• No conflicts of interest or disclosures
Objectives

- Define current standards for the evaluation of diabetes
- Review new technologies in diabetes management
13. Children and Adolescents: Standards of Medical Care in Diabetes—2020

*Diabetes Care* 2020;43(Suppl. 1):S163–S182 | https://doi.org/10.2337/dc20-S013
Diabetes

• A diagnosis characterized by hyperglycemia resulting from the body’s inability to use blood glucose for energy.

• In Type 1 diabetes, the pancreas no longer makes insulin. Blood glucose cannot enter the cells to be used for energy.

• In Type 2 diabetes, either the pancreas does not make enough insulin or the body is unable to use insulin correctly.
Diabetes
Symptoms and complications

- Skin infections
- Diabetic retinopathy
- Arteriosclerosis
- Heart damage
- Permanent kidney damage
- Fatty liver
- Osteoporosis
**DIABETES INDICATORS**

Criteria for the Diagnosis of Diabetes

<table>
<thead>
<tr>
<th>Table 2.2—Criteria for the diagnosis of diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPG ≥126 mg/dL (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>2-h PG ≥200 mg/dL (11.1 mmol/L) during OGTT. The test should be performed as described by the WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>A1C ≥6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dL (11.1 mmol/L).</td>
</tr>
</tbody>
</table>

DCCT, Diabetes Control and Complications Trial; FPG, fasting plasma glucose; OGTT, oral glucose tolerance test; WHO, World Health Organization; 2-h PG, 2-h plasma glucose. *In the absence of unequivocal hyperglycemia, diagnosis requires two abnormal test results from the same sample or in two separate test samples.
What is a Hemoglobin A1c (HgbA1c)?

REFLECTS AVERAGE GLUCOSE LEVEL OVER THE PAST 3 MONTHS

NOT UNCOMMON FOR HGBA1C TO BE HIGH AT DIAGNOSIS

HGBA1C GOAL OF <7.5% IS RECOMMENDED ACROSS ALL PEDIATRIC AGE GROUPS

2019 ADA STANDARDS OF CARE (PEDIATRIC)
<table>
<thead>
<tr>
<th>A1C %</th>
<th>eAG mg/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>97</td>
</tr>
<tr>
<td>5.5</td>
<td>111</td>
</tr>
<tr>
<td>6</td>
<td>126</td>
</tr>
<tr>
<td>6.5</td>
<td>140</td>
</tr>
<tr>
<td>7</td>
<td>154</td>
</tr>
<tr>
<td>7.5</td>
<td>169</td>
</tr>
<tr>
<td>8</td>
<td>183</td>
</tr>
<tr>
<td>8.5</td>
<td>197</td>
</tr>
<tr>
<td>9</td>
<td>212</td>
</tr>
<tr>
<td>9.5</td>
<td>226</td>
</tr>
<tr>
<td>10</td>
<td>240</td>
</tr>
<tr>
<td>10.5</td>
<td>255</td>
</tr>
<tr>
<td>11</td>
<td>269</td>
</tr>
<tr>
<td>11.5</td>
<td>283</td>
</tr>
<tr>
<td>12</td>
<td>298</td>
</tr>
</tbody>
</table>

Estimated Average Glucose (eAG) and HgbA1c
What to Know about Diabetic Ketoacidosis (DKA)

DKA is a serious condition that can result from untreated or undiagnosed diabetes or from too little insulin. It can lead to a diabetic coma or even death.

**EARLY SIGNS OF DKA**

- Feeling very thirsty
- Urinating often
- High blood glucose levels
- High ketone levels in urine

**LATER, EXTREME SIGNS**

- Feeling weak or constantly sleepy
- Dry/flushed skin
- Nausea, vomiting, pain in the abdomen
- Difficulty breathing, fruity-smelling breath

**KNOW THE SIGNS, SAVE LIVES.**

Learn more about diabetic ketoacidosis and appropriate emergency treatment at diabetes.org/dka.

⚠️ If you think you have diabetic ketoacidosis, contact your doctor IMMEDIATELY, or go to the nearest hospital emergency room.

