

# Beyond Insulin: Advancements in Type 1 Diabetes Care

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Managing Metabolic Disorders Conference, iCARE Pharmacy Services, Inc.

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## SPEAKER DISCLOSURE

I do not have (nor does any immediate family member have):

- a vested interest in or affiliation with any corporate organization offering financial support or grant monies for this continuing education activity
- any affiliation with an organization whose philosophy could potentially bias my presentation

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## CPE INFORMATION

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**This activity offers 1.5 contact hours (0.15 CEU).**

- Target Audience:
- ACPE #:
- Activity Type:
  - Knowledge based*
  - Application based*

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## LEARNING OBJECTIVES

1. Discuss the pathophysiology, clinical presentation, and risk factors of diabetes mellitus (DM).
2. Explain the differences between Type 1 and Type 2 diabetes.
3. Understand available treatment options for Type 1 diabetes.
4. Demonstrate proper insulin administration.
5. Discuss blood glucose (BG) monitoring and management of hypoglycemia and hyperglycemia.
6. Introduce emerging therapies and technologies used in the treatment of diabetes, specifically Type 1 diabetes.
7. Discuss the financial implications of Type 1 diabetes and available resources to address patient concerns and questions.
8. Highlight lifestyle management of Type 1 diabetes.
9. Apply learned concepts about Type 1 diabetes to a patient case.

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## Glucagon

- Increases hepatic glucose production
- Increases breakdown of glycogen to make glucose

## Insulin

- Suppresses hepatic glucose production
- Stimulates uptake of glucose by peripheral tissues
- Suppresses glucagon release

## Diabetes

### Pathophysiology

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## Let's Meet Diane Betis

Diane Betis is a 27-year-old female that was diagnosed with Type 1 Diabetes at the age of 7. Diane currently takes the following medications: Lantus 20 units at bedtime, Novolog 6 units before meals, and fluticasone 2 sprays in each nostril daily. Diane recently completed graduate school at USF and recently started working as a marketing professional with a demanding schedule. She enjoys playing basketball with her friends in her free time and generally tries to eat healthy although her meals are often irregular due to her work schedule. She socially drinks but denies smoking or illicit drug use. Her most recent A1C was 8.3 and her BMI is 22.5.

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## What is the Difference?

### TYPE 1 DIABETES (T1D)

Hyperglycemia due to

- ✓ *Absolute insulin deficiency*
- ✓ *Autoimmune destruction of  $\beta$ -cells in the pancreas*

### TYPE 2 DIABETES (T2D)

Hyperglycemia due to

- ✓ *Relative insulin deficiency*
- ✓ *Pancreatic  $\beta$ -cells dysfunction*
- ✓ *Decreased insulin sensitivity*
- ✓ *Insulin resistance*

May see complications including organ and nerve damage

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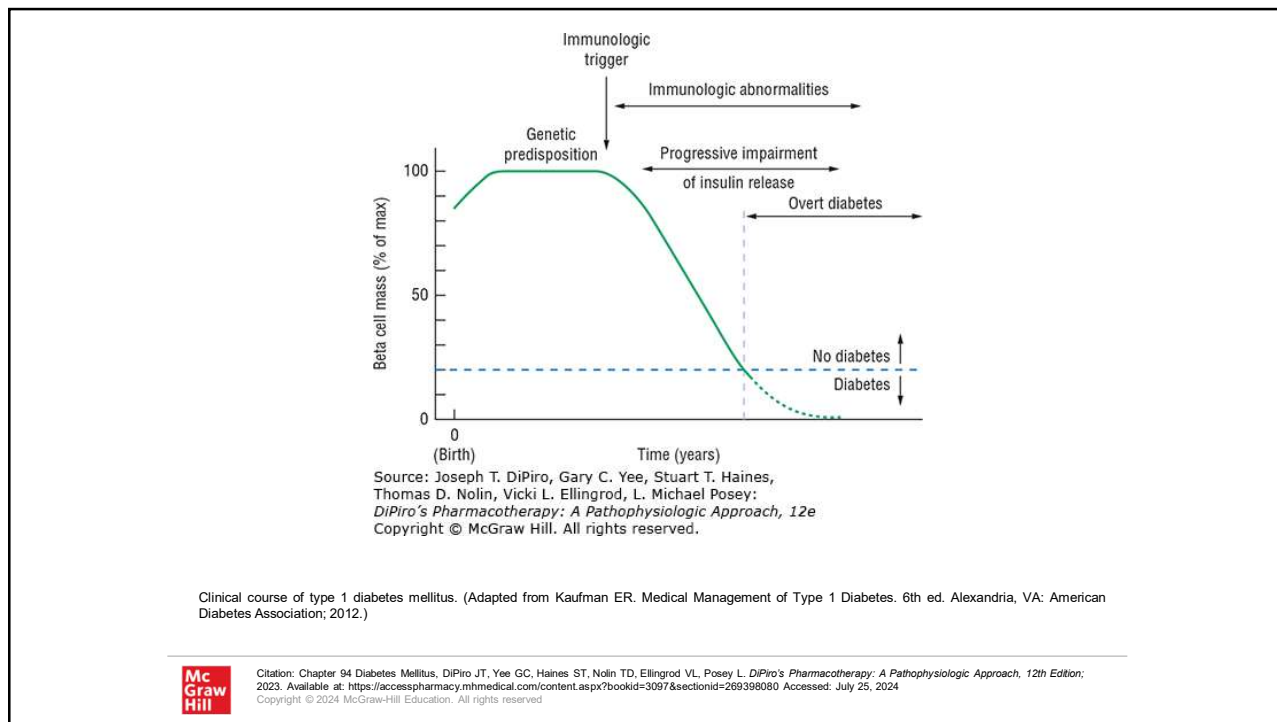


## Biomarkers, Autoantibodies, and T1D<sup>1,2</sup>

- Persistent presence of two or more islet autoantibodies
- Linked to genetic polymorphisms
- Genetic variants associated with higher risk of developing T1D: *DRB1\*03-DQB1\*0201*, *DRB1\*04-DQB1\*302*, and *HLA-B\*39*
- Protective genetic variants for T1D: *DRB1\*1501-DQA1\*0102-DQB1\*0602*

