

Diabetes and Devices

Rachel Calendo, MS, RN, CPNP, CDE
Endocrine NP & Diabetes Program Manager
Martha Cuevas, RN, BSN, CPT

What is diabetes?

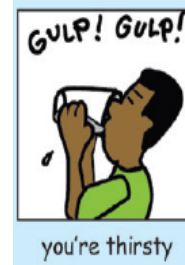
- A metabolic disorder
- An ongoing condition that impairs the body's ability to use food properly, most of the food we eat is turned into glucose or sugar, the body uses glucose for energy
- Caused by an *absolute* or *relative* lack of insulin
- Has **serious** short term and long term health implications

Type 1 Diabetes

- In Type 1 Diabetes the pancreas makes no insulin
 - The cells that produce insulin have been destroyed-Autoimmune destruction
 - Insulin must be given by injection for the child to get energy from the foods they eat

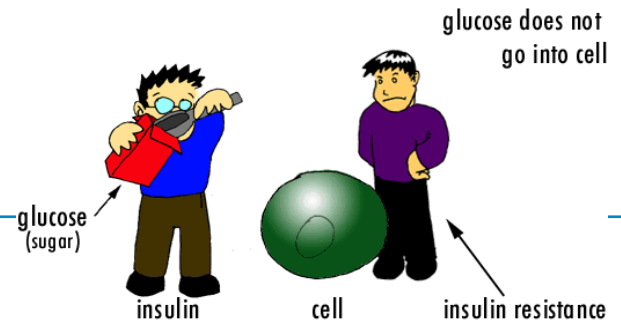
Clinical Manifestations

- Polyuria
- Polydipsia
- Polyphagia
- Weight loss



Type 2 Diabetes

- In Type 2 diabetes, the lock is “rusty”. Thus, the body initially overproduces insulin to compensate.
 - Requires an insulin sensitizer
 - or
 - 5-10% weight loss
 - or
 - exercise (breaking a sweat) of at least 60 minutes/day
- INSULIN alone is NOT enough for kids with Type 2 diabetes!



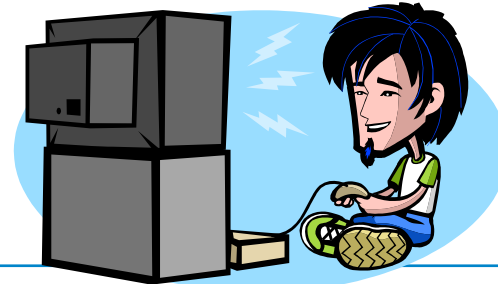
Acanthosis Nigricans: Hallmark of Insulin Resistance





Physical Activity Improves Insulin Sensitivity!

- Encourage unstructured play 60 minutes 5 times/wk
- Decrease “screen-viewing” to < 2 hrs/day
- Use access to fun activities as a reward
- Encourage “show up” activities (classes, teams)
- Start small: walking home from school
- Get the whole family moving!



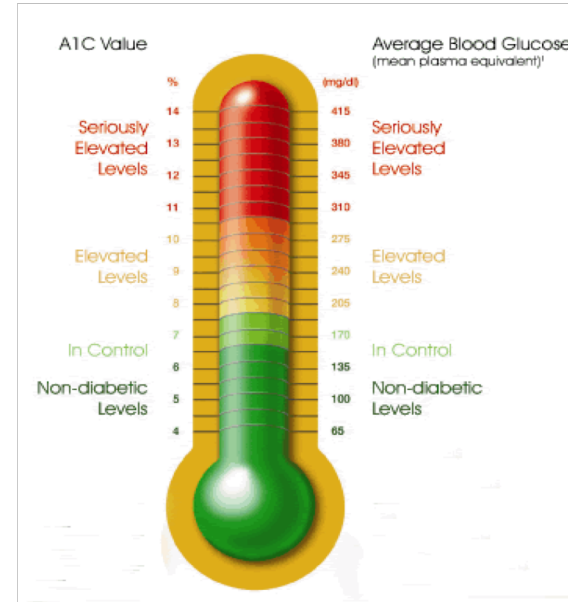
You are part of the Team

- By keeping diabetes in control at school you are helping the child live a long and healthy life.
- By encouraging the child to fully participate in school you are allowing them to develop normally.



