of fat-soluble vitamins, especially vitamin B12, and increased triglyceride levels. Colesevelam is contraindicated in patients with serum triglyceride levels greater than 500 mg/dL and in those with a history of hypertriglyceridemia-induced pancreatitis.
DPP-4 Inhibitors

- Include linagliptin (Tradjenta™), saxagliptin (Onglyza®), and sitagliptin (Januvia®)
- Taken once daily
- Few clinically relevant drug-drug interactions
- Neutral effect on weight and caloric intake, may reduce risk of cardiovascular events
- No dose adjustment required for patients with hepatic impairment
- Dose adjustments needed with saxagliptin and sitagliptin for patients with moderate or severe renal impairment
- Well tolerated; very low risk of hypoglycemia unless taken with insulin secretagogue

DPP-4 inhibitors currently approved by the US FDA are linagliptin (Tradjenta™), saxagliptin (Onglyza®), and sitagliptin (Januvia®). Combination products consisting of saxagliptin plus metformin (Kombiglyze™) and sitagliptin plus metformin (Janumet®) are also available. DPP-4 inhibitors are taken once daily, and no dose titration is needed at the start of treatment. The risk of clinically significant drug-drug interactions is low, although linagliptin should not be taken with a CYP3A4 or P-glycoprotein inducer and saxagliptin should be taken at the lowest therapeutic dose (2.5 mg) during coadministration with a strong CYP3A4/5 inhibitor. DPP-4 inhibitors have a neutral effect on weight and caloric intake, and post hoc analyses suggest that they may reduce the risk of cardiovascular events.

No dose adjustment is required for patients with hepatic impairment. However, dose adjustment is needed when saxagliptin or sitagliptin is prescribed for patients with moderate or severe renal impairment.

The DPP-4 inhibitors are very well tolerated, and during clinical trials, the most commonly reported adverse events were nonspecific effects such as upper respiratory tract infection and urinary tract infection. There is a very low risk for hypoglycemia except when a DPP-4 inhibitor is taken with an insulin secretagogue. Hypersensitivity reactions, including angioedema, urticaria, and skin exfoliation, are rare but potentially serious adverse effects.
Benefits of DPP-4 Inhibitor Therapy in Older Adults

- Efficacy and safety profiles similar to those seen in younger adults
- Placebo-level risk of hypoglycemia, except during coadministration with insulin secretagogue
- Weight neutrality
  - Preserves muscle and total body protein mass
  - Avoids additional weight gain
- Low risk of drug-drug interactions
- Convenient administration
  - Once-daily oral dosing; no titration needed at start of therapy
  - Saxagliptin and sitagliptin available as combination products with metformin

DPP-4 inhibitor therapy has many benefits for older adults. The efficacy and safety profiles of linagliptin, saxagliptin, and sitagliptin are similar in older and younger adults. During DPP-4 inhibitor therapy, there is a placebo-level risk of hypoglycemia in older adults, except during coadministration with an insulin secretagogue. When treatment with a DPP-4 inhibitor is initiated, prescribers should consider reducing the dose of a concomitantly administered insulin secretagogue.

The weight-neutral effect of the DPP-4 inhibitors preserves muscle and total body protein mass while avoiding additional weight gain.

There is a low risk for drug-drug interactions although, as mentioned previously, linagliptin should not be given concurrently with a CYP3A4 or P-glycoprotein inducer and the saxagliptin dose may need to be reduced during concomitant therapy with a strong CYP3A4/5 inhibitor.

The DPP-4 inhibitors offer the convenience of once-daily oral dosing, with no titration needed at the start of therapy. Both saxagliptin and sitagliptin are available as fixed-dose combination products with metformin.
The benefits of DPP-4 inhibitor therapy were shown in a post hoc analysis of 2 randomized, double-blind studies conducted in patients 65 years of age or older. Participants had inadequate glycemic control during metformin monotherapy at a dose of at least 1500 mg/day and the baseline A1C was approximately 7.5% in both studies. Patients were followed for 52 weeks in Study 1 and for 30 weeks in Study 2. In Study 1, patients received sitagliptin 100 mg/day or glipizide initiated at a dose of 5 mg/day and uptitrated to a maximum dose of 20 mg/day. In Study 2, patients received sitagliptin 100 mg/day or glimepiride initiated at a dose of 1 mg/day and uptitrated to a maximum dose of 6 mg/day.

At the end point of each study, both treatments resulted in a statistically significant improvement in the A1C from baseline, and the efficacy of sitagliptin was similar to that of the SU. Body weight decreased modestly with sitagliptin and increased modestly with the SU, and the differences in body weight change between sitagliptin and the SU were statistically significant.

In both studies, a significantly higher percentage of patients in the SU group than in the sitagliptin group experienced hypoglycemia. The incidence of hypoglycemia was 5.0% with sitagliptin versus 39.0% with glipizide in Study 1 and 7.6% with sitagliptin versus 17.9% with glimepiride in Study 2.

The investigators concluded that the addition of sitagliptin to patients at least 65 years of age with an inadequate response to metformin provided similar A1C-lowering efficacy, with less hypoglycemia, compared to the addition of a SU.
The glinides include nateglinide (Starlix®) and repaglinide (Prandin®). Because they are absorbed quickly and have a rapid onset of action, glinides should be taken no more than 30 minutes before meals. Therefore, they are well suited to patients with irregular meal schedules. Therapeutic dose ranges are 60 to 180 mg for nateglinide and 0.5 to 4 mg for repaglinide. Typically, repaglinide is somewhat more effective than nateglinide.

Since the glinides are insulin secretagogues, hypoglycemia is a potential adverse effect. The incidence of hypoglycemia is thought to be somewhat lower with nateglinide than with repaglinide and some SUs. The glinides are also associated with mild weight gain.