1. Trujillo J, Haines S. Diabetes Mellitus. In: DiPiro JT, Yee GC, Haines ST, Nolin TD, Ellingrod VL, Posey L. eds. *DiPiro's Pharmacotherapy: A Pathophysiologic Approach*, 12th Edition. McGraw Hill; 2023. Accessed July 25, 2024. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=3097&sectionid=269398080>  
2. American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1): S20–S42

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**Table 2.3—Staging of type 1 diabetes**

	Stage 1	Stage 2	Stage 3
Characteristics	<ul style="list-style-type: none"> <li>• Autoimmunity</li> <li>• Normoglycemia</li> <li>• Presymptomatic</li> </ul>	<ul style="list-style-type: none"> <li>• Autoimmunity</li> <li>• Dysglycemia</li> <li>• Presymptomatic</li> </ul>	<ul style="list-style-type: none"> <li>• Autoimmunity</li> <li>• Overt hyperglycemia</li> <li>• Symptomatic</li> </ul>
Diagnostic criteria	<ul style="list-style-type: none"> <li>• Multiple islet autoantibodies</li> <li>• No IGT or IFG</li> </ul>	<ul style="list-style-type: none"> <li>• Islet autoantibodies (usually multiple)</li> <li>• Dysglycemia: IFG and/or IGT</li> <li>• FPG 100–125 mg/dL (5.6–6.9 mmol/L)</li> <li>• 2-h PG 140–199 mg/dL (7.8–11.0 mmol/L)</li> <li>• A1C 5.7–6.4% (39–47 mmol/mol) or ≥10% increase in A1C</li> </ul>	<ul style="list-style-type: none"> <li>• Autoantibodies may become absent</li> <li>• Diabetes by standard criteria</li> </ul>

Adapted from Skyler et al. (40). FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; 2-h PG, 2-h plasma glucose. Alternative additional stage 2 diagnostic criteria of 30-, 60-, or 90-min plasma glucose on oral glucose tolerance test ≥200 mg/dL (≥11.1 mmol/L) and confirmatory testing in those aged ≥18 years have been used in clinical trials (79).

Table extracted from American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1): S20–S42

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# Latent autoimmune diabetes in adults (LADA)<sup>1,2</sup>

## Slow-onset type 1 autoimmune diabetes

- Autoimmune markers present
- Glutamic acid decarboxylase (GAD) antibody most commonly
- Age at onset is usually > 30 years
- May have remaining pancreatic  $\beta$ -cell function, like T2D

Often misdiagnosed as T2D, and treated with non-insulin therapies, further contributing to hyperglycemia

Seen more in patients of African or Asian descent

1. Trujillo J, Haines S. Diabetes Mellitus. In: DiPiro JT, Yee GC, Haines ST, Nolin TD, Ellingrod VL, Posey L, eds. *DiPiro's Pharmacotherapy: A Pathophysiologic Approach, 12th Edition*. McGraw Hill; 2023. Accessed July 25, 2024. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=30978&sectionid=269398080>

2. American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1): S20–S42

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*Meta-Analysis and Systematic Review*



Journal of  
**INTERNATIONAL  
MEDICAL RESEARCH**

## **COVID-19 induced type 1 diabetes: A systematic review of case reports and series**

Journal of International Medical Research  
2023, Vol. 51(11) 1–24

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DOI: 10.1177/03000605231210403

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## COVID-19 and T1D

Stathi D, Triantafyllidis KK, Zafeiri M, Karalliedde J, Kechagias KS. COVID-19 induced type 1 diabetes: A systematic review of case reports and series. *J Int Med Res*. 2023;51(11):3000605231210403. doi:10.1177/03000605231210403

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- Polyuria
- Polyphagia
- Polydipsia
- Unexplained weight loss
- Fatigue
- Blurred vision
- Urinary tract infections
- Yeast infections
- Dry, itchy skin
- Numbness/tingling in the extremities
- Acanthosis nigricans
- Ketoacidosis
- Plasma glucose > 360 mg/dL

## Diabetes

### Clinical Presentation

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- **Polyuria**
- Polyphagia
- **Polydipsia**
- **Unexplained weight loss**
- Fatigue
- Blurred vision
- Urinary tract infections
- Yeast infections
- Dry, itchy skin
- Numbness/tingling in the extremities
- Acanthosis nigricans
- **Ketoacidosis**
- **Plasma glucose > 360 mg/dL**

## Diabetes

### Clinical Presentation (T1D)

- A**ge (< 35 years old)
- A**utoimmunity
- B**ody habitus
- B**ackground
- C**ontrol
- C**omorbidities

Acronym taken from American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1): S20–S42

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- Obesity (BMI  $\geq$  25 kg/m<sup>2</sup>)
- Physical inactivity
- Hypertension
- Dyslipidemia
- Unhealthy diet
- Cardiovascular disease
- Family history
- Racial/Ethnic subgroups
- History of gestational diabetes
- Delivery of baby > 9 pounds
- Polycystic ovary disease (PCOS)

## Diabetes

### Risk Factors<sup>1,2</sup>

1. Trujillo J, Haines S. Diabetes Mellitus. In: DiPiro JT, Yee GC, Haines ST, Nolin TD, Ellingrod VL, Posey L, eds. *DiPiro's Pharmacotherapy: A Pathophysiologic Approach, 12th Edition*. McGraw Hill; 2023. Accessed July 25, 2024. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=3097&sectionid=269398080>

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- Obesity (BMI  $\geq$  25 kg/m<sup>2</sup>)
- Physical inactivity
- Hypertension
- Dyslipidemia
- Unhealthy diet
- Cardiovascular disease
- **Family history**
- Racial/Ethnic subgroups
- History of gestational diabetes
- Delivery of baby > 9 pounds
- Polycystic ovary disease (PCOS)
- **Presence of other autoimmune conditions**
- **Introduction of immunotherapy (checkpoint inhibitors), although rare<sup>2</sup>**
- **Virus, including enteroviruses, although rare<sup>2</sup>**

## Diabetes

### Risk Factors (T1D)<sup>1,2</sup>

1. Trujillo J, Haines S. Diabetes Mellitus. In: DiPiro JT, Yee GC, Haines ST, Nolin TD, Ellingrod VL, Posey L, eds. *DiPiro's Pharmacotherapy: A Pathophysiologic Approach, 12th Edition*. McGraw Hill; 2023. Accessed July 25, 2024. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=3097&sectionid=269398080>

2. American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1): S20–S42

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## Summary of Differences<sup>1,2</sup>