Hemoglobin A1c Goals

- All Children and Adolescents under age 19 years: <7.5%
- <7% is appropriate for adolescents when no excessive risk of hypoglycemia is present



Age-Appropriate Blood Glucose Goals

Age (years)	Plasma blood glucose goal range (mg/dl) Before meals	Plasma blood glucose goal range (mg/dl) Bedtime/overnight
19 years and below	90-130 * 80-180 (typical target range)	90-150

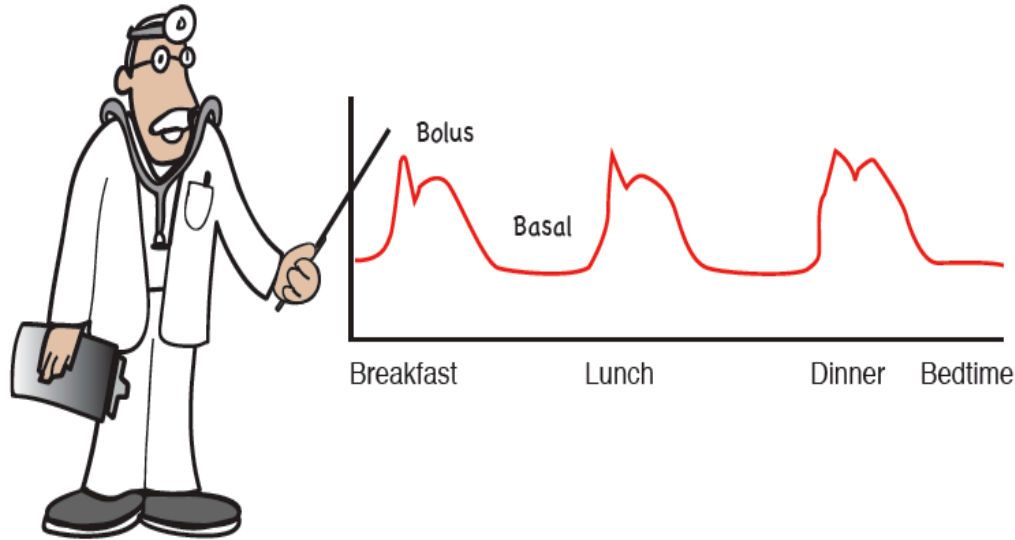


American Diabetes Association. Standards of medical care in diabetes. *Diab Care*. 2016

Intensive Management Therapy

- Goal (from DCCT results) is to maintain near normal blood glucose
- Multiple daily injections or insulin pump therapy with more physiologic insulin is helpful to reach this goal
- Intensive management utilizes a basal and bolus (for carbs) insulin to mimic normal physiologic insulin production

Physiologic Insulin Production



Basal and Bolus Insulin

- **Basal** – insulin given for non-food related glucose excursions (Lantus, Levemir, and rarely NPH)
 - Fasting (release of stored glucose for fuel - glucagon)
 - Circadian rhythms
 - 4-6 a.m. rise of cortisol a.k.a. Dawn phenomenon
 - growth hormone production during REM sleep
 - Stress (cortisol or epinephrine surges with illness, exams, peer pressure, nicotine etc.)
- **Bolus** – insulin released for food-related glucose excursions (Humalog, Novolog, Apidra, and rarely Regular)

Insulin Options	Category	Onset	Peak	Effective Duration	Teaching Points
Humalog (lispro) Novolog (aspart) Apidra (glulisine)	Rapid acting	10-20 min.	30-90 min	3 hrs	<ul style="list-style-type: none"> •Pre-meal dosing is ideal. Can dose after meals if needed (give within 30 minutes)
Humulin R Novolin R (regular)	Regular-acting	30-60 min.	2-3 hrs	5-8 hrs	<ul style="list-style-type: none"> •Must wait 30 minutes after injection to eat •Used in IV drips
NPH (isophane insulin)	Intermediate Acting	2-4 hrs	4-10 hrs (NPH)	10-16 hrs (NPH)	<ul style="list-style-type: none"> • May mix with other insulins •Used with fixed meal amounts
Lantus (glargine) Levemir (detemir) Tresiba (degludec)	Long acting	1-4 hrs	No peak	20-24 hrs 42 hours	<ul style="list-style-type: none"> •Do NOT mix with other insulin

Basal Insulin: Lantus/Levemir/Tresiba/Basaglar

- Most important injection in plan
- If child misses this dose, DKA can ensue quickly
- Taken at the same time every day
- Some children better off taking it at school each day
- Lasts for 24 hours, in some less: then split in two doses, 12 hours apart



The Insulin to Carb Ratio with Rapid Acting Insulin (Humalog, Novolog or Apidra)

- This is the number of carbohydrates that one unit of Humalog/Novolog will cover
- This is calculated using the student's weight and will change as the child grows
- It is adjusted depending on the child's insulin sensitivity

Calculating The Dose of Rapid Acting Insulin (Humalog, Novolog or Apidra)