In other respects, the glinides are generally well tolerated, and GI adverse effects are infrequent. During clinical trials, commonly reported adverse events were nonspecific disorders, such as upper respiratory tract infections. The glinides should be used with caution in patients with hepatic dysfunction. No dose adjustments for renal impairment are needed with nateglinide. Patients with severe renal impairment should initiate repaglinide therapy with the 0.5 mg dose and upward titration should proceed cautiously.
Sulfonylureas (SUs)

- Long-acting (glyburide) and short-acting (eg, glipizide, glimepiride) products available
- Rapid onset of glucose-lowering effect, but maintenance of glycemic targets over time less robust than with metformin or TZD
- Most products inexpensive
- Major adverse effect is hypoglycemia
  - More frequent with long-acting products
  - Common cause of hospitalization in patients ≥80 years
- Weight gain may occur
- Glycemic benefits nearly fully realized at half-maximal doses
- Often contraindicated in patients with renal or hepatic insufficiency

The SUs include the long-acting agent glyburide and short-acting agents such as glipizide and glimepiride. The efficacy of the SUs is similar to that of metformin, with an expected A1C reduction of about 1.5%. Another important advantage is the low cost of most SUs. Although the glucose-lowering effect of the SUs has a rapid onset, maintenance of glycemic targets over time is generally less sustained than with metformin or the TZDs.

Because the sulfonylureas act continuously to stimulate pancreatic beta cells, their most common side effect is hypoglycemia. Hypoglycemia occurs more frequently with the long-acting than the short acting SUs. Severe hypoglycemia, which may be life-threatening, has been identified as a common cause of hospitalization in patients 80 years of age or older. Since hypoglycemia in hospitalized patients is associated with adverse short- and long-term outcomes, many experts believe that SUs should not be used in the inpatient setting. Other side effects include headache, nausea, diarrhea, rash, and a bitter metallic taste. Weight gain may occur.

The glycemic benefits of the SUs are nearly fully realized at half-maximal doses, and higher doses should generally be avoided. Adding a second glucose-lowering drug from a different class is generally the more effective and safer approach.

Because they are metabolized in the liver and excreted through the kidney, SUs should be used with caution in older adults. Many members of this class are contraindicated in patients with hepatic or renal insufficiency.

The TZDs include pioglitazone (Actos®) and rosiglitazone (Avandia®). In addition to expected A1C reductions ranging from 0.5 to 1.4%, the TZDs have beneficial effects on lipid profiles. TZD therapy is associated with a very low risk of hypoglycemia unless administered with an insulin secretagogue.

The most common adverse effect of TZD therapy is weight gain, which results both from increased adipose tissue mass and fluid retention. TZD–related fluid retention can lead to peripheral edema and to the precipitation or exacerbation of congestive heart failure (CHF). The TZDs are contraindicated in patients with New York Heart Association class III or IV heart failure and should be used with caution in patients with less severe CHF and in those with peripheral vascular disease. A meta-analysis of 52 clinical trials found a statistically significant increase in the risk of myocardial infarction in patients treated with rosiglitazone. Therefore, rosiglitazone has been withdrawn from use in the European Union and is available in the US only through a restricted distribution program called the AVANDIA-Rosiglitazone Medicines Access Program.

TZD treatment is also associated with an increased risk of nonosteoporotic bone fractures. Due to evidence suggesting an increased risk of bladder cancer, pioglitazone should not be used in patients with active liver cancer and should be used with caution in patients with a prior history of bladder cancer.
In patients with type 2 diabetes, the amylin agonist pramlintide (Symlin®) is indicated as an adjunct treatment for patients who use mealtime insulin therapy and have failed to achieve the desired glucose control despite optimal insulin therapy, with or without a current SU and/or metformin. Until recently, pramlintide was available for administration either with a vial and syringe or a pen device, but vials are no longer being produced, and existing patients must transition to the pen.

Pramlintide should be administered immediately before each major meal, which is defined as a meal consisting of at least 250 kcal or at least 30 g of carbohydrate. The major adverse effect of pramlintide is nausea, which was reported in up to 48% of patients in long-term clinical trials. The process of initiating pramlintide therapy can be complex, requiring close coordination with the health care provider. Pramlintide should be initiated at a dose of 60 µg, with the preprandial insulin dose reduced by 50%. The pramlintide dose should be increased to 120 µg when no clinically significant nausea has occurred for 3 to 7 days. Once this target dose of pramlintide has been achieved, the insulin dose should be adjusted to optimize glycemic control. Because of the risk of hypoglycemia associated with the pramlintide–prandial insulin regimen, pramlintide should only be used in patients known to fully understand and adhere to SMBG and insulin adjustments. Pramlintide often causes mild weight loss.

Since it slows gastric emptying, pramlintide should not be considered for patients who take drugs that alter GI motility, such as metoclopramide, or that slow the intestinal absorption of nutrients, such as AGIs.
The currently approved GLP-1 agonists are exenatide (Byetta®) and liraglutide (Victoza®). Exenatide is taken twice daily and liraglutide is taken once daily. Both exenatide and liraglutide are administered using disposable pen devices. GLP-1 agonists have many benefits in addition to BG lowering. These include weight loss, reduction of BP (especially systolic BP), reduction of triglyceride levels by ≥20%, and a possible decrease in the risk of cardiovascular events. No routine exenatide or liraglutide dose adjustments are required for patients with renal or hepatic insufficiency, but exenatide is not recommended for patients with severe renal impairment or end-stage renal disease.