	Type 1 Diabetes	Type 2 Diabetes
Prevalence	5-10% of cases	90-95% of cases
Age at Diagnosis	< 35 years	Any age, but normally $\geq$ 30 years
Family history	Some	Strong
Onset/Manifestation of Symptoms	Abrupt, can lead to diabetic ketoacidosis (DKA), in 25-50% of patients <sup>2</sup>	Gradual
Body weight	Lean (BMI < 25 kg/m <sup>2</sup> )	Overweight/obese (BMI $\geq$ 25 kg/m <sup>2</sup> ), typically with abdominal obesity
Autoantibodies	Usually present	Rarely present
Need for Insulin	Immediate	Years after diagnosis
Treatment	Insulin	Oral $\pm$ non-insulin injectable $\pm$ insulin

1. Trujillo J, Haines S. Diabetes Mellitus. In: DiPiro JT, Yee GC, Haines ST, Nolin TD, Ellingrod VL, Posey L, eds. *DiPiro's Pharmacotherapy: A Pathophysiologic Approach, 12th Edition*. McGraw Hill; 2023. Accessed July 25, 2024. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=3097&sectionid=269398080>

2. American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1): S20–S42

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## Clinical Presentation of DKA



- Extreme thirst
- Frequent urination
- Vomiting or stomach pain
- Tiredness or weakness
- Confusion
- Shortness of breath
- Fruity breath

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**Patient / Disease Features**

More stringent ← A1C 7% → Less stringent

low high

newly diagnosed long-standing

long short

absent few / mild severe

absent few / mild severe

highly motivated, excellent self-care capabilities preference for less burdensome therapy

readily available limited

Usually not modifiable

Potentially modifiable

## Goals of Therapy

Use shared-decision making and patient/disease features to determine HbA1c goal for each patient

Table Extracted from: American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S111–S125

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## HbA1c/BG Correlation

HbA1c	Estimated Average BG, mg/dL
5	97 (76-120)
6	126 (100-152)
7	154 (123-185)
8	183 (147-217)
9	212 (170-249)
10	240 (193-282)
11	269 (217-314)
12	298 (240-347)

Extracted directly from Table 6.1. American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S111–S125

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## Let's Revisit Diane Betis

Diane Betis is a 27-year-old female that was diagnosed with Type 1 Diabetes at the age of 7. Diane currently takes the following medications: Lantus 20 units at bedtime, Novolog 6 units before meals, and fluticasone 2 sprays in each nostril daily. Diane recently completed graduate school at USF and recently started working as a marketing professional with a demanding schedule. She enjoys playing basketball with her friends in her free time and generally tries to eat healthy although her meals are often irregular due to her work schedule. She socially drinks but denies smoking or illicit drug use. Her most recent A1C was 8.3 and her BMI is 22.5.

Based on DB's most recent A1C, which of the following BG levels correlates the closest to her average glucose reading?

- A. 130 mg/dL
- B. 190 mg/dL
- C. 220 mg/dL
- D. 250 mg/dL

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Ultra Rapid		<h2>T1D Treatment Options</h2> <h3>Insulin</h3>
Rapid		
Short/Regular		
Intermediate		
Long		
Pre-Mixed Combination		
<p><b>Continuous subcutaneous insulin infusion devices and Continuous Glucose Monitoring (CGM)s Vary</b></p>		

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## T1D Landmark Trial

Diabetes Control and Complications Trial Research Group (DCCT)

- Prospective, randomized, controlled trial that followed 1441 T1D patients for a median of 6.5 years
- Compared intensive therapy (3+ injection/day or insulin pump) vs. conventional therapy (1-2 injections/day)
- Intensive therapy arm saw a 76% reduction in development of retinopathy, 39% reduction in occurrence of microalbuminuria, 54% reduction in occurrence of albuminuria, and 60% reduction in clinical neuropathy
- Intensive therapy arm saw 2-3-fold increase in severe hypoglycemia

Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med.* 1993;329:977-986.

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Type of Insulin	Generic (Brand)	Onset (hours)	Peak (hours)	Duration (hours)	Caveats
Ultra Rapid	Inhaled technosphere (Afrezza), <b>aspart (Fiasp)</b> , <b>lispro-aabc (Lyumjev)</b>	12-20 min (inhaled) 5 min (aspart)	0.5 0.5 - 1	2-3 5	Fiasp contains Vitamin B3 + L-arginine to increase speed of absorption and stabilize formulation <b>Used in insulin pumps</b>
Rapid	<b>Lispro (Humalog)</b> , <b>aspart (Novolog)</b> , <b>glulisine (Apidra)</b> , <b>lispro (Admelog)</b>	<b>5-15 min</b>	<b>1-2</b>	<b>3-5</b>	<b>Commonly used in insulin pumps</b>
Short/Regular	Regular (Humulin R, Novolin R)	0.5 – 1	2-5	4-8	*some types available OTC in some states
Intermediate	NPH (Humulin N, Novolin N)	1-2	6-10	12	*some types available OTC in some states
Long	Glargine (Lantus, Toujeo), detemir (Levemir), degludec (Tresiba)	3-6 (glargine) 3-4 (detemir) 1 (degludec)	No peak or small peak (detemir)	24 (glargine) 6-24 (detemir, dose-dependent) 42 (degludec)	Degludec <sup>1</sup> has a lower incidence of hypoglycemia
Combination products (some types available OTC in some states): *NPH + regular: Humulin 70/30, 50/50, and Novolin 70/30 *Neutral protamine lispro+ lispro: Humalog Mix 75/25 and 50/50 *Neutral protamine aspart + aspart: Novolog Mix 70/30					
<small>1. Lane W, Bailey TS, Gerety G, et al. Effect of Insulin Degludec vs Insulin Glargine U100 on Hypoglycemia in Patients With Type 1 Diabetes: The SWITCH 1 Randomized Clinical Trial. JAMA. 2017;318(1):33-44. doi:10.1001/jama.2017.7115</small>					

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## Recommendations from 2024 ADA Guidelines

1. Treat most adults with T1D with continuous subcutaneous insulin infusion or multiple daily doses of prandial (injected or inhaled) and basal insulin.
2. For most adults with T1D, insulin analogs (or inhaled insulin) are preferred over injectable human insulins to minimize hypoglycemia risk.
3. Early use of continuous glucose monitoring (CGM) is recommended for adults with T1D to improve glycemic outcomes and quality of life and minimize hypoglycemia.
4. Automated insulin delivery (AID) systems should be considered for all adults with type 1 diabetes.