American Diabetes Association.
What’s the difference

**Type 1 diabetes**
- The body cannot produce the insulin it needs
- Causes unknown, but develops when the immune system attacks insulin producing cells
- Incidence is growing steadily
- Usually diagnosed in children or young adults
- Must take insulin daily

**Type 2 diabetes**
- The body produces too little insulin and/or is unable to respond to it
- Incidence is rising at an epidemic rate
- The symptoms often appear gradually
- Healthy diet, regular physical activity, maintaining a normal body weight and avoiding tobacco use can prevent or delay the onset of type 2 diabetes

**Risk factors include:**
- Advancing age
- Obesity
- Poor diet
- Family history of type 2 diabetes
- Physical inactivity
- Ethnicity

*Often managed by exercise and a healthy diet or oral medication.*
*If the condition progresses, it can be treated with insulin.*
Type 1 Diabetes

- Chronic metabolic disorder
- Autoimmune process that destroys the beta cells of the pancreas
- Absolute insulin deficiency
- Diagnosis is confirmed by testing for antibodies:
  - Glutamic Acid Decarboxylase Autoantibodies (GAD 65)
  - Islet Cell Autoantibodies (ICA 512)
  - Zinc transporter 8 autoantibody (ZnT8Ab)
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Autoimmunity</td>
<td>Autoimmunity</td>
<td>New-onset hyperglycemia</td>
</tr>
<tr>
<td></td>
<td>Normoglycemia</td>
<td>Dysglycemia</td>
<td>Symptomatic</td>
</tr>
<tr>
<td></td>
<td>Presymptomatic</td>
<td>Presymptomatic</td>
<td></td>
</tr>
<tr>
<td>Diagnostic criteria</td>
<td>Multiple autoantibodies</td>
<td>Multiple autoantibodies</td>
<td>Clinical symptoms</td>
</tr>
<tr>
<td></td>
<td>No IGT or IFG</td>
<td>Dysglycemia: IFG and/or IGT</td>
<td>Diabetes by standard criteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FPG 100–125 mg/dL (5.6–6.9 mmol/L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-h PG 140–199 mg/dL (7.8–11.0 mmol/L)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A1C 5.7–6.4% (39–47 mmol/mol) or ≥10% increase in A1C</td>
<td></td>
</tr>
</tbody>
</table>
Table 13.1—Blood glucose and A1C targets for children and adolescents with type 1 diabetes

<table>
<thead>
<tr>
<th>Blood glucose goal range</th>
<th>A1C</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before meals</td>
<td>Bedtime/overnight</td>
<td>90–130 mg/dL (5.0–7.2 mmol/L) 90–150 mg/dL (5.0–8.3 mmol/L) &lt;7.5% (58 mmol/mol)</td>
</tr>
</tbody>
</table>

Key Concepts in Setting Glycemic Targets
- Targets should be *individualized*, and lower targets may be reasonable based on a benefit-risk assessment.
- Blood glucose targets should be modified in children with frequent hypoglycemia or hypoglycemia unawareness.
- Postprandial blood glucose values should be measured when there is a discrepancy between preprandial blood glucose values and A1C levels and to assess preprandial insulin doses in those on basal-bolus or pump regimens.
- Thyroid function tests (TSH/Free T4)
- Lipid Panel
- Transglutaminase IgA
- Vitamin D
- Microalbumin/Creatinine ratio
- Hemoglobin A1c
# Pre-Diabetes

<table>
<thead>
<tr>
<th>Table 2.5—Criteria defining prediabetes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPG 100 mg/dL (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L) (IFG)</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>2-h PG during 75-g OGTT 140 mg/dL (7.8 mmol/L) to 199 mg/dL (11.0 mmol/L) (IGT)</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>A1C 5.7–6.4% (39–47 mmol/mol)</td>
</tr>
</tbody>
</table>

FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; 2-h PG, 2-h plasma glucose. *For all three tests, risk is continuous, extending below the lower limit of the range and becoming disproportionately greater at the higher end of the range.

---

2020 ADA Standards of Care (Pediatric)

[Akron Children’s Hospital Logo]
Table 2.4—Risk-based screening for type 2 diabetes or prediabetes in asymptomatic children and adolescents in a clinical setting (163)

Testing should be considered in youth* who have overweight (≥85th percentile) or obesity (≥95th percentile) and who have one or more additional risk factors based on the strength of their association with diabetes:

- Maternal history of diabetes or GDM during the child’s gestation
- Family history of type 2 diabetes in first- or second-degree relative
- Race/ethnicity (Native American, African American, Latino, Asian American, Pacific Islander)
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovary syndrome, or small-for-gestational-age birth weight)

GDM, gestational diabetes mellitus. *After the onset of puberty or after 10 years of age, whichever occurs earlier. If tests are normal, repeat testing at a minimum of 3-year intervals, or more frequently if BMI is increasing, is recommended. Reports of type 2 diabetes before age 10 years exist, and this can be considered with numerous risk factors.