- Orders are given in a carb ratio
 - 1 unit of Humalog, Novolog or Apidra insulin to x grams of carbohydrate consumed
 - Ex: 1:10
 - Humalog, Novolog or Apidra is given for all meals/snacks containing carbs

Doing the Math

- What you need to know
 - The amount of carbohydrates eaten
 - Carb ratio
 - Whether you are going to give the insulin before the student eats or after (most kiddos after age 5 dose pre meal)



Correction Dosing

- Called: *Correction Factor (CF)*, or *Insulin Sensitivity Factor (ISF)*
 - The amount 1 unit of rapid-acting insulin will lower the BG.
- When the current blood sugar is too high, you can give extra rapid-acting insulin to lower the BG.

Target Blood Glucose

- You do not want to overcorrect and cause a low BG
- Check the orders for the target blood sugar
- Targets may be different for Day and Night
 - Targets may vary based on age

Let's Do an Example:

1. Calculate Carbohydrates (Meal Dosing)

$$\frac{60}{10} = 6$$

Carbs to Eat Carb Ratio Insulin for Carbs

2. Calculate Correction Dose

$$346 - 120 = 226 \div 30 = 7.5$$

Blood Glucose Correction Target Amount to Correct Correction Factor Correction Dose

Numbers

- Target BG 120 mg/dL
- Insulin to Carb Ratio 10 (1 unit for every 10 grams)
- Correction factor 30 (1 unit lowers BG 30 mg/dL)

Rules for Correction

1. Correct with meals (Breakfast, Lunch, and Dinner)
2. Correct when BG is greater than: circle one
120 150 180 200 250 300 mg/dL
3. Correct no sooner than every 3 hours, unless you have moderate or large ketones
4. Do not correct if you have had a low blood sugar in the last 1-2 hours or it has been less than one hour since vigorous exercise

Review orders for Intensive Management:

Child's pre-lunch BG = 346

She wants to eat 60 gms CHO for lunch

Correct any BG > 180

Correction Factor = 30

Target BG = 120

Insulin to CHO ratio = 10

6

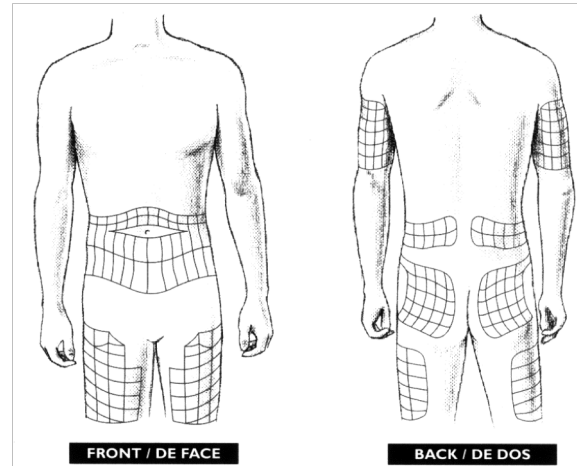
+7.5

13.5 units (New onset- round to nearest $\frac{1}{2}$ unit)

is

Injection/Insertion Sites

- Talk about importance of rotation with student
- Pump sites same as injection sites
- Areas with lipohypertrophy don't absorb insulin well





Insulin Storage



- Unopened, Insulin is good until expiration date on bottle, AND when is stored in the **refrigerator**.
- Once opened, good for 28 days, as long as stored below 86 degrees Fahrenheit. (In or out of fridge)
- Insulin will be stored in patient med bins.
- Remind parents about using travel packs with ice for hot days.
- Insulin pen in use should be kept out of fridge at room temp.



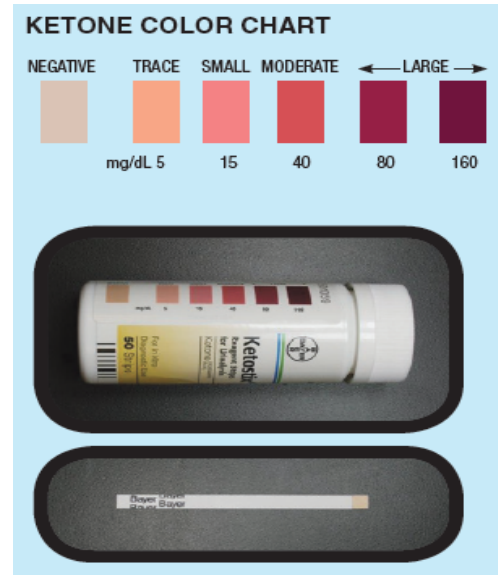
Checking Blood Sugar



- **When to Check BG:**
 - Pre-meal
 - Before activity (sometimes during and after too)
 - With s/s of highs/lows
- **Avoid using alcohol swabs*** - dries skin
- **Wash hands with warm water**

Ketone Monitoring

- Know when to test
 - BG >250 mg/dl
 - Check reaction at 15 seconds. Compare the color of the strip to the bottle color
- Know what ketones tell us
 - Moderate or Large: home, rest and ketone corrections
 - Trace or Small: correct BG per protocol and go back to normal routine



What is Hypoglycemia in Diabetes?