American Diabetes Association Professional Practice Committee. 9. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care 2024;47 (Suppl. 1):S158–S178

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## Recommendations from 2024 ADA Guidelines

5. To improve glycemic outcomes and quality of life and minimize hypoglycemia risk, most adults with type 1 diabetes should receive education on how to match mealtime insulin doses to carbohydrate intake and, additionally, to fat and protein intake. They should also be taught how to modify the insulin dose (correction dose) based on concurrent glycemia, glycemic trends (if available), sick-day management, and anticipated physical activity.
6. Glucagon should be prescribed for all individuals taking insulin or at high risk for hypoglycemia. Family, caregivers, school personnel, and others providing support to these individuals should know its location and be educated on how to administer it. Glucagon preparations that do not require reconstitution are preferred.
7. Insulin treatment plan and insulin-taking behavior should be reevaluated at regular intervals (e.g., every 3–6 months) and adjusted to incorporate specific factors that impact choice of treatment and ensure achievement of individualized glycemic goals.

American Diabetes Association Professional Practice Committee. 9. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care 2024;47 (Suppl. 1):S158–S178

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## Insulin Dosing in T1D

Typical maintenance doses are 0.4-1.0 units/kg/day

- Starting dose: 0.3-0.5 units/kg/day
- “Honeymoon phase” dose: 0.2-0.5 units/kg/day

Basal + Bolus	Insulin Pump
<ul style="list-style-type: none"> <li>• Basal insulin suppresses glucose production between meals and overnight and is usually 50% of total daily insulin requirement</li> <li>• Bolus insulin (injected or inhaled) suppresses glucose provided by meals with each meal being 10-20% of total insulin requirement</li> </ul>	<ul style="list-style-type: none"> <li>• Delivers basal at a set rate (generally 30-50% of total daily insulin) &amp; patient boluses for meals/snacks</li> <li>• Combine with CGM device to help with insulin delivery adjustments and prevent hypoglycemia</li> </ul>

American Diabetes Association Professional Practice Committee. 9. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care 2024;47 (Suppl. 1):S158–S178

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## Other Therapies for T1D

### Pramlintide (Symlin)

- Amylin analog FDA approved for T1D and T2D
- Administer prior to meals
- Use associated with a modest reduction in A1C and modest weight loss

### Other Therapies Researched

- GLP-1 receptor agonists, liraglutide (Victoza) – saw modest reduction in A1C, decrease in weight, and reduction in insulin doses
- SGLT2 inhibitors – saw improvements in A1C, reduced body weight, improved blood pressure, but associated with increased rate of **DKA**

American Diabetes Association Professional Practice Committee. 9. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care 2024;47 (Suppl. 1):S158–S178

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## Other Therapies for T1D

### Pancreas transplant

- Requires patient lifelong immunosuppressive therapy

### Allogenic pancreatic islet transplantation

- Regulated as cell therapy in U.S.
- Donislecel-jujn (Lantidra)
  - FDA approved in 2023
  - Approved for treatment of adults with T1D who are unable to approach A1C goals because of current repeated episodes of severe hypoglycemia despite intensive diabetes management and education

American Diabetes Association Professional Practice Committee. 9. Pharmacologic approaches to glycemic treatment: Standards of Care in Diabetes—2024. Diabetes Care 2024;47 (Suppl. 1):S158–S178

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1. Wash your hands with soap and water/hand sanitizer
2. Prepare items (alcohol swab/cotton gauze, insulin pen, insulin syringe, insulin vial)
3. Inspect insulin and expiration date
4. Choose an injection site
5. Clean the injection site (institutional setting)
6. Prepare the insulin (pen or vial)
7. Inject the insulin into subcutaneous tissue (pinch the skin and insert at 90° to the skin surface) and ensure all medication is injected
8. Dispose of the needle

Check out more guidance at: Frid AH, Kreugel G, Grassi G, et al. New Insulin Delivery Recommendations. *Mayo Clin Proc.* 2016;91(9):1231-1255. doi:10.1016/j.mayocp.2016.06.010

## Insulin Administration

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A Video Is Worth A Thousand Words

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## T1D Injection Considerations



**Lipohypertrophy**

- Lump under skin caused by repeated injections into same site
- Results in decreased insulin absorption
- Rotate injection site

**Lipoatrophy**

- Atrophy of SQ adipose tissue
- Caused by insulin antibodies or allergic reaction

Image accessed via Diabetes.com, <https://diabetes.co.in/insulin-injection-sites-complications/>, Published July 20, 2024. Accessed August 16, 2024.

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## BG Management Hypoglycemia

**Higher Prevalence in T1D**

- Recommend glucagon is prescribed
- Screen for hypoglycemia unawareness
- Continuous glucose monitor (CGM) preferred

**Common Causes**

- Inadequate food intake
- Incorrect insulin dosing
- Medication changes
- Increased physical exertion
- Increased alcohol intake/substance use disorder
- Illness

American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S111–S125

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# Hypoglycemia

## CLASSIFICATION

**Level 1:** glucose < 70 mg/dL and ≥ 54 mg/dL

**Level 2:** glucose < 54 mg/dL

**Level 3:** altered mental status and assistance required

## SYMPTOMS


- Shakiness/dizziness
- Sweatiness
- Irritability
- Hunger
- Tachycardia
- Vision changes
- Confusion



American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: Standards of Care in Diabetes— 2024. Diabetes Care 2024;47(Suppl. 1):S111–S125

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**Check**




Check your blood sugar right away if you have any symptoms of low blood sugar. If you think your blood sugar is low but cannot check it at that time, treat anyway.