2020 ADA Standards of Care (Pediatric)
New-Onset Diabetes in Overweight Youth

Initiate lifestyle management and diabetes education

**A1C <8.5%**
No acidoses or ketosis
- Metformin PO b.i.d.
  - Titrate up to 2,000 mg per day as tolerated

**A1C ≥8.5%**
No acidoses with or without ketosis
- Basal insulin: start at 0.5 units/kg/day and escalate every 2–3 days based on meter glucose
- Metformin
  - Titrate up to 2,000 mg per day as tolerated

**Acidoses and/or DKA and/or HHNK**
- Manage DKA or HHNK
  - i.v. insulin until acidoses resolves, then subcutaneous, as for type 1 diabetes until antibodies are known

Pancreatic autoantibodies

**NEGATIVE**
- Continue metformin
- Wean insulin guided by meter glucose values

**A1C goals not met**
- Initiate add-on insulin or continue insulin therapy—basal insulin to maximum 1.5 units/kg/day
- A1C goals not met

**POSITIVE**
- Continue or initiate MDI insulin or pump therapy, as for type 1 diabetes

Consider other drug therapy (not currently approved for those aged <16 years old)

---

**Figure 13.1—Management of new-onset diabetes in overweight youth** [2]. A1C 8.5% = 69 mmol/mol. DKA, diabetic ketoacidosis; HHNK, hyperosmolar hyperglycemic nonketotic syndrome; MDI, multiple daily injections.

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**2019 ADA Standards of Care (Pediatric)**

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**Akron Children’s Hospital**
Management of new-onset diabetes in youth with overweight or obesity. A1C 8.5% = 69 mmol/mol. Adapted from the ADA position statement “Evaluation and Management of Youth-Onset Type 2 Diabetes” (2). DKA, diabetic ketoacidosis; HHNK, hyperosmolar hyperglycemic nonketotic syndrome; MDI, multiple daily injections.

2020 ADA Standards of Care (Pediatric)
Maturity-Onset Diabetes of the Young (MODY) is frequently characterized by onset of hyperglycemia at an early age (classically before age 25 years, although diagnosis may occur at older ages). MODY is characterized by impaired insulin secretion with minimal or no defects in insulin action (in the absence of coexistent obesity). It is inherited in an autosomal dominant pattern with abnormalities in at least 13 genes on different chromosomes identified to date. The most commonly reported forms are GCK-MODY (MODY2), HNF1A-MODY (MODY3), and HNF4A-MODY (MODY1).

**Genetic testing required**

Table 2.7—Most common causes of monogenic diabetes (119)

<table>
<thead>
<tr>
<th>Gene</th>
<th>Inheritance</th>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCK</td>
<td>AD</td>
<td>GCK-MODY: stable, nonprogressive elevated fasting blood glucose; typically does not require treatment; microvascular complications are rare; small rise in 2-h PG level on OGTT (&lt;54 mg/dL [3 mmol/L])</td>
</tr>
<tr>
<td>HNF1A</td>
<td>AD</td>
<td>HNF1A-MODY: progressive insulin secretory defect with presentation in adolescence or early adulthood; lowered renal threshold for glucosuria; large rise in 2-h PG level on OGTT (&gt;90 mg/dL [5 mmol/L]); sensitive to sulfonylureas</td>
</tr>
<tr>
<td>HNF4A</td>
<td>AD</td>
<td>HNF4A-MODY: progressive insulin secretory defect with presentation in adolescence or early adulthood; may have large birth weight and transient neonatal hypoglycemia; sensitive to sulfonylureas</td>
</tr>
<tr>
<td>HNF1B</td>
<td>AD</td>
<td>HNF1B-MODY: developmental renal disease (typically cystic); genitourinary abnormalities; atrophy of the pancreas; hyperuricemia; gout</td>
</tr>
</tbody>
</table>

2019 ADA Standards of Care (Pediatric)
CFRD

CYSTIC FIBROSIS–RELATED DIABETES

Recommendations

2.14 Annual screening for cystic fibrosis–related diabetes (CFRD) with an oral glucose tolerance test should begin by age 10 years in all patients with cystic fibrosis not previously diagnosed with CFRD. B