- Low blood sugar is defined as BG < 70
- In children, we use < 80 with symptoms or ≤ 70 .



SWEATING



SHAKING

Hypoglycemia S/S

- Pale face/lips
- Sleepy or quieter
- Hungry
- Sweaty
- Shaky
- Worried
- Mad
- Head hurts
- Heart beating fast
- Dizzy



Low Blood Sugar Treatment

Student IS ALERT AND ABLE TO SWALLOW:

If blood sugar is: 50-80 mg/dL

- Birth through 4 years old = 5g fast-acting sugar
- 5 through 11 years old = 10g fast-acting sugar
- 12 years and older = 15g fast-acting

If blood sugar is: less than 50 mg/dL

- Birth through 4 years = 10g fast-acting sugar
- 5 through 11 years = 20g fast-acting sugar
- 12 years and older sugar = 30g fast-acting sugar

Continue to recheck BG Q 15 mins and repeat appropriate treatment

Fast-Acting Sugar: Sources and Amounts

	5 Grams	10 Grams	15 Grams
100% fruit juice or regular soda	1 oz.	1/3 cup or 2.5 oz.	4oz./1 small juice box
Smarties® (6g each roll)	1 roll	2 roll	2-3 rolls
Glucose tabs (4-5g each)	1 tab	2 - 2½ tabs	3 - 3½ tabs
Sugar (6g/packet)	1 packet	2 packets	3 packets
Raisins (4g each)	12 raisins	25 raisins	37 raisins
Glucose gel (15g tube)	1/3 tube	2/3 tube	1 tube
Honey (5g/1tsp.) Do not use under age 1	1 tsp.	2 tsp.	3 tsp.
Gummy bears	2-3 bears	4-5 bears	7-8 bears

Severe Hypoglycemia

PATIENT IS AWAKE BUT NOT ABLE TO SWALLOW

- Glucose gel
- If cake decorating gel (need scissors)
- Place in cheek pocket
- Rub cheek, and encourage pt. to swallow
- Once more alert, re-check BG and proceed with treatment protocol
- If passes out- see next slide



Severe Hypoglycemia

If the child has PASSED OUT or CAN'T SWALLOW,
a glucagon shot is needed

- Prepare to give
- Have someone call 911



Glucagon Dosing

- Dosing Guidelines
 - Ages 6 to 11yrs. get 0.5ml/0.5mg
 - 12yrs. and older get 1ml/1mg



After Glucagon

- Roll the student on their side, they will likely vomit
- Start with clear liquid- juice once awake
- Monitor and treat low blood sugar per protocol
- Within 1 hour after low blood sugar, pt. needs to eat a meal or snack with fat and/or fiber, if they consume CHO dose accordingly