**Treat**


Treat by eating or drinking **15 grams** of something high in sugar, such as:




4 ounces (½ cup) of regular fruit juice (like orange, apple, or grape juice)




4 glucose tablets or 1 tube of glucose gel



4 ounces (½ cup) of regular soda pop (not diet)




1 tablespoon of sugar, honey, or corn syrup



2 tablespoons of raisins

**Wait**



Wait **15 minutes** and then check your blood sugar again:

- If it is still low, eat or drink something high in sugar again
- If your next meal is more than an hour away, eat a snack to keep your low blood sugar from coming back

Pure glucose preferred treatment

Avoid high fat or high protein products

Patients using automated insulin delivery system – ingest 5-10 grams carbohydrates

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## Hypoglycemia Medications

- GlucaGen HypoKit (1mg/mL) -discontinued in US on July 1, 2024
- [Baqsimi](#)<sup>®</sup> (3 mg) – nasal spray for patients ≥ 4 years of age that does not require inhalation
- [Gvoke](#)<sup>®</sup>
  - Available as an auto-injector, pre-filled syringe, and kit
  - Children aged ≥ 2 years who weigh < 45 kg should be dosed with 0.5 mg
  - Patients aged ≥ 12 years or weigh ≥ 45 kg should be dosed with 1 mg
- [Zegalogue](#)<sup>®</sup> - autoinjector or prefilled syringe that contains 0.6 mg/0.6 mL of dasiglucagon for patients ≥ 6 years of age



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### Common Causes

- Stress/sickness
- Skipping insulin or malfunctioning insulin infusion device
- Miscalculating carbohydrate intake
- Medication changes

### Solutions

- Maintain/calculate oral carbohydrate intake
- Consume extra clear liquids
- Measure BG more frequently
- Test urine for ketones if BG > 240 mg/dL
- Contact healthcare provider/ER if signs of DKA

## BG Management Hyperglycemia

American Diabetes Association Professional Practice Committee. 6. Glycemic goals and hypoglycemia: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S111–S125

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## Let's Revisit Diane Betis

Diane Betis comes to your clinic today, and the physician wants her to consult with you about ways to improve her A1C. Upon talking more to Diane, she tells you that she is fearful of being too stringent with her BG levels since she has had frequent episodes of hypoglycemia, mainly mid-day since she sometimes skips lunch while working or in the evenings if she goes to play pick-up basketball after work.

Which of the following would you recommend to DB?

- A. She could benefit from a CGM device.
- B. She should acquire and fill a prescription for glucagon.
- C. She should consider injecting less Novolog if she skips lunch.
- D. All of the above

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## Let's Revisit Diane Betis

After meeting with Diane Betis, you recommend that she should consider using an insulin pump and CGM to provide more consistent insulin delivery, lower rates of hypoglycemia, and better overall blood glucose management.

Which of the following insulins can be used in an insulin pump?

- A. Fiasp
- B. Afrezza
- C. Novolin R
- D. Levemir

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### Continuous Subcutaneous Insulin Infusion (CSII) Systems<sup>1</sup>

- Insulin delivery using catheter under the skin to supply continuous basal and bolus doses
- Mimics endogenous insulin production

### Continuous Glucose Monitor (CGM)<sup>1,2</sup>

- Patient wears a sensor that measures interstitial glucose
- Provides patient and clinician with more detailed analysis of BG, which includes time in range, time above/below targeted goals, glycemic variability, estimated A1C over wear period
- Available as real-time CGM (rtCGM), intermittently scanned CGM (isCGM), professional CGM (owned by health care provider), or implantable CGM<sup>2</sup>

1. American Diabetes Association Professional Practice Committee. 7. Diabetes technology: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1):S126–S144.
2. Senseonics. Eversense® CGM System Receives iCGM Designation by the US FDA. April 30, 2024. Accessed August 18, 2024. [https://www.senseonics.com/investor-relations/news-releases/2024/04-30-2024-120116563#:~:text=iCGM%20status%20indicates%20that%20Senseonics,insulin%20delivery%20\(AID\)%20system.](https://www.senseonics.com/investor-relations/news-releases/2024/04-30-2024-120116563#:~:text=iCGM%20status%20indicates%20that%20Senseonics,insulin%20delivery%20(AID)%20system.)

## Emerging Therapies and Technologies

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### Automated Insulin Delivery (AID) Systems<sup>1,2,3</sup>

- CGM-informed algorithms modulate insulin delivery, connected insulin pens, as well as diabetes self-management support software serving as medical devices<sup>3</sup>
- Requires manual entry of carbohydrates consumed or meal estimates to calculate mealtime doses<sup>3</sup>
- Must indicate adjustment needs surrounding physical activity<sup>3</sup>
- Hybrid closed-loop systems may be superior to sensor-augmented pump therapy for increased percentage of time in range and reduced hypoglycemic episodes<sup>1,2,3</sup>

1. Brown SA, Kovatchev BP, Raghinaru D, et al. Six-Month Randomized, Multicenter Trial of Closed-Loop Control in Type 1 Diabetes. *N Engl J Med*. 2019;381(18):1707–1717. doi:10.1056/NEJMoa1907863
2. Collyns OJ, Meier RA, Betts ZL, et al. Improved Glycemic Outcomes With Medtronic MiniMed Advanced Hybrid Closed-Loop Delivery: Results From a Randomized Crossover Trial Comparing Automated Insulin Delivery With Predictive Low Glucose Suspend in People With Type 1 Diabetes. *Diabetes Care*. 2021;44(4):969–975. doi:10.2337/dc20-2250
3. American Diabetes Association Professional Practice Committee. 7. Diabetes technology: Standards of Care in Diabetes—2024. *Diabetes Care* 2024;47(Suppl. 1):S126–S144

## Emerging Therapies and Technologies

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## CSII Systems

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Can adjust basal rates</li> <li>• Flexibility in meal timing and content</li> <li>• Pump can deliver insulin in increments of fractions of units</li> <li>• Integration with CGM</li> <li>• Some may not have tubing</li> </ul>	<ul style="list-style-type: none"> <li>• Expensive</li> <li>• Must be continuously worn</li> <li>• Risk of rapid development of ketosis or DKA if pump malfunctions</li> <li>• Risk of reactions to adhesives and site infections (contact dermatitis)</li> <li>• Patient must be tech savvy</li> <li>• Some may have tubing</li> <li>• Supplies may be delayed</li> <li>• Lipohypertrophy and lipoatrophy</li> </ul>

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## CSII Systems

[Medtronic MiniMed Systems](#)  
(630G/770G/780G)

[Tandem Diabetes Care](#) (t:slim X2 with control IQ, t:slim X2 with basal IQ, Mobi)

[Insulet Omnipod Systems](#) (Dash, 5)

[Beta Bionics iLet ACE Pump](#)

[Accu-Chek Solo](#)

[Dana Diabecare IIS](#)