2.15 A1C is not recommended as a screening test for cystic fibrosis–related diabetes. B

2.16 Patients with cystic fibrosis–related diabetes should be treated with insulin to attain individualized glycemic goals. A

2.17 Beginning 5 years after the diagnosis of cystic fibrosis–related diabetes, annual monitoring for complications of diabetes is recommended. E

2020 ADA Standards of Care (Pediatric)
Carbohydrate Counting: A key to success

- Macronutrient supplying 4 kcals/gram
- Made of carbon, hydrogen, oxygen
- Important mainly as an energy source
- Responsible for largest increase in blood sugar (more than fat and protein)
- Found in starches, fruits, dairy products, some vegetables

13.4 Comprehensive nutrition education at diagnosis, with annual updates, by an experienced registered dietitian nutritionist is recommended to assess caloric and nutrition intake in relation to weight status and cardiovascular disease risk factors and to inform macronutrient choices. E

2020 ADA Standards of Care (Pediatric)
Carbohydrate Counting: A key to success

- Carbohydrate counting is a tool that helps to identify and measure the amount of carbohydrate foods eaten.
- Carbohydrate is the food source most concerning to people with diabetes because it is the main nutrient that rapidly change blood glucose.
- Over 90% of carbohydrates eaten are converted into blood glucose in 1-2 hours.

2020 ADA Standards of Care (Pediatric)

** Sugar Free does not mean carbohydrate free!!**
INSULIN
Insulin

- Insulin is an anabolic hormone
- Produced by the pancreatic beta cells in the islets of Langerhans
- First discovered in 1921 by Dr. Fredrick Banting and Charles Best
- First used a pancreatic extract to treat dogs with diabetes and then the following summer in a 14 year old boy
Insulin

• Essential to process carbohydrates
• Decreases blood glucose
• Facilitates glucose into tissues (muscle/adipose)
• Stimulates the liver to store glucose in the form of glycogen
• Promotes synthesis of fatty acids in the liver
• Inhibits the breakdown of fat in adipose tissue, therefore stimulating fat storage
Types of Insulin

- Short
- Rapid
- Intermediate
- Long
- Premixed
- Inhaled
<table>
<thead>
<tr>
<th>Insulin type</th>
<th>How it is delivered</th>
<th>Expiration when opened</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rapid Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admelog</td>
<td>Pens and vials</td>
<td>28 days</td>
<td>15-30 min</td>
<td>30 min-2 ½ hours</td>
<td>4-5 hours</td>
</tr>
<tr>
<td>Afrezza inhaled powder</td>
<td>4, 8 and 12 unit Cartridges</td>
<td>3 days</td>
<td>3-7 minutes</td>
<td>12-15 min</td>
<td>1 ½-3 hours</td>
</tr>
<tr>
<td>Apidra</td>
<td>Vials and pens</td>
<td>28 days</td>
<td>10-20 min</td>
<td>30 min-1 ½ hours</td>
<td>2-4 hours</td>
</tr>
<tr>
<td>Flasp</td>
<td>Vials and pens</td>
<td>28 days</td>
<td>15-20 min</td>
<td>1 ½- 2 hours</td>
<td>5 hours</td>
</tr>
<tr>
<td>Humalog, U-100 and U-200</td>
<td>Vials, pens, cartridges for refillable pen</td>
<td>28 days</td>
<td>10-20 min</td>
<td>30 min-1/12 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Novolog</td>
<td>Vials, pens, cartridges for refillable pen</td>
<td>28 days</td>
<td>10-20 min</td>
<td>1-3 hours</td>
<td>3-5 hours</td>
</tr>
<tr>
<td><strong>Short Acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>Vials and pens</td>
<td>31-42 days, depending upon brand</td>
<td>15-30 min</td>
<td>2 ½-5 hours</td>
<td>4-12 hours</td>
</tr>
<tr>
<td>U-500 (5x the concentration)</td>
<td>Vials and pens</td>
<td>28 days</td>
<td>30 min</td>
<td>4-8 hours</td>
<td>18-24 hours</td>
</tr>
<tr>
<td><strong>Intermediate acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH (created in 1946)</td>
<td>Vials and pens</td>
<td>31-42 days, depending upon brand</td>
<td>1-2 hours</td>
<td>4-12 hours</td>
<td>14-24 hours</td>
</tr>
<tr>
<td><strong>Long acting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basaglar</td>
<td>Vials and pens</td>
<td>28 days</td>
<td>3-4 hours</td>
<td>No peak +</td>
<td>11-24 hours</td>
</tr>
<tr>
<td>Lantus</td>
<td>Vials and pens</td>
<td>28 days</td>
<td>3-4 hours</td>
<td>No peak +</td>
<td>11-24 hours</td>
</tr>
<tr>
<td>Levevhir</td>
<td>Vials and pens</td>
<td>42 days</td>
<td>3-4 hours</td>
<td>No peak +</td>
<td>6-23 hours</td>
</tr>
<tr>
<td>Toujeo, U-300</td>
<td>Pen only</td>
<td>42 days</td>
<td>6 hours</td>
<td>No peak</td>
<td>24-36 hours</td>
</tr>
<tr>
<td>Tresiba, U-100 and U-200</td>
<td>Pen only</td>
<td>56 days</td>
<td>1 hour</td>
<td>9 hours</td>
<td>36-42 hours</td>
</tr>
<tr>
<td><strong>Combination</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH/Regular 70/30</td>
<td>Vials and pens</td>
<td>31-42 d vial 10 d pen</td>
<td>30 min</td>
<td>50 min-2 hours and 6-10 hours</td>
<td>18-24 hours</td>
</tr>
<tr>
<td>Rapid acting 70/30</td>
<td>Vials and pens</td>
<td>28 d vial 14 d pen</td>
<td>15-30 min</td>
<td>1-4 hours</td>
<td>18-24 hours</td>
</tr>
<tr>
<td>Rapid acting 75/25</td>
<td>Vials and pens</td>
<td>28 d vial 10 d pen</td>
<td>15-30 min</td>
<td>1-6 ½ hours</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Rapid acting 50/50</td>
<td>Vials and pens</td>
<td>28 d vial 10 d pen</td>
<td>15-30 min</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