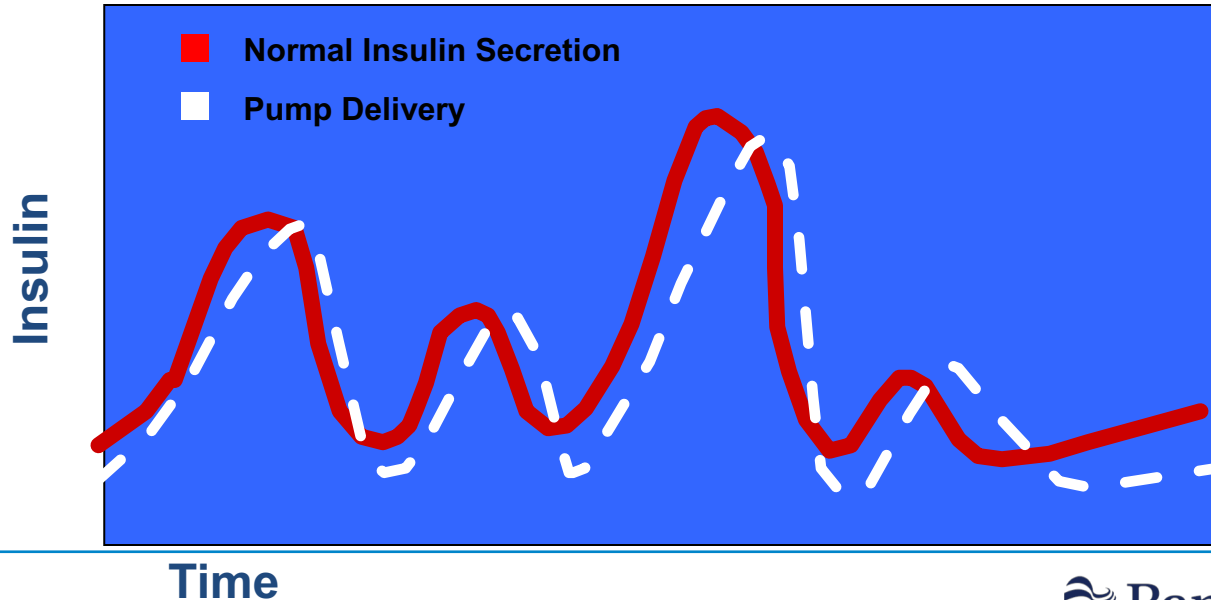
TECHNOLOGY

Insulin Pumps Today

- Insulin is stored in the pump, delivered through a catheter placed in the skin
- Doses as small as 0.025 units can be given with accuracy for gradual absorption
- There is no “best” age to begin using a pump
- Easier to pre-meal bolus
- 1-800 number on back of every pump
- CGMS technology now available

The Pump: More like a Healthy Pancreas

- Delivery that's customizable, flexible, adjustable
- Can more closely mimic the natural delivery patterns of the pancreas



Schematic representation only

Insulin Pump Therapy in the Past



Pumps Have.....Predictability, Customizable Delivery

- Less than 3% absorption variability
- One insertion every 2 to 3 days
- Delivers insulin in tiny micro-doses (as little as 0.025 units), for more accurate dosing.
- 24-hours-a-day, tailored to individual needs
- Keeps track of insulin on board
- Pump does the dosage calculations resulting in fewer dosage errors.
- Closed loop technology in some pumps



Challenges of an Insulin Pump

Requires:

- User input, problem solving, and parental supervision
- Frequent blood sugar checks and diligent site rotation
- Can increase risk of sudden highs and ketones
- Worn on the body at all times
- Learning curve
- Financial considerations



Link meters

- One-touch Ultra Ping meter and
- Bayer Contour Next link meter use radio frequencies to send blood glucose to the pump.
- Must be within 4 feet of each other to receive BG reading.
- Blood Glucose number remains for 12-20 minutes on the screen.



Insulin Pump Therapy Today

Omnipod



Tandem



Medtronic



Omnipod

Omnipod DASH™ System



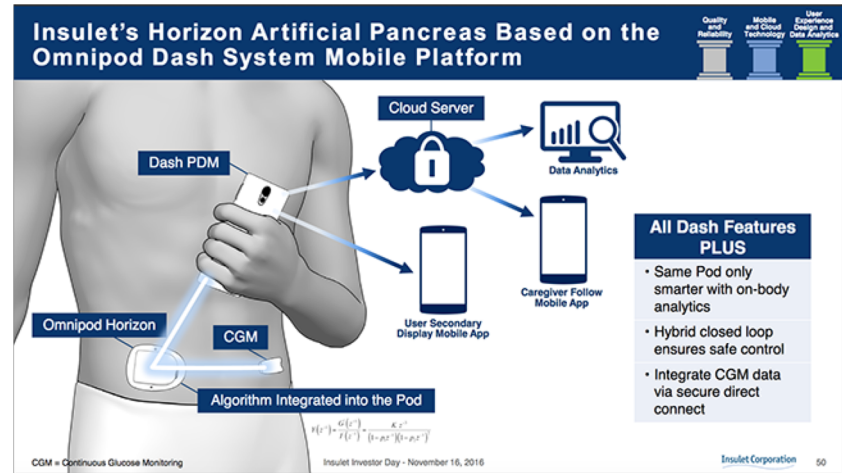
- Tubeless
- Waterproof*
- 3-day continuous insulin delivery

Insulet / Omnipod

- Omnipod system: pod + PDM
- **Only tubeless pump on market**
- Waterproof/submergible
- Hands-free insertion (cannula)
- Approved for all ages
- **Holds 200 units of insulin**
- Basal range 0.05-30 U/h
- Bolus range 0.05-30 U (increments of 0.05/0.1/0.5/1 U)



Insulet/Omnipod future plans



- Omnipod Horizon Automated Glucose Control System
 - Algorithm integrated into pod
 - Hybrid closed loop
 - Investigational study on algorithm in adults completed
 - **Expected launch late 2019**