Nausea and other GI disorders, usually transient and of mild intensity, are the most common adverse effects. In phase 3 clinical trials, between 28% and 44% of patients reported nausea. The risk of nausea and other GI disturbances can be minimized by carefully following manufacturer’s directions about dose titration. The risk of hypoglycemia is very low unless a GLP-1 agonist is administered with an insulin secretagogue. Injection site reactions occur infrequently and are usually mild.

Cytochrome P450–mediated drug-drug interactions are not a concern with the GLP-1 agonists. However, since exenatide and liraglutide can slow gastric emptying, the extent and rate of absorption of orally administered drugs can potentially be reduced. Patients taking medications that depend on threshold concentrations for efficacy, such as antibiotics, should take those drugs at least 1 hour before exenatide administration. If such drugs are to be administered with food, they should be taken with a meal or snack when exenatide is not injected. In patients receiving warfarin therapy, the prothrombin time should be monitored more frequently than usual after initiation of exenatide. During clinical trials, liraglutide did not affect the absorption of orally administered drugs to a clinically meaningful extent, but caution should be exercised when oral medications are administered concomitantly with liraglutide.
Benefits of GLP-1 Therapy in Older Adults

- Efficacy similar to that observed in younger adults
- Minimal risk of hypoglycemia, except during coadministration with insulin secretagogue
- Often causes modest weight loss
- GI adverse effects may occur more frequently in patients >70 years, but are generally mild and transient
- No CYP450–mediated drug-drug interactions; other clinically significant drug interactions are avoidable
- Disposable pen device makes administration more accurate and convenient

Treatment with a GLP-1 agonist can provide many benefits for older adults. The efficacy of exenatide and liraglutide is similar in older and younger adults. During GLP-1 agonist therapy, there is a minimal risk of hypoglycemia, except during coadministration with an insulin secretagogue. When treatment with a GLP-1 agonist is initiated, prescribers should consider reducing the dose of a concomitantly administered insulin secretagogue.

The modest weight loss associated with GLP-1 agonist therapy can be beneficial to the high proportion of older adults who are overweight or obese. An analysis of pivotal study data for liraglutide showed that patients above age 70 may experience more GI adverse effects than younger adults. It is not known whether this is also the case with exenatide. However, as in younger adults, GI effects in older patients are usually mild and transient.

The absence of cytochrome P-450–mediated drug-drug interactions is a distinct advantage of the GLP-1 agonists. Clinically significant drug interactions associated with delayed gastric emptying can generally be avoided as long as the manufacturers’ recommendations are followed.

The GLP-1 agonists are given by subcutaneous injection, but the disposable pen device makes administration more accurate and convenient for patients.
A consideration in selecting a glucose-lowering agent for an older adult is: __________.

a. metformin can be used in patients with any degree of hepatic or renal impairment
b. DPP-4 inhibitors are weight-neutral agents whose most common adverse effect is nausea
c. GLP-1 agonists are not associated with cytochrome P450–mediated drug interactions
d. the oral agents most likely to cause hypoglycemia are the AGIs and SUs
The correct answer is c.

A consideration in selecting a glucose-lowering agent for an older adult is: GLP-1 agonists are not associated with cytochrome P450–mediated drug interactions.
Insulin and insulin analogs are highly effective glucose-lowering agents. They are considered first-line therapy for individuals with type 2 diabetes and severe hyperglycemia, ketonuria, intolerance of other diabetes medications, or contraindications to the use of other diabetes medications. Because type 2 diabetes is a progressive disease, most patients eventually need to transition to insulin to maintain their glycemic targets. Insulin is also commonly used during acute illnesses, surgery, and hospitalizations.

This graph depicts the insulin secretion profile of a person without diabetes who eats 3 meals per day. Insulin plasma concentrations are shown in orange. There are 2 phases of insulin secretion in response to glucose intake. The first is represented in the graph by the 3 peaks. This phase occurs within 10 minutes of glucose intake and involves the secretion of stored insulin. First-phase insulin response is often assessed using an intravenous glucose tolerance test (IVGTT). Loss of first-phase insulin secretion in response to an IVGTT is typically the earliest detectable abnormality in type 2 diabetes.

Second-phase insulin secretion is represented in the graph as the troughs. This phase begins about 20 minutes after glucose intake and represents insulin newly synthesized in pancreatic beta cells. The goal of insulin therapy is to mimic the 2 phases of insulin secretion as closely as possible, taking into account individual needs and capabilities.
Currently Available Insulins, Insulin Analogs, and Premixed Insulins

<table>
<thead>
<tr>
<th>Category</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid-acting insulin analogs</td>
<td>Insulin aspart (NovoLog®), insulin glulisine (Apidra®),</td>
</tr>
<tr>
<td></td>
<td>insulin lispro (Humalog®),</td>
</tr>
<tr>
<td>Short-acting insulin</td>
<td>Regular human insulin (Humulin®, Novolin® R)</td>
</tr>
<tr>
<td>Intermediate-acting insulin</td>
<td>NPH human insulin (Humulin® N, Novolin® N)</td>
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<tr>
<td>Long-acting insulin analogs</td>
<td>Insulin detemir (Levemir®), insulin glargine (Lantus®)</td>
</tr>
<tr>
<td>Premixed insulin</td>
<td>Humulin® 70/30, Novolin® 70/30</td>
</tr>
<tr>
<td>Premixed insulin analogs</td>
<td>Humalog® Mix50/50™, Humalog® Mix75/25™, NovoLog® Mix 70/30</td>
</tr>
<tr>
<td>U-500 short-acting insulin</td>
<td>Humulin® U-500</td>
</tr>
</tbody>
</table>

Short-acting insulin and especially rapid-acting insulin analogs are used as components of basal-bolus insulin therapy. Short-acting insulin is also used during surgery and rapid-acting analogs are used in insulin pumps. Intermediate-acting insulin and long-acting insulin analogs are used to mimic basal insulin secretion.