https://www.ontrackdiabetes.com/blood-glucose/insulin-basics
Aspart, Lispro, Glulisine (3-4 hours)

Regular (4-6 hours)

NPH (10-16 hours)

Detemir (~14-20 hours)

Glargine (~22-24 hours)

Degludec (>24 hrs)

Plasma Insulin Levels

Time (hours)
**types of insulin**

- **rapid-acting**
  - starts to work 5-10 minutes
  - peaks 30-90 minutes
- **regular/short-acting**
  - starts to work 2-5 hours
  - peaks 5-10 hours
- **intermediate-acting**
  - starts to work 1-2 hours
  - peaks 3-10 hours
- **long-acting**
  - peaks 0-12 hours
does not peak

---

**Pharmacokinetic profile: Fiasp® vs NovoLog®**

<table>
<thead>
<tr>
<th></th>
<th>Fiasp® (meatime) (0.2 U/kg dose)</th>
<th>NovoLog® (meatime) (0.2 U/kg dose)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>~2.5 MINUTES</td>
<td>~5.2 MINUTES</td>
</tr>
</tbody>
</table>

**Fiasp® appears in the bloodstream 2X faster than NovoLog®**
# Basal vs. Bolus: The Difference

<table>
<thead>
<tr>
<th>Basal Insulin</th>
<th>Bolus Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Intended to mimic normal pancreatic secretion</td>
<td>• Intended to be rapid onset</td>
</tr>
<tr>
<td>• Long lasting effect 18-24 hours</td>
<td>• Short duration of action</td>
</tr>
<tr>
<td>• Smooth and peakless</td>
<td>• Meal time insulin</td>
</tr>
<tr>
<td>• Reduced risks of nocturnal hypoglycemia</td>
<td>• Correction insulin</td>
</tr>
<tr>
<td>• Once per day administration</td>
<td>• Predictable action profile</td>
</tr>
</tbody>
</table>
A. **Rapid acting insulin analogues**

- Onset: 5-15 mins
- Peak: 30-90 mins
- Duration: 3-5 hours

B. **Pre-mixed insulin analogues vary according to the mixture**

- Rapid acting
  - Onset: 5-15 minutes
  - Peak: 1-4 hours
  - Duration: 24 hours