Tandem t:slim x2



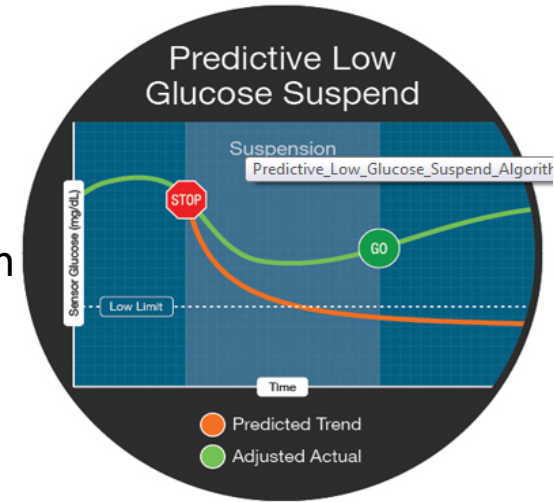
Tandem t:slim x2

- Smallest insulin pump on market
- Compatible with Dexcom G5 and G6 (depending on pump)
- Full color touchscreen display, watertight
- Bluetooth-enabled (remote software updating capability)
- Pump is capable of remote feature updates
- Micro-Delivery[®] technology
- Basal rate increments as low as 0.001 U/h (range: 0.001-35 U/h)
- Bolus as low as 0.05 U minimum bolus, 25 U maximum bolus
- Holds 300 units of insulin
- Predictive low glucose suspend available now (Basal IQ)
- Closed loop coming fall 2019 (Control IQ)



Tandem t:slim x2 with PLGS

- **Predictive Low Glucose Suspend (PLGS)**
- 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.



Tandem t:slim x2 future Plans

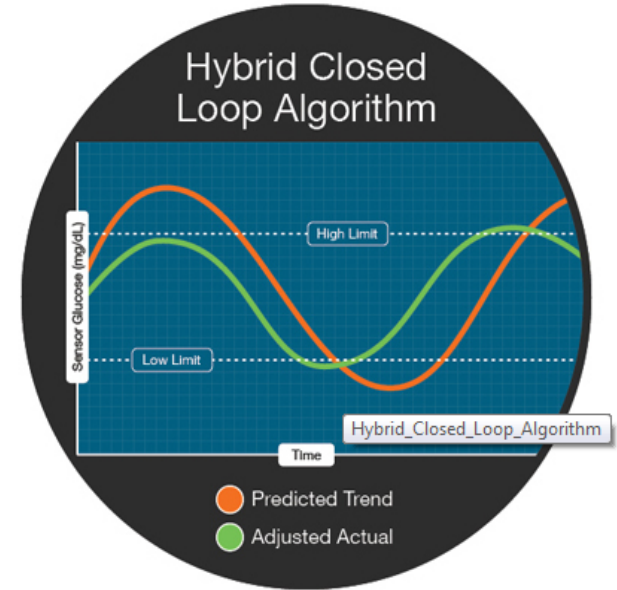
Hybrid Closed Loop (HCL)

Timeline

- Launch goal: 2nd half 2019



Dexcom G6



Medtronic 670G – Hybrid Closed Loop System

- The first and only system that **constantly self-adjusts to keep your sugar levels in range when in auto mode**
- Compatible with Guardian Sensor 3
- Utilizes SmartGuard HCL (hybrid closed loop) technology
- **Performs automatic adjustments to basal rates**
- **User must bolus before meals/blood sugar correction**
- Similar specifications/appearance as 630g



Medtronic 670G

The MiniMed 670G system with **SmartGuard® HCL technology** offers two levels of personalization:

- The **Suspend before low^s** option avoids lows and rebound highs proactively by automatically stopping insulin 30 minutes before you reach your pre-selected low limits, then automatically restarts insulin when your levels recover, all without bothersome alerts.
- The **Auto Mode[±]** option **automatically adjusts your basal insulin delivery every 5 minutes based on your sugar levels to keep you in target range, all day and night.**
- **Guardian® Sensor 3** continuous glucose monitoring sensor. Introducing the most accurate sensor from Medtronic, now with up to **7 day wear** and easy insertion. It is the **FIRST and ONLY** continuous glucose monitoring sensor FDA approved and trusted to control insulin dosing.