Premixed insulins and insulin analogs were developed for the convenience of patients. Premixed insulins are mixtures of regular human insulin and NPH insulin. Premixed insulin analogs are mixtures of insulin aspart or insulin lispro and protamine, an arginine-rich protein used to increase the duration of action of the rapid-acting insulin analog.

Except for the formulation in the last row, all of the insulins and insulin analogs shown in the table are U-100 products, meaning that they have an insulin concentration of 100 units per milliliter. In contrast, U-500 insulin has a concentration of 500 units per milliliter. U-500 insulin is intended for patients with marked insulin resistance (daily requirement >200 units), since a large dose may be administered in a reasonable volume. Because of these marked differences in concentration, U-500 insulin and U-100 insulin or insulin analogs must never be used interchangeably.
This graph compares the time courses of the various insulin products with the profile of normal (physiologic) insulin secretion, which is shown by the black line. The mealtime component is represented by the peak and the basal component is represented by the relatively flat line at either side of the peak.

The dark blue line shows the time course of regular human insulin. Note that, compared with the prandial component of endogenous insulin, regular insulin is absorbed and falls back to baseline more slowly. The green line shows the time course of the rapid-acting insulin analogs. Compared with regular insulin, the rapid-acting insulin analogs more closely resemble prandial physiologic insulin secretion. Rapid-acting insulin analogs are absorbed, reach peak plasma levels, and decline back to baseline more quickly than regular insulin.

The purple line shows the time course of NPH insulin. Unlike the basal component of endogenous insulin, which has a flat action profile, NPH insulin peaks at 4 to 10 hours postinjection. The time course of NPH insulin is highly variable. The orange line shows the time course of the premixed insulin analogs. Their rapid-acting component closely reproduces the prandial component of physiologic insulin. However, their long-acting component has a pronounced peak and therefore differs from the basal component of endogenous insulin. The gray line shows the time course of the long-acting insulin analogs. Unlike NPH insulin and the long-acting component of premixed insulin analogs, long-acting insulin analogs are relatively peakless, with flat action profiles. Thus, they more closely reproduce the basal component of physiologic insulin secretion.
Beginning Insulin Therapy in Older Adults

- Mental status
  - Can learn and recall dosing regimen
  - Able to mix different insulins, adjust dosage, and perform SMBG accurately
  - Willing to self-inject
- Manual dexterity
  - Can use insulin delivery system and self-inject (with or without assistive devices)
  - Able to perform SMBG
- Visual acuity
  - Can dose and perform SMBG accurately (with or without injection aids and specialized BG meter)
- Quality of life issues

The health care provider should consider several factors when determining whether to initiate insulin therapy in older adults. Especially when patients live independently, they should be evaluated thoroughly to determine whether their cognitive skills are sufficiently intact to allow them to master the administration regimen and perform SMBG. It is also important to determine whether they are willing to self-inject insulin.

Furthermore, the health care provider needs to establish whether an older adult has the manual dexterity to self-administer insulin, with or without an assistive device, and to perform SMBG. Similarly, it is important to assess whether the patient has sufficient visual acuity to dose insulin accurately, with or without the use of a syringe magnifier or other device. Determining whether the individual has the ability to perform SMBG, either using a conventional BG meter or a system designed for an individual with limited vision, is also essential.

The health care provider should also be mindful of quality of life issues that could influence a decision about initiating insulin therapy. Transitioning to insulin often helps to improve a patient’s quality of life, especially in the presence of hyperglycemia–related symptoms. However, the patient’s desires and life expectancy, as well as the presence of diabetic complications and significant comorbidity, should all be considered when determining whether the benefits of insulin therapy outweigh its risks.

References:
When it is economically feasible, using a device other than a syringe is often a preferable insulin delivery system for older adults. The most frequently used alternative systems are durable or disposable insulin pens. These systems offer simple and accurate dosing, relatively large, easy to read numbers, and ease of handling. The memory functions of some durable pens are a potentially useful feature for many older adults.

Many assistive devices are available for older adults who use the vial and syringe insulin delivery method. These include injection safety guards, syringe magnifiers, and plunger guides.

Needle insertion aids are available for use with a syringe or insulin pen.

Detailed descriptions of insulin delivery systems and assistive devices for people with visual or other disabilities can be found in the annual ADA Consumer Guide, which is available in the January issue of Diabetes Forecast magazine or online at forecast.diabetes.org.

Note that insulin dosers are no longer available for purchase in the US.
### Key Features of Glucose-Lowering Drugs

<table>
<thead>
<tr>
<th>Class</th>
<th>Benefits</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PPG Lowering</td>
<td>FPG Lowering</td>
</tr>
<tr>
<td>AGI</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Biguanide</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Bile acid sequestrant</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>DPP-4 inhibitor</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Glinide</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>SU</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TZD</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Amylin agonist</td>
<td>2–3</td>
<td>1</td>
</tr>
<tr>
<td>GLP-1 agonist</td>
<td>2–3</td>
<td>1</td>
</tr>
<tr>
<td>Insulin</td>
<td>2–3</td>
<td>2–3</td>
</tr>
</tbody>
</table>

Key for benefits: 0 = neutral; 1 = mild; 2 = moderate; 3 = marked.
Key for risks: –1 = benefit; 0 = neutral; 1 = mild; 2 = moderate; 3 = marked; 4 = severe.

FPG = fasting plasma glucose; PPG = postprandial glucose.

This table is a shortened version of an analysis conducted by a consensus panel of the AACE and the American College of Endocrinology (ACE). Because it compares the different classes of glucose-lowering drugs with respect to major benefits and risks, it is a useful tool for planning individualized therapy for older adults with type 2 diabetes.