- Long acting

C. **Long acting analogues**

- Onset: 1-4 hours
- Peak: None
- Duration: up to 24hrs

D. **Newer long-acting analogues**

- Onset: 30 - 90 mins
- Peak: None
- Duration: 24 - 40 hours
Oral Hypoglycemics: Indications for use

• Failure of diet and lifestyle therapy
• Partially functioning pancreas/Endogenous insulin production
• Type 2 diabetes

• Steroid induced diabetes
• MODY
• Can be used in monotherapy or in combination with insulin
Metformin (Glucophaghe)

- Belongs to class BIGUANIDES
- Used alone or with insulin to improve sensitivity
- Available in liquid and tab form
- Available as extended release formulations
Metformin – Side effects

• Common
  – Diarrhea
  – Gas
  – Heartburn
  – Nausea
  – Abdominal pain

• Severe
  – Confusion
  – Drowsiness/Dizziness
  – Difficulty breathing
  – Weakness
  – Increased heart rate
  – Vomiting
  – Fatigue
  – Unusual muscle pain
Glucagon-like Peptide-1 (GLP-1) Receptor Agonists

- Liraglutide (Victoza)
- Approved by the FDA 2019 for children >10 years of age with T2DM
- Incretin mimetic agent that elicits glucagon like peptide-1 (GLP-1) receptor agonist activity
Victoza - Side effects

- Common
  - Nausea
  - Diarrhea
  - Vomiting
  - Constipation
  - Headache
  - Dyspepsia
  - Injection site reaction

- Severe
  - Thyroid C-cell tumor
  - Papillary thyroid carcinoma
  - Nephrotoxicity
  - Pancreatitis
  - Hypoglycemia
Recent FDA approval

- Baqsimi

Giving the dose

1. Hold Device between fingers and thumb. Do not push Plunger yet.

2. Insert Tip gently into one nostril until finger(s) touch the outside of the nose.

3. Push Plunger firmly all the way in. Dose is complete when the Green Line disappears.
Recent FDA approval

- **Gvoke**
  - Premixed, prefilled, premeasured
  - 2 doses: 1.0 mg and 0.5 mg
  - No refrigeration
GLUCOSE MONITORING
Glucose Monitoring

- Before meals
- Before going to bed
- Before driving
- Before physical activity
- School dismissal
- With symptoms of hypo/hyperglycemia
<table>
<thead>
<tr>
<th>Time</th>
<th>Morning</th>
<th>Afternoon</th>
<th>Evening</th>
<th>Night</th>
<th>Daily Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>12A</td>
<td>115</td>
<td>122</td>
<td>192</td>
<td>161</td>
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<tr>
<td>11/21</td>
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<td>TUE</td>
<td>120</td>
<td>109</td>
<td>136</td>
<td>156</td>
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<td>SUN</td>
<td>130</td>
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<td>185</td>
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<td>145</td>
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<td>11/17</td>
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<tr>
<td>FRI</td>
<td>120</td>
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<td>244*</td>
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<td>THU</td>
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<td>11/15</td>
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<tr>
<td>AVG. MORNING (5AM - 10AM)</td>
<td>120.0 mg/dL</td>
<td>116.0 mg/dL</td>
<td>160.0 mg/dL</td>
<td>155.0 mg/dL</td>
<td></td>
</tr>
<tr>
<td>AVG. AFTERNOON (10AM - 3PM)</td>
<td>120.0 mg/dL</td>
<td>116.0 mg/dL</td>
<td>160.0 mg/dL</td>
<td>155.0 mg/dL</td>
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</tr>
<tr>
<td>AVG. EVENING (3PM - 8PM)</td>
<td>120.0 mg/dL</td>
<td>116.0 mg/dL</td>
<td>160.0 mg/dL</td>
<td>155.0 mg/dL</td>
<td></td>
</tr>
<tr>
<td>AVG. NIGHT (8PM - 5AM)</td>
<td>120.0 mg/dL</td>
<td>116.0 mg/dL</td>
<td>160.0 mg/dL</td>
<td>155.0 mg/dL</td>
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</table>

**Blood Sugar Log for the Week of Jan 29**

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
<th>During the Night</th>
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</thead>
<tbody>
<tr>
<td>Mon</td>
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<tr>
<td>Tue</td>
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<tr>
<td>Wed</td>
<td>125.40</td>
<td>17.95</td>
<td>21.25</td>
<td>133.4</td>
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<td>Thurs</td>
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<td>Fri</td>
<td>133.80</td>
<td>122.60</td>
<td>41.30</td>
<td>115.3</td>
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<td>Sat</td>
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<tr>
<td>Sun</td>
<td>115.75</td>
<td>111.95</td>
<td>31.40</td>
<td>91.5</td>
<td></td>
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</tbody>
</table>