CGMs (Continuous Glucose Monitoring)



Medtronic
Guardian Sensor &
Enlite Sensor

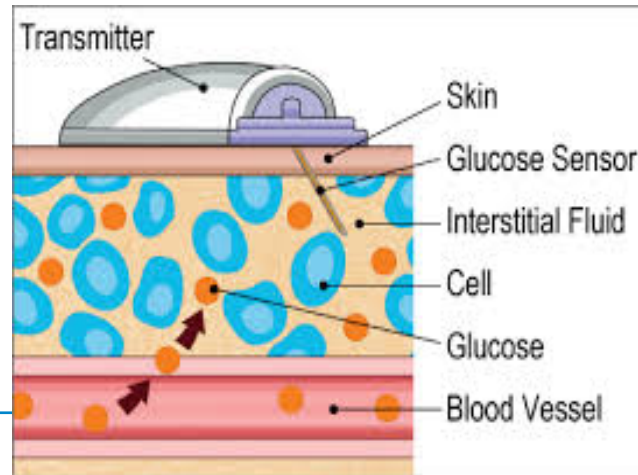


Dexcom G5

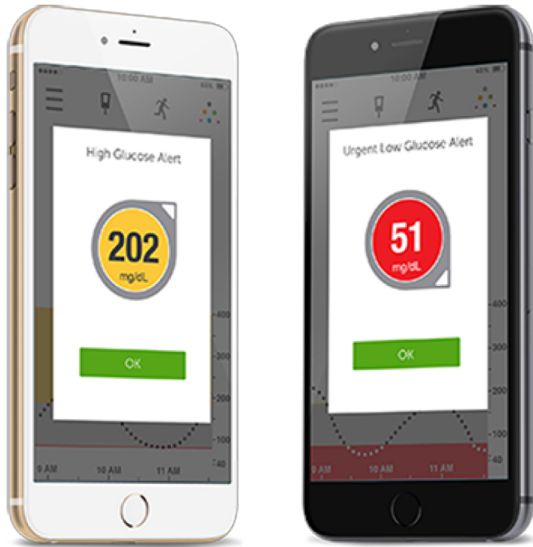
Dexcom G6

How does CGM technology work?

- CGM technology measures glucose in the interstitial fluid. The patient inserts a CGM sensor into the skin (much like inserting their pump sets), and a chemical reaction on the enzyme coated sensor tip is translated into a glucose level. Calibration measurements are required by the systems every 12 hours.



CGMS (Continuous Glucose Monitoring System)



- For G5 system only:
 - Patient should not use the readings from a CGM to treat either high or low blood sugars –Sensors are FDA approved for 7 days or sooner if sensor failure.
- For **G6 ok to treat** from sensor readings, 10 day wear

CGMS

Calibrations (finger stick reading)

- Calibration:

- Dexcom G5 2 times/day

- Dexcom G6 **No Calibration required**

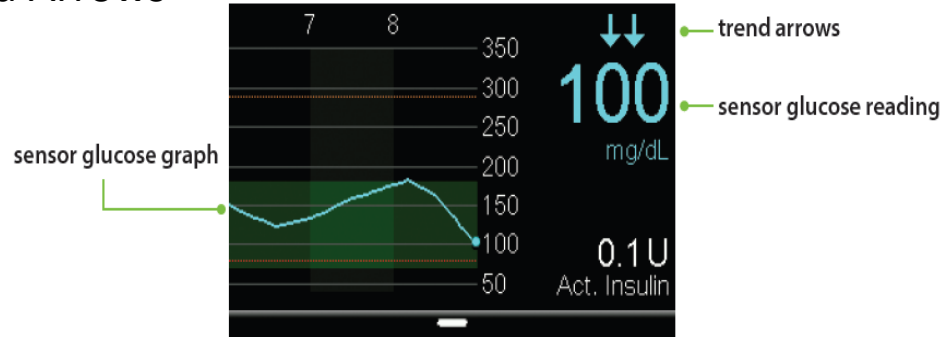
- Medtronic 3-4 times/day






- Tylenol may falsely raise your sensor glucose readings with the Dexcom G5

Medtronic Trend Arrows

- Medtronic 670G Trend Arrows

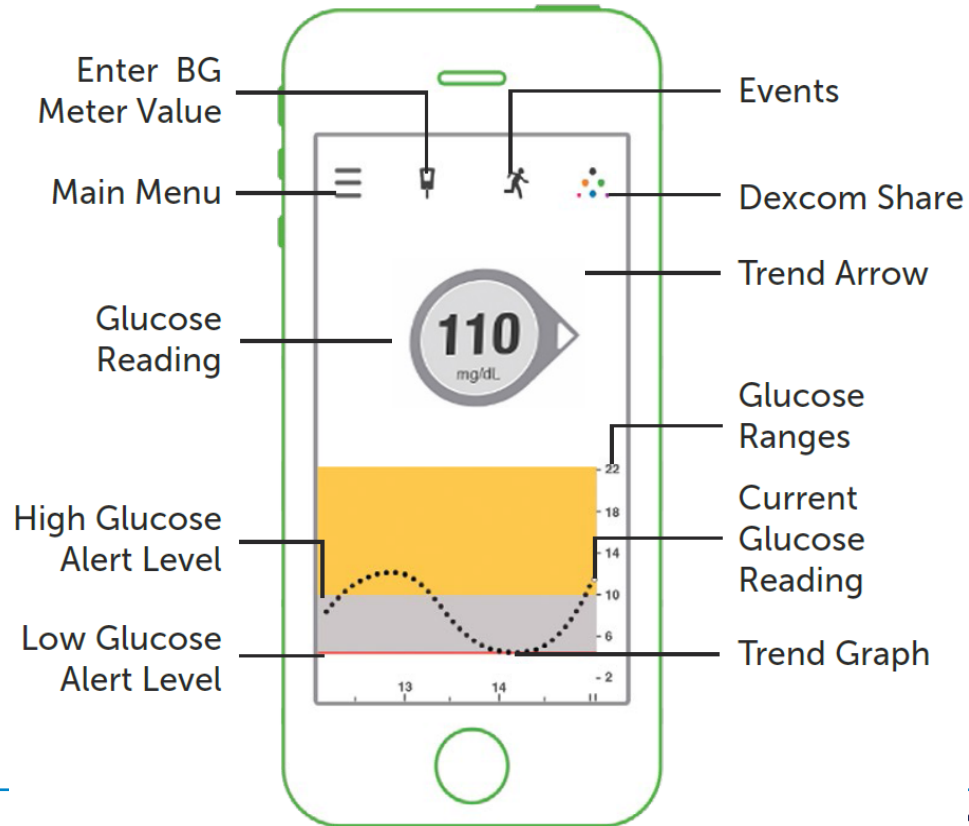


- This shows how fast the Sugar Glucose has been rising or falling

	=	SG has been changing SG has been rising or falling about 20-40 mg/dL over the last 20 minutes (1-2 mg/dL per minute)
	=	SG has been changing quickly SG has been rising or falling about 40-60 mg/dL over the last 20 minutes (2-3 mg/dL per minute)
	=	SG has been changing very quickly SG has been rising or falling more than 60 mg/dL over the last 20 minutes (more than 3 mg/dL per minute)

If you see no arrows above the sensor glucose value, your sensor glucose is not rising or falling quickly.

Dexcom Arrow Trends



Dexcom Arrow Trends

Where You Are

To know where you are now, look at the color and number.



Red = Low



Yellow = High



Gray = In Target



Your system can have issues or errors. These show up on your home screen as black circles with information related to the issue or error. **You won't get sensor glucose readings or alerts when a black circle is shown.** Tap the blue question mark for more information.

	Steady: Glucose is steady (not increasing/decreasing more than 1 mg/dL each minute).
	Slowly rising: Your glucose could increase up to 30 mg/dL in 15 minutes.
	Rising: Your glucose could increase up to 45 mg/dL in 15 minutes.
	Rapidly rising: Your glucose could increase more than 45 mg/dL in 15 minutes.
	Slowly falling: Your glucose could decrease up to 30 mg/dL in 15 minutes.
	Falling: Your glucose could decrease up to 45 mg/dL in 15 minutes.
	Rapidly falling: Your glucose could decrease more than 45 mg/dL in 15 minutes.

Glucose Sensor readings versus Glucose meters:

- Glucose values will rarely come out the same between the two measurements. There is up to 20% variability allowed by the FDA.
- We see up to a **20% variability between different blood glucose meter readings.**



Old Platform Pumps still seen in the Market

Medtronic Minimed Paradigm



523: 180 U reservoir
723: 300 U reservoir

Animas OneTouch Ping



Medtronic Minimed 530g



180 U reservoir
300 U reservoir

**Customer Service Number
Found on back of the insulin pumps**

Animas VIBE



Pump Tips

- **Site changes** should be occurring **every 2-3 days**.
- Have student keep **extra** infusion sets at school.
- Easier to **pre-meal bolus**
- Know **KISS** protocol



KISS

Protocol for Insulin Pumps

For High Blood Sugars (greater than 250mg/dl) you can't explain, just **KISS**:

K - **Ketones** - check for them

I - **Insulin by injection**

Positive Ketones - Insulin by injection, and Set/Site Change

Negative Ketones - Correction via pump, re-check in 1 hour. Administer insulin by injection at this point if no improvement and complete S/S.

SS - **Set/Site change** - whenever ketones present or blood sugar remains high after 2 checks and no effect from correction bolus.