The benefit analysis shows that the amylin agonist pramlintide, the GLP-1 agonists, and insulin and insulin analogs are most beneficial in terms of postprandial glucose lowering, while insulin is most effective at reducing FPG levels.

With respect to hypoglycemia during monotherapy, risks are moderate to severe for insulin, moderate for SUs, mild for glinides, and neutral for the other agents.

AGIs, metformin, colesevelam, pramlintide, and the GLP-1 agonists are associated with a moderate risk of GI effects, while the other agents are considered neutral.

Weight gain is most likely to occur with TZDs and insulin products, whereas metformin, pramlintide, and the GLP-1 agonists are associated with modest weight loss.
This slide shows the current AACE/ACE Diabetes Algorithm for Glycemic Control. It was published in September 2009, eight months after publication of the definitive version of the ADA/EASD algorithm. Therefore, it is the most up-to-date major algorithm used in the US today. It divides patients into 3 groups according to their A1C at the time of presentation: 6.5% to 7.5%, 7.6% to 9.0%, and >9.0%. The low end of the first range is 6.5% because the AACE and ACE recommend a target A1C of ≤6.5 rather than <7.0% for nonpregnant adults.

Within the algorithm, there is a progression from monotherapy, to dual therapy, to triple therapy, to insulin therapy with or without additional agents. The order of presentation of regimens indicates general priorities that should be customized to the individual patient, with consideration of contraindications, precautions, allergies, comorbid conditions, and drug-drug interactions.

Whichever regimen is selected, the patient’s response to therapy should be monitored closely, by measuring the A1C every 2 to 3 months. Dose titration or regimen changes should be implemented in a timely manner.

Noteworthy features of the algorithm are the prominent role played by the incretin-based therapies—DPP-4 inhibitors and GLP-1 agonists—and the less prominent role played by the SUs. The authors recommend that health care providers prescribe rapid-acting insulin analogs rather than regular human insulin and long-acting insulin analogs rather than NPH insulin.
Syndromes of Special Concern in Older Adults With Diabetes

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>Older adults with diabetes significantly more likely to develop major depression than overall population of older adults, but pharmacological and psychological treatments are generally effective</td>
</tr>
<tr>
<td>Polypharmacy</td>
<td>Polypharmacy increases risk of adverse effects and drug-drug interactions, as well as other geriatric syndromes. Older adults should have continually updated list of medications</td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>Diabetes associated with increased risk of cognitive impairment. Effective treatment of hyperglycemia may improve cognitive function</td>
</tr>
<tr>
<td>Urinary incontinence</td>
<td>More common in older women with diabetes than in overall population of older women. Treatable causes include urinary tract infection, urine retention, fecal impaction, and use of some medications</td>
</tr>
<tr>
<td>Injurious falls</td>
<td>Frequently go unreported and undetected. Risk can be reduced by exercise, addressing hazardous conditions in the home, and reducing psychotropic medication doses</td>
</tr>
<tr>
<td>Neuropathic pain</td>
<td>Often underreported and undertreated. Older adults should be screened for pain. Anticonvulsants and antidepressants often effective</td>
</tr>
</tbody>
</table>


This slide shows 6 geriatric syndromes identified by the California Healthcare Foundation/American Geriatrics Society Panel on Improving Care for Adults with Diabetes as being of greater concern in older adults with diabetes than in the overall population of older adults. Older adults with diabetes are significantly more likely to develop major depression than other older adults, and older adults with diabetes and depression incur higher non-mental health costs than those without depression. However, pharmacological and psychological treatments are effective in reducing depressive symptoms. As mentioned previously, older adults with diabetes are at risk for adverse effects and drug-drug interactions due to polypharmacy. Polypharmacy may also contribute to other geriatric syndromes, including depression, cognitive impairment, urinary incontinence, and falls. Therefore, the older adult with diabetes should maintain an updated medication list for review by health care providers.

Diabetes is associated with decreased cognitive function, which often manifests as impaired memory, learning skills, or verbal skills. Hyperglycemia is a treatable cause of cognitive impairment. Urinary incontinence, which is associated with social isolation, depression, falls, and fractures, is more common in women with diabetes than in the general population of older women. Reversible or treatable causes of urinary incontinence include urinary tract infection, urine retention, fecal impaction, and the use of certain medications. Injurious falls are often unreported and undetected. Their risk can be reduced by exercise, addressing hazardous conditions in the home, and reducing doses of psychotropic medications. Because it is often underreported and undertreated, older adults with diabetes should be screened for persistent pain by the use of a targeted history and physical examination. Both antidepressants and anticonvulsants are effective in reducing pain associated with diabetic neuropathy.
Hyperosmolar Hyperglycemic State (HHS)

- Life-threatening condition most often seen in older adults with undiagnosed or undertreated type 2 diabetes
- Usually precipitated by infection, drugs, acute or chronic diseases that increase BG, or dehydration
- Most common cause of diabetic coma in older patients
- Main symptoms are thirst and confusion
- Corrected by rehydration, correction of precipitating event, insulin administration, and potassium replacement for electrolyte imbalance

Insulin resistance and relative insulin deficiency can result in high BG levels. If undetected or untreated, hyperosmolar hyperglycemic state (HHS) can occur. Infection is the most frequent cause of HHS, but it can also be caused by myocardial infarction, stroke, or drugs or disease states that cause dehydration (eg, diuretics, diarrhea, or severe burns). Since HHS generally occurs in patients with type 2 diabetes who produce some insulin, marked ketosis and acidosis are not usually presenting features. Prompt recognition and treatment are vital, because HHS can be life-threatening.