**Weekly blood sugar notes**

1/31: 8:55pm felt low, 48 hr. treated with NovoLinx
         1-9 40-20, felt low at 8:36, 12/38, 1:05 after 

**Comparison: Logbook/table**

<table>
<thead>
<tr>
<th>Time</th>
<th>00:00</th>
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<th>23:00</th>
<th>Daily totals</th>
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</tbody>
</table>

**Average (7): 151.8 mg/dL**

**Carbs:** ---

**Insulin:** ---

---

Akron Children's Hospital
CONTINUOUS GLUCOSE MONITORS
# Factors That Affect BG

## Food
- 1. Carbohydrate quantity
- 2. Carbohydrate type
- 3. Fat
- 4. Protein
- 5. Caffeine
- 6. Alcohol
- 7. Meal timing
- 8. Dehydration
- ? 9. Personal microbiome

## Biological
- 20. Insufficient sleep
- 21. Stress and illness
- 22. Recent hypoglycemia
- 23. During-sleep blood sugars
- 24. Dawn phenomenon
- 25. Infusion set issues
- 26. Scar tissue and lipodystrophy
- 27. Intramuscular insulin delivery
- 28. Allergies
- 29. A higher glucose level
- 30. Periods (menstruation)
- 31. Puberty
- 32. Celiac disease
- 33. Smoking

## Medication
- ↓ 10. Medication dose
- ↑ 11. Medication timing
- ↓ 12. Medication interactions
- ↑ 13. Steroid administration
- ↑ 14. Niacin (Vitamin B3)

## Activity
- ↓ 15. Light exercise
- ↑ 16. High-intensity and moderate exercise
- ↓ 17. Level of fitness/training
- ↑ 18. Time of day
- ↑ 19. Food and insulin timing

## Environmental
- ↑ 34. Expired insulin
- 35. Inaccurate BG reading
- ↓ 36. Outside temperature
- ↑ 37. Sunburn
- ? 38. Altitude

## Behavioral & Decision Making
- ↓ 39. Frequency of glucose checks
- ↑ 40. Default options and choices
- ↓ 41. Decision-making biases
- ↑ 42. Family relationships and social pressures
Continuous Glucose Monitors

- Continuous Glucose Monitors (CGM) provide continuous insight into glucose levels throughout the day and night.

7.12 Continuous glucose monitoring (CGM) should be considered in all children and adolescents with type 1 diabetes, whether using injections or continuous subcutaneous insulin infusion, as an additional tool to help improve glucose control. Benefits of CGM correlate with adherence to ongoing use of the device.
Continuous Glucose Monitors

- Sensor is placed just below the skin and can be worn for 7-14 days*
- Measures the glucose in interstitial fluid
- Glucose readings are transmitted to a receiver (graph and numerical reading)
- Depending on the model the display device may be a cell phone, iPod, iPad, insulin pump or brand receiver

CGM: The benefits

- Reduction of HgbA1c
- Less frequent hypoglycemia events
- Decreases the time spent in hypoglycemia
- Ability to see both glucose value trends
  - Value, direction and rate of change
- Adjustments to insulin delivery
  - Pumps: basal/bolus, advanced features
  - Injections: basal, carb counting
CGM: The benefits

• Less fear of hypoglycemia
• Higher satisfaction with treatment
• Seeing the effect of specific foods and activity
• Notice trends
• Transition to independence
• Ability to be more active in their own management
• More aggressive management style
• Alerts of highs and lows*
Why not...?

