MANAGING DIABETES IN THE PHYSICALLY ACTIVE POPULATION

DISCLOSURE

- No disclosure or conflicts to report

COURSE AUTHOR

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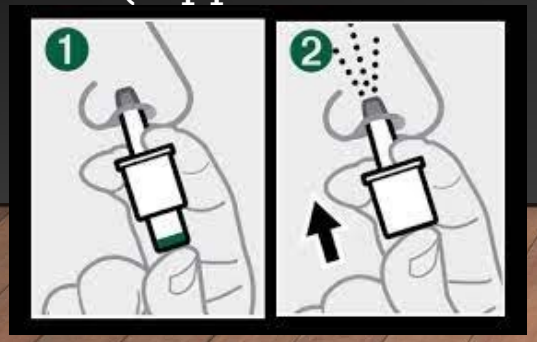
Athletic Trainer


Exit


Walt

COURSE OBJECTIVES

- Identify the difference between Type 1 and Type 2 Diabetes
- Recognize the importance of the preparticipation physical examination
- Diabetes Overview: Insulin action/dosing/stacking
- Recognize, treat and prevention of hyperglycemia. Understanding insulin administration , pumps, continuous glucous monitors and injections
- Recognize, treat and prevention of hypoglycemia. Symptoms / Rule of 15. Understanding and seeing the various types of glucagon and demonstrating the appropriate way to administer it.
- Technology" CGMs, pumps and hybrid closed loop. Demonstrate and analyze the data of a continual glucose monitor and educate the student and their parent about how to use this information.
- Understand failures and ketones with pump therapy
- Be able to calculate insulin dose using ICR, ISF, and Target BG
- Identify the importance of developing a written diabetic care plan specifically to each diabetic athlete (supplies needed for an athletic training



The Statistics

- 37.3 million children and adults in US (11.3% of population) have diabetes 28.7 million diagnoses and another 8.6 undiagnosed
- 96 million people are pre-diabetic