Common signs and symptoms of HHS include thirst, dehydration, hypotension, confusion, stupor, aphasia, seizures, and coma. The BG level typically exceeds 600 mg/dL and serum osmolality exceeds 320 mOsm/kg. Treatment of HHS includes rehydration with normal saline solution, since dehydration is the primary initial concern. If fluid replacement does not correct the hyperglycemia, administration of insulin, with or without potassium, may be needed. The precipitating event must also be identified and treated appropriately.
Hypoglycemia in Older Adults

- Major risk factors: advanced age, polypharmacy, recent hospitalization, use of SU and/or insulin
- Elevated risk for medication-induced hypoglycemia due to:
  - Decreased or slowed glucagon response
  - Inadequate food intake
  - Slowed intestinal absorption
  - Renal insufficiency
  - Reduced awareness of warning cues
  - Polypharmacy
- Increased risk for morbidity due to injuries from falls; associated with MI and stroke
- Prevention includes patient and caregiver education

Major risk factors for hypoglycemia are advanced age, polypharmacy, recent hospitalization, and treatment with a SU and/or insulin. Older adults are at increased risk for medication-induced hypoglycemia for many reasons. Even mild recurrent episodes of hypoglycemia may have a negative impact on the quality of life of older adults. Recognition of hypoglycemia is complicated by the fact that some older individuals have impaired coordination, cognitive impairment, or dementia even during euglycemia. Older adults are at an increased risk of injuries from falls or stumbles due to hypoglycemia. Hypoglycemia has also been associated with stroke or myocardial infarction, although experts disagree about the correlation between hypoglycemia and new cardiovascular events.

Education of patients, family members, and other caregivers can prevent most episodes of hypoglycemia and hypoglycemia–related injuries. Education should cover the recognition of typical symptoms as well as atypical symptoms that may occur in elderly persons. (Frequently, older patients with hypoglycemia do not experience adrenergic symptoms, such as nervousness, sweating, or trembling, because their adrenergic response to low BG levels may be diminished or absent. Instead, they are likely to experience neuroglycopenic symptoms, such as diminished motor skills or confusion.) Education should also cover the importance of SMBG, eating habits that reduce the risk for hypoglycemia, and alcohol as a risk factor for hypoglycemia. Patients should be encouraged to wear a visible type of medical identification at all times.
Treatment of Hypoglycemia

• Fast-acting carbohydrate – 15:15:60 rule
  – 1/2 cup juice or sweetened soda
  – Commercially available liquid glucose product
• Check BG
• Follow with meal or snack
• If patient cannot swallow, administer glucagon followed by liquid carbohydrates as soon as possible
• Severe or prolonged hypoglycemia may require IV glucose and professional assistance

Treatment of hypoglycemia depends on the patient’s BG level and symptoms. Glycemic thresholds for the onset of symptoms differ among individuals, but symptoms often occur when the BG level drops to 70 mg/dL.

To treat hypoglycemia in a patient who can swallow, the basic approach is to check the BG, consume 15 grams of a fast-acting carbohydrate such as a commercially available glucose product, juice, or sweetened soda, and then recheck the BG in 15 minutes, if possible. If the BG level is still below 70 mg/dL, treatment should be repeated even if the symptoms have disappeared. Patients should be advised that hypoglycemia may recur, so they should check their BG again in 60 minutes. This should be followed by a meal or snack. Patients should also be cautioned against using high-fat foods to treat hypoglycemia, since they take longer to raise BG levels.

Treatment for severe hypoglycemia, defined as hypoglycemia that requires treatment by another person, depends on whether the individual is able to swallow. If the patient can swallow, glucose gel, honey, or syrup can be placed inside the cheek. Otherwise, a glucagon injection can be given to stimulate hepatic glucose production. A family member or friend should be taught how and when to inject glucagon. After the glucagon injection, the patient should drink a liquid source of carbohydrate as soon as possible, since the effects of glucagon are short-lived. Severe hypoglycemia may require the use of intravenous glucose and medical assistance.
Glucose-lowering agents often associated with weight loss include: __________.

a. metformin and sulfonylureas  
b. pramlintide and GLP-1 agonists  
c. DPP-4 inhibitors and insulin  
d. glinides and TZDs
The correct answer is b.

Glucose-lowering agents often associated with weight loss include pramlintide and GLP-1 agonists.
This case describes the process of modifying an older adult’s treatment regimen.

Tim is a 69-year-old white male who returns to his health care provider for a routine checkup. He is married and has 2 grown children who live out of state. Until retiring 4 years ago, he worked as a civil engineer.

Tim is 70 inches tall, weighs 197 pounds, and has a BMI of 28.3 kg/m². He has lost 12 pounds over the past year and credits his progress to his wife’s ability to prepare delicious meals that are consistent with his diet plan. Tim’s wife has just retired as a bank manager and, with his encouragement, plans to spend most of the summer visiting historic gardens in North America and Europe with her sister. Tim says he is delighted that his wife will have the chance to travel, but is concerned about his ability to manage in the kitchen. He explains that he has basic cooking skills but knows little about nutrition and meal planning.

Tim says that now that he is retired, he spends as much time as possible in his shop, making Shaker-style furniture. He walks for about 20 minutes, 5 or 6 days per week.

Tim has a 6-year history of type 2 diabetes. He has no diagnosed diabetic complications. Testing 3 months ago revealed normal renal function. Aside from hypertension and dyslipidemia, for which he is taking medication, he has no health issues. He has excellent cognitive skills, vision (with corrective lenses), and manual dexterity.

He has Medicare Part D prescription drug insurance, along with supplemental prescription drug coverage through his former employer.
Tim’s current glucose-lowering drug regimen is metformin ER 2000 mg once daily and glipizide ER 10 mg once daily. He also takes losartan 100 mg once daily and pravastatin 80 mg once daily. All drugs are well tolerated.