- Do not want something attached to body
- A second device
- Reminder of chronic disease
- Expense
Integrated Pumps

• Medtronic MiniMed 670G – Guardian Sensor
• Medtronic MiniMed 630G – Enlite Sensor
• Medtronic Paradigm Revel – Enlite Sensor
• Tandem t:slim x2 – Dexcom G6

Stand Alone CGM

• Medtronic Guardian Connect
• FreeStyle Libre
• Eversense
• Dexcom G5/G6
Freestyle Libre

- FDA approved 18+ years
- No fingerstick calibrations
- Fingersticks required for treatment decisions
- No alarms
- Captures data every minute and records every 15 minutes
- Stores 90 days of data
- Download on LibreView
Medtronic Guardian Connect

- Does not communicate with pump/stand alone sensor
- Uses Apple mobile device as receiver
- Seven day wear
- Calibration by finger stick after warm up, 6 hours after warm up and every 12 hours
- **Sugar IQ App**: Predictive high and low glucose alerts
- Rechargeable transmitter
- Caregiver data share
Eversense

THE
EVERSENSE
CGM SYSTEM

See step by step how our system works
Dexcom G6

- Stand Alone Sensor
- FDA approved in ages 2+ years
- Glucose trends on receiver or sent to a mobile device
- Data is able to be shared with the Clarity App
- High and low alerts
100% of Sensors Undergo Performance Evaluation

Each sensor is labeled with a four digit code

Code entered through phone

Code results in accurate sensor glucose readings
Insulin pumps
** No long acting insulin when using an insulin pump. If there is a pump failure- no long acting insulin on board**
Sensor for CGM optional extra

- Insulin vial to fill reservoir
- Reservoir
- Insulin Pump
- Infusion set before insertion
- Infusion set after insertion
Omnipod: features

- No tubing
- Pod (pump) includes infusion set with automatic insertion
- All programming done via PDM
- 200 unit reservoir
- Integrated Freestyle glucose meter
Omnipod Dash

User Phone

Caregiver Phone

CGM/Pod Data with iOS Widgets
Medtronic Integrated Sensors:
Enlite
Guardian 3

NEW GUARDIAN SENSOR 3
TRUSTED TO POWER A HYBRID CLOSED LOOP SYSTEM

- New diagnostic technology
- Enhanced accuracy
- Advanced performance
- Longer life – 7 day wear
- Only sensor approved to drive insulin delivery

Both sensor & transmitter look similar to Enlite on the outside, but very different on the inside.
Tandem X2 with Basal IQ: Features

- Touch screen
- Rechargeable battery
- 300-unit reservoir
- Micro-delivery infusion
- Integrated Dexcom G6 CGM capability
- Software updates available
How does Basal-IQ Technology work?

The Basal-IQ feature helps reduce the frequency and duration of low-glucose events by predicting glucose levels 30 minutes ahead and suspending insulin if they are expected to drop below 80 mg/dL.

1. Predicts glucose 30 minutes ahead
2. Suspends insulin to help avoid the low
3. Resumes insulin once glucose rises
Best Insulin Pumps

Compare the Top 3 Insulin Pumps of 2019

**MiniMed™ 670G**

**PROS**
- Integrated Enlite 3 Continuous Glucose Monitor (CGM)
- Automatically adjusts basal insulin delivery based on data from CGM
- Bluetooth Bayer Contour Next Link Meter with remote bolusing.

**CONS**
- Enlite 3 CGM has accuracy issues
- Medtronic belt clip does not pivot so pump must be unclipped to view screen
- Screen is small
- Not a touch screen

**Omnipod® DASH**

**PROS**
- Only tubeless insulin pump
- Sleek touch screen personal diabetes manager
- Bluetooth Bayer Contour Next Meter
- Automatic insertion of cannula with the press of a button (great for toddlers)

**CONS**
- No integrated CGM
- Not capable of automatically adjusting insulin delivery or suspending delivery
- Holds only 200 units of insulin
- Must change pod every 3 days

**t:slim X2™**

**PROS**
- Smallest insulin pump on the market
- Integrated Dexcom CGM is very accurate
- Automatically adjusts basal insulin based on data from CGM
- Pump software can be updated

**CONS**
- No link meter
- Tubing connector looks medical
- Rechargeable battery can be a con for some users
Open APS and Looping...

https://loopkit.github.io/looperdocs/faqs/FAQs/

Akron Children’s Hospital
World Diabetes Day (WDD) was created in 1991 by IDF and the World Health Organization in response to growing concerns about the escalating health threat posed by diabetes. World Diabetes Day became an official United Nations Day in 2006 with the passage of United Nation Resolution 61/225. It is marked every year on 14 November, the birthday of Sir Frederick Banting, who co-discovered insulin along with Charles Best in 1922.

WDD is the world’s largest diabetes awareness campaign reaching a global audience of over 1 billion people in more than 160 countries. The campaign draws attention to issues of paramount importance to the diabetes world and keeps diabetes firmly in the public and political spotlight.