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## CGM

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Provides patient and clinician with valuable information</li> <li>• Alarm features provide reassurance for high-risk hypoglycemia</li> <li>• Can be paired with a CSII system</li> </ul>	<ul style="list-style-type: none"> <li>• Some lags BG ~15 minutes (sometimes more)</li> <li>• Expensive</li> <li>• Must be continuously worn</li> <li>• Insertion may be painful</li> <li>• Risk of reactions to adhesives and site infections (contact dermatitis)</li> <li>• Patient must be tech savvy</li> <li>• May be inaccurate</li> <li>• May need to be calibrated</li> <li>• Supplies may be delayed</li> </ul>

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# CGMs

## rtCGM

- Dexcom G6
- [Dexcom G7](#)
- [Freestyle Libre 3](#)
- [Medtronic Guardian 3](#)
- [Medtronic Guardian 4](#)

## isCGM

- [Freestyle Libre 2](#)

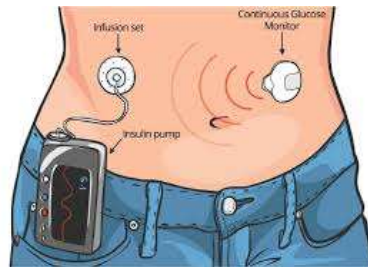
## Implantable CGM

- [Senseonics Eversense](#)

\*All approved for use with AID systems\*

\*FDA approved for use in pregnancy\*

1. American Diabetes Association Professional Practice Committee. 7. Diabetes technology: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S126–S144  
 2. Senseonics Eversense® CGM System Receives iCGM Designation by the US FDA. April 30, 2024. Accessed August 18, 2024. [https://www.senseonics.com/investor-relations/news-releases/2024/04-30-2024-120116563#:~:text=iCGM%20status%20that%20indicates%20that%20Senseonics,insulin%20delivery%20\(AID\)%20system.](https://www.senseonics.com/investor-relations/news-releases/2024/04-30-2024-120116563#:~:text=iCGM%20status%20that%20indicates%20that%20Senseonics,insulin%20delivery%20(AID)%20system.)



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CGMs

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**Table 7.4—Continuous glucose monitoring devices interfering substances**

Medication	Systems affected	Effect
Acetaminophen >4 g/day Any dose	Dexcom G6, Dexcom G7 Medtronic Guardian	Higher sensor readings than actual glucose Higher sensor readings than actual glucose
Ascorbic acid (vitamin C), >500 mg/day	FreeStyle Libre 14 day, FreeStyle Libre 2, FreeStyle Libre 3	Higher sensor readings than actual glucose
Hydroxyurea	Dexcom G6, Dexcom G7, Medtronic Guardian	Higher sensor readings than actual glucose
Mannitol (intravenously or as peritoneal dialysis solution)	Senseonics Eversense	Higher sensor readings than actual glucose
Sorbitol (intravenously or as peritoneal dialysis solution)	Senseonics Eversense	Higher sensor readings than actual glucose

Table extracted directly from: American Diabetes Association Professional Practice Committee. 7. Diabetes technology: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1):S126–S144

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## Hot Off the Presses

FDA approved three new OTC CGM systems, Dexcom's Stelo and Abbott's Lingo™ and LibreRio™

- Products are not marketed for T1D
- Products to be used by patients who are non-insulin dependent and are ≥18 years of age

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## Patient Considerations

### CSII SYSTEMS

- Possibility of becoming dislodged
- Age of patient
- Tubing vs. no tubing
- Batteries vs chargeable
- Amount of insulin reservoir holds and frequency of changing infusion sets
- Size and/or bulkiness of system
- Impact of water
- Requirements to remove for medical procedures (MRIs, etc)
- Cost and availability

### CGMS

- Possibility of becoming dislodged
- Age of patient
- “Warm up” time
- Need for calibration
- Smartphone app or transmitter
- Number of days CGM can be worn
- Impact of water
- Requirements to remove for medical procedures (MRIs, etc)
- Cost and availability
- Compatibility with CSII Systems

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## Smart Insulin Pen



- Marketed as [InPen™](#)
- Reusable insulin pen that uses Bluetooth® technology to send dose information to mobile application to help track insulin doses, calculate insulin needs, and provide reminders of upcoming doses
- Pen monitors insulin temperature
- Can be used alongside a CGM
- Approved for patients aged  $\geq 7$  years old

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## Let's Revisit Diane Betis

After much consideration, Diane decides that she would like to switch over to a CSII system and CGM. Which of the following items should you counsel Diane about prior to her starting these technologies?

- A. She must remove the CGM while playing basketball.
- B. She should still ensure she has an "old school" blood glucose monitor with strips at home.
- C. She can use the LibreRio™ OTC CGM to save some money.
- D. She still needs to inject the Lantus at bedtime for basal coverage.

55

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## Let's Revisit Diane Betis

After a lot of research and talking with her insurance, Diane decides she would like to start using the t:slim X2 and Dexcom G7. Around February, Diane starts feeling a little under the weather and is scared she may be coming down with some type of virus. Which of the following medications may affect her CGM sensor readings, leading to inaccurate readings?

- A. Amoxicillin
- B. Ibuprofen
- C. Acetaminophen
- D. Vitamin C

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## Let's Revisit Diane Betis

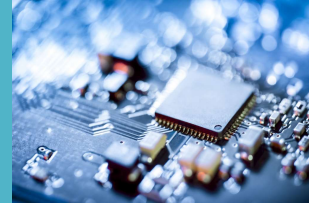
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- C. Acetaminophen
- D. Vitamin C

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- Assess use of health care apps, online education, and patient portals
- Use data and results from meter or CGM to review BG
- Review insulin pump settings and use, connected pen, and glucose data
- Encourage patients to use resources

## Pharmacist Role with Technology



Extracted directly from American Diabetes Association Professional Practice Committee. 4. Comprehensive Medical Evaluation and Assessment of Comorbidities: Standards of Care in Diabetes—2024. Diabetes Care 2024;47(Suppl. 1): S52–S76

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1. [DiabetesWise](#)
2. [DiabetesWisePro](#)
3. [PantherProgram](#)
4. Facebook and Social Media Groups
5. Meeting with device training specialists, certified diabetes educator, and using device company website and contact information
6. Websites: ADA, CDC, Joslin Diabetes Center

## Patient Resources

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- Costs associated with CSII systems can range from around \$4,000 – \$7,000+ with supplies costing \$2,500+/year
- Must consider patient's insurance coverage, changes in insurance, or lack of insurance
- Consider ability to navigate DME and device supplier
- Involve social worker
- CSII system and CGM use greater in patients with higher socioeconomic status

## Financial Implications



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## Medicare Coverage

### To qualify for a CGM (under Part B), patients must:

- Have DM
- Take insulin or have a history of problems with low blood sugar
- Have a prescription for testing supplies and instructions on how often to test their blood glucose
- Have been trained (or had your caregiver trained) to use a CGM as prescribed by their doctor
- Make routine in-person or Medicare-approved telehealth visits with their doctor

### CSII Systems and Insulin

- Covered under Part B as DME, but may require cost-sharing from patient
- Medicare Part D covers the insulin used within the pump

Medicare.gov. Continuous glucose monitor. <https://www.medicare.gov/coverage/therapeutic-continuous-glucose-monitors>. Accessed August 18, 2024.