As the table shows, Tim’s BG, systolic BP (SBP), and triglyceride levels do not meet ADA goals. His A1C is 7.7%, his FPG level is 157 mg/dL, and his PPG level is 193 mg/dL. Thus, his A1C exceeds the ADA target by 0.7%, his FPG exceeds the high end of the recommended range by 27 mg/dL, and his PPG exceeds the recommended value by 14 mg/dL.

During treatment with the maximum recommended daily dose of losartan, Tim’s BP is 134/78 mmHg. Thus, his SBP slightly exceeds the recommended value and his DBP is just below the maximum value. Options for lowering Tim’s SBP and lowering or maintaining his DBP are increasing his activity level, administering 50 mg of losartan twice daily instead of 100 mg once daily, adding a diuretic, changing to a different antihypertensive drug, or adding a glucose-lowering agent with beneficial effects on BP.

At the maximum daily recommended dose of pravastatin, Tim’s triglyceride level is 168 mg/dL, or 18 mg/dL above target. Options for bringing this value to goal are increasing his activity level, adding a fibrate or nicotinic acid, changing to a different statin, or adding a glucose-lowering agent with beneficial effects on triglycerides.

Two other issues also need to be addressed. Tim says that he knows little about nutrition and meal planning, and his wife will be away for much of the summer. Clearly, receiving MNT is important for Tim. Furthermore, he says that he walks for about 20 minutes on 5 to 6 days of the week, for a total of 100 to 120 minutes per week of moderate-intensity aerobic activity. However, the ADA recommends that people with diabetes perform at least 150 minutes per week of moderate-intensity aerobic activity. In the absence of contraindications, people with type 2 diabetes should also be encouraged to perform resistance training 3 times per week. Therefore, as long as testing reveals no previously undetected contraindications, Tim needs to begin a more intensive exercise program.
Case Study: Considerations in Selecting a Treatment Regimen

- Tim’s A1C, FPG, and PPG are not at goal
- He also has elevated SBP and triglyceride values
- He has 2 types of prescription drug coverage and sufficient financial resources to cover unreimbursed expenses

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase MET dose from 2000 mg/d to maximum (2500 mg/d)</td>
<td>Unlikely to have substantial effect on BG values</td>
</tr>
<tr>
<td>Increase glipizide extended release dose from 10 mg/d to maximum (20 mg/d)</td>
<td>Might have beneficial effect on BG values, but could cause weight gain and hypoglycemia</td>
</tr>
<tr>
<td>Add a T2D</td>
<td>Might bring BG values to goal and improve lipid profile, but could result in weight gain</td>
</tr>
<tr>
<td>Add a DPP-4 inhibitor</td>
<td>Would reduce BG levels, but probably not sufficiently; unlikely to affect weight</td>
</tr>
<tr>
<td>Add a GLP-1 agonist</td>
<td>Might bring BG values to goal and have beneficial effects on weight, BP (especially SBP), and lipids (especially triglyceride level)</td>
</tr>
</tbody>
</table>

In determining the optimal treatment regimen for Tim, several considerations are important. His A1C, FPG and PPG are not at goal. He also has elevated SBP and triglyceride values. He has 2 types of prescription drug insurance and sufficient financial resources to cover unreimbursed costs.

There are several glucose-lowering options for Tim. His metformin ER dose could be increased from 2000 mg/day to the maximum of 2500 mg/day, but this small increase would probably not improve his BG values, since the maximum clinically effective dose of metformin ER is 2000 mg per day. His glipizide ER dose could be increased from 10 mg/day to the maximum of 20 mg/day. This escalation might have a beneficial effect on his BG values, but would probably not be sufficient to bring Tim to goal. Furthermore, this approach could cause weight gain and episodes of hypoglycemia, which would be very dangerous for someone who works with power tools. Adding a T2D to Tim’s regimen might bring his BG values to goal and improve his lipid profile, but it could also lead to weight gain. Adding a DPP-4 inhibitor would reduce Tim’s BG levels, but probably not sufficiently. Furthermore, DPP-4 inhibitor therapy would not help him continue to lose weight.

Considering Tim’s overall situation, adding a GLP-1 agonist is his best option. It might bring his BG values to goal while also exerting beneficial effects on his weight, BP (especially SBP), and lipid levels (especially his triglyceride level). Although Tim’s insurance covered ExBID but not liraglutide, he elected to pay the out-of-pocket costs for liraglutide because he wanted to administer only one injection per day.

Tim’s health care provider referred him to a registered dietitian for MNT. After testing ruled out retinopathy or other contraindications, Tim was also referred to an exercise physiologist at the health and wellness center affiliated with the local hospital.
Case Study: Treatment Regimen and 3-Month Results

- Metformin ER 2000 mg once daily, glipizide ER 5 mg once daily, and liraglutide 1.2 mg once daily
- Losartan 100 mg once daily, pravastatin 80 mg once daily
- Weight reduction: 7 pounds

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Tim’s Value</th>
<th>ADA Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1C, %</td>
<td>7.1</td>
<td>&lt;7.0</td>
</tr>
<tr>
<td>FPG, mg/dL</td>
<td>125</td>
<td>70–130</td>
</tr>
<tr>
<td>PPG, mg/dL</td>
<td>167</td>
<td>&lt;180</td>
</tr>
<tr>
<td>SBP/DBP, mmHg</td>
<td>126/75</td>
<td>&lt;130/80</td>
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<tr>
<td>LDL-C, mg/dL</td>
<td>93</td>
<td>&lt;100*</td>
</tr>
<tr>
<td>HDL-C, mg/dL</td>
<td>59</td>
<td>&gt;40†</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>152</td>
<td>&lt;150</td>
</tr>
</tbody>
</table>

Green type = meets ADA goal; red type = does not meet ADA goal.
*Goal for individuals without overt cardiovascular disease (CVD). Goal is <70 mg/dL in individuals with overt CVD.