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## Medicaid Coverage



CGM coverage varies per state although most states offer some level of coverage



Florida's CS/HB 967 law requires CGM coverage to children and adults with diabetes who are treated with insulin although coverage is based on available funds



Covers CSII system and supplies, but must be deemed medically necessary, may require a prior authorization, may have quantity limits, and must be obtained from a Medicaid-approved DME supplier

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Smoking cessation

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Alcohol in moderation

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Psychosocial care (financial, social, family, emotional)

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Mental health professional

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Diabetes educator

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Healthcare team (pharmacist, endocrinologist, podiatrist, dentist, dietitian/nutritionist, social worker, nephrologist)

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Physical exercise

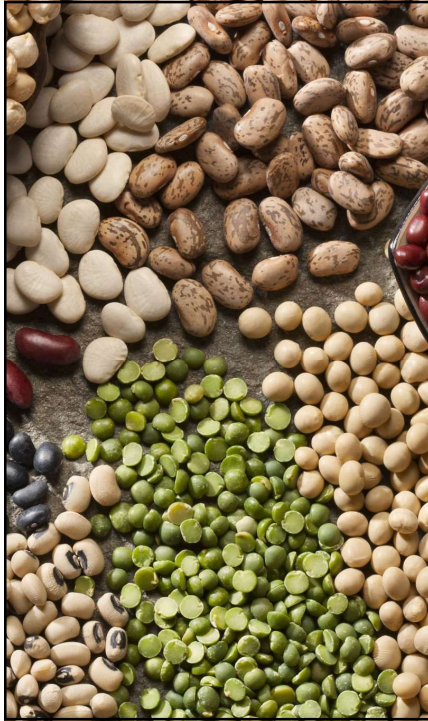
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Healthy diet (low fat, low carbohydrate)

## Lifestyle Management

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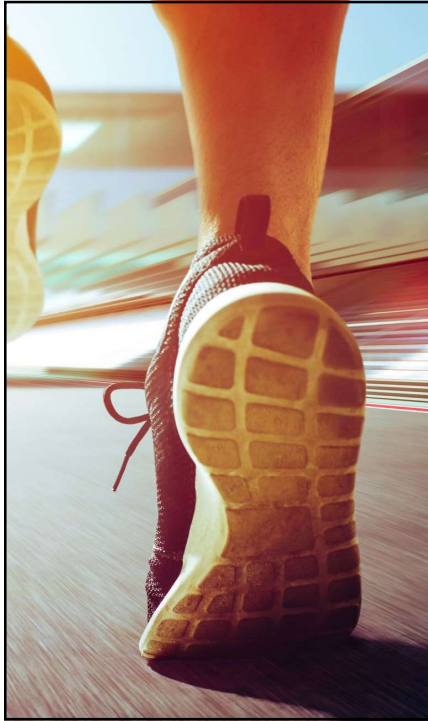
## Diet

- Individualized evaluation of eating patterns/macronutrient (total calorie, carbohydrate, protein, fat) distribution
- Generally, encourage low-fat dairy, fish, vegetables, fruits, whole grains/legumes, low carbohydrate, low-fat calorie restricted Mediterranean diets and appropriate portion sizes
- Nonnutritive sweeteners may be considered as alternatives to sugar-sweetened products
- Educate about reading food labels
- Use smartphone apps and company nutritional facts/menus
  - My Fitness Pal
  - Calorie King
  - FitBit Food Tracker

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The food you eat can either be the safest and most powerful form of medicine or the slowest form of poison.

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## Physical Exercise

- Incorporate aerobic exercise, resistance training, and anaerobic exercise
- Educate patients on effect of physical exercise on BG levels
  - Know BG level before and after exercise
  - Consider the intensity of the activity and length of time patient is active
  - Be aware of any changes made to insulin doses
  - Patients should be proactive and ensure they are prepared to treat hypoglycemia
  - Patients should remain hydrated

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Let's Revisit Diane  
Betis One Last Time

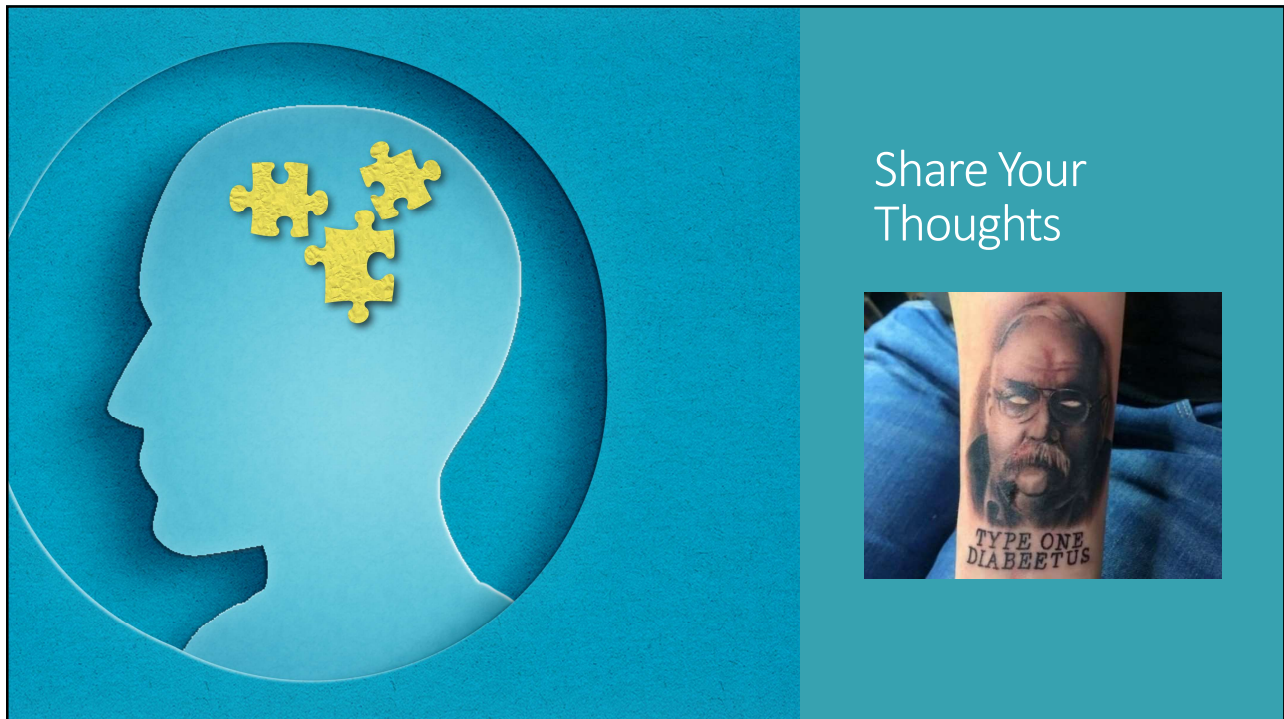
Time to Break Out

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## Final Thoughts on Diane Betis

Based on your research, which technolog(ies) do you think would be the best for Diane Betis? What important counseling points should you provide about the technolog(ies) you selected? Do you recommend any other lifestyle changes for Diane?

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Share Your Thoughts

70

1. [American Diabetes Association \(ADA\) Standards of Care in Diabetes, 2024 Guidelines](#)
2. [American Association of Clinical Endocrinology \(AACE\) Clinical Practice Guideline: Developing a Diabetes Mellitus Comprehensive Care Plan-2022 Update](#)
3. [Nutrition Therapy for Adults With Diabetes or Prediabetes: A Consensus Report](#)
4. [Danatech](#)

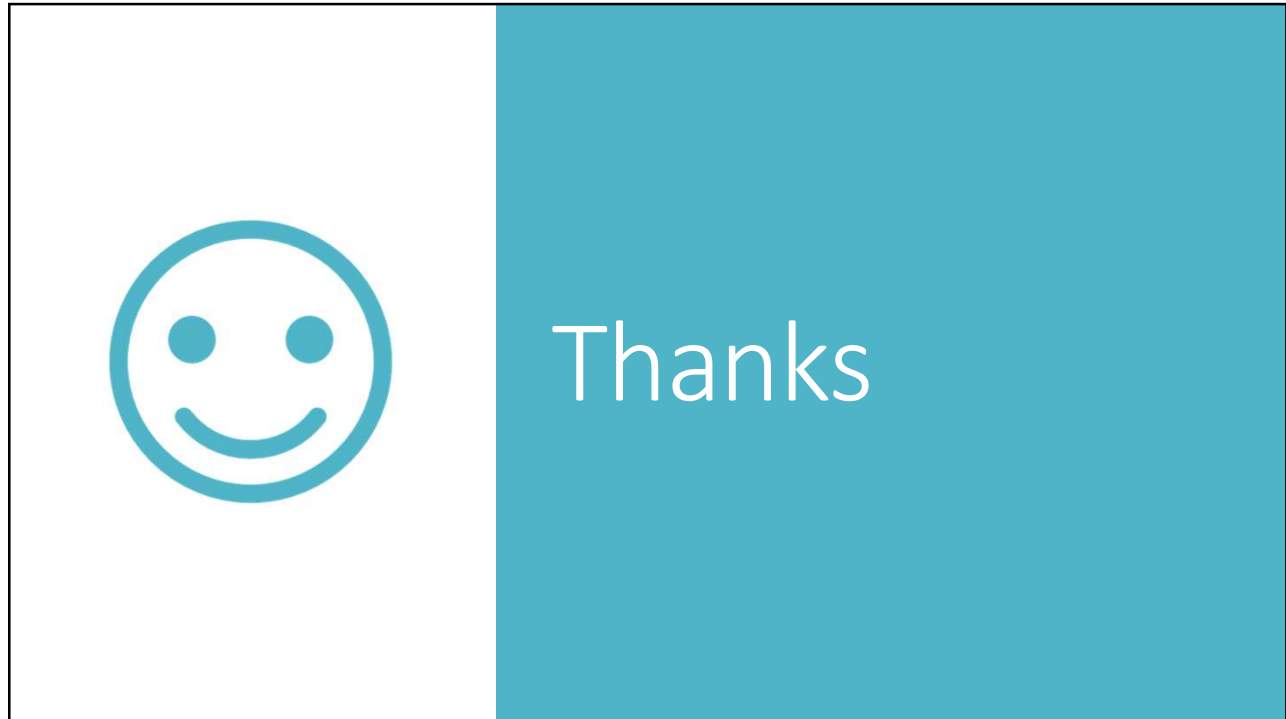
## Resources for Practitioners

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## Questions

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# Beyond Insulin: Advancements in Type 1 Diabetes Care

Jasmine Cutler, PharmD, CPh  
Assistant Professor, University of South Florida, Taneja College of Pharmacy  
Managing Metabolic Disorders Conference, iCARE Pharmacy Services, Inc.

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## LEARNING ASSESSMENTS

Which of the following genetic variants is associated with a higher risk of developing Type 1 Diabetes?

- A. *D2C19*
- B. *DRB1\*1501*
- C. *DRB1\*04-DQB1\*302*
- D. *DQA1\*0102-DQB1\*0602*

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## LEARNING ASSESSMENTS

Along with elevated blood glucose levels, which of the following clinical symptoms is more indicative of a patient suffering from Type 1 diabetes than Type 2 diabetes?

- A. Unexplained weight loss
- B. Polyphagia
- C. Numbness and tingling in the leg
- D. Extreme fatigue and weakness

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## LEARNING ASSESSMENTS

True/False. Type 1 Diabetes is only diagnosed in children or adolescent patients.

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## LEARNING ASSESSMENTS

Which of the following medications is FDA approved for use in T1D and T2D patients?

- A. empagliflozin
- B. liraglutide
- C. pramlintide
- D. metformin

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## LEARNING ASSESSMENTS

Which of the following CGM(s) is/are FDA approved for use in pregnant patients?

- A. Dexcom G7
- B. Senseonics Eversense
- C. Medtronic Guardian 4
- D. All of the above