After learning about GLP-1 agonist therapy and how to use a disposable pen device, Tim began receiving a glucose-lowering regimen that included 3 agents. Following titration of the GLP-1 agonist, his new regimen included metformin ER 2000 mg once daily, glipizide ER 5 mg once daily, and liraglutide 1.2 mg once daily. Note that Tim’s former dose of glipizide was reduced by 50%, an approach recommended for reducing the risk of hypoglycemia when a SU is administered together with a GLP-1 agonist. Tim also continued to receive losartan 100 mg once daily and pravastatin 80 mg once daily.

Tim found MNT to be very helpful, and lost 7 pounds over a 3-month period. In addition to keeping up with his walking, he joined a men’s aerobics class at the health and wellness center and uses the center’s resistance training facilities.

Tim had substantial improvement in his BG values, BP, and lipid levels after 3 months of treatment with his new glucose-lowering regimen. In the table, values that are at goal are shown in green and those not at goal are shown in red. Although Tim’s A1C still exceeds the A1C goal, it has decreased by 0.6% and is 7.1%—nearly at goal. Both his FPG and PPG are at goal. Weight loss and treatment with a GLP-1 agonist appear to have had beneficial effects on Tim’s BP, and both his SBP and DBP are now at goal. Ongoing statin therapy, continued weight loss, and treatment with a GLP-1 agonist also seem to have had a favorable effect on Tim’s lipid levels. His LDL-C and HDL-C levels remain at goal. His triglyceride level decreased by 16 mg/dL, to 152 mg/dL, putting him nearly at goal.

Given his substantial progress and the fact that all values are at or approaching goal, Tim will continue his current regimen for 3 more months. At that point a decision will be made about whether his regimen of glucose-lowering agents should be modified in some way, whether his antihypertensive regimen needs to be changed, and whether another or a different drug should be prescribed to help Tim lower his triglyceride level.
Summary

• Risk for developing diabetes increases with age
• Diagnosis and management of diabetes in older adults are complicated by heterogeneity of population
• Setting treatment goals and treating diabetes in older adults should be individualized
• Special treatment considerations
  – Providing customized DSME and MNT
  – Careful medication selection; DPP-4 inhibitors and GLP-1 agonists likely to benefit many older adults
  – Identifying optimal insulin delivery system
  – Addressing geriatric syndromes
  – Minimizing risks for HHS and hypoglycemia

Providing optimal care for the older adult with type 2 is similar to the process of providing excellent care to younger adults, although some special considerations apply. Older adults are at higher risk for developing diabetes than younger persons, but their diabetes often remains undiagnosed because its symptoms may be confused with the symptoms of other age–related disorders. Diabetes management in older adults is especially challenging because this population is extremely heterogeneous. While the treatment of each person with diabetes, irrespective of age, should be individualized, provision of individualized care to older adults is particularly important. Setting individualized treatment goals is also essential.

Many special considerations apply to the treatment of older adults. Providing customized DSME and MNT is challenging but usually gratifying to the diabetes educator, since many older adults learn to perform much or all of their diabetes–related care independently.

Careful medication selection and monitoring of medication effects is essential, both because older adults are likely to be taking several different medications and because they are more likely to experience adverse drug reactions than younger adults. The availability of multiple classes of oral and injectable glucose-lowering medications makes it possible to identify one or more agents whose characteristics meet the needs of the individual patient. Emerging data suggest that the DPP-4 inhibitors and GLP-1 agonists are likely to benefit many older adults. For patients who transition from an oral antidiabetes agent to insulin, possible limitations in vision and manual dexterity make the choice of an insulin delivery system very important.

Addressing the geriatric syndromes of depression, polypharmacy, cognitive impairment, urinary incontinence, injurious falls, and neuropathic pain is challenging in older adults with diabetes, who are at greater risk for these syndromes than their contemporaries without diabetes. Older adults with diabetes are at elevated risk for HHS and hypoglycemia, and it is important for health care providers to offer education that will help them to avoid these potentially life-threatening complications.
Some additional resources for older adults with diabetes are shown on this side. They are:

- AARP (American Association of Retired Persons)
- American Diabetes Association
- Medicare Information on Diabetes Prevention and Treatment
- National Diabetes Education Program
- NCOA (National Council on the Aging)
- US Administration on Aging
- USA.gov Senior Citizens’ Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Internet Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>AARP (American Association of Retired Persons)</td>
<td><a href="http://www.aarp.org/">http://www.aarp.org/</a></td>
</tr>
<tr>
<td>American Diabetes Association</td>
<td><a href="http://www.diabetes.org/">http://www.diabetes.org/</a></td>
</tr>
<tr>
<td>Medicare Information on Diabetes Prevention and Treatment</td>
<td><a href="http://www.medicare.gov/">http://www.medicare.gov/</a></td>
</tr>
<tr>
<td>National Diabetes Education Program</td>
<td><a href="http://www.ndep.nih.gov/">http://www.ndep.nih.gov/</a></td>
</tr>
<tr>
<td>NCOA (National Council on the Aging)</td>
<td><a href="http://www.ncoa.org/">http://www.ncoa.org/</a></td>
</tr>
<tr>
<td>US Administration on Aging</td>
<td><a href="http://www.aoa.gov/">http://www.aoa.gov/</a></td>
</tr>
<tr>
<td>USA.gov Senior Citizens’ Resources</td>
<td><a href="http://www.usa.gov/Topics/Seniors.shtml/">http://www.usa.gov/Topics/Seniors.shtml/</a></td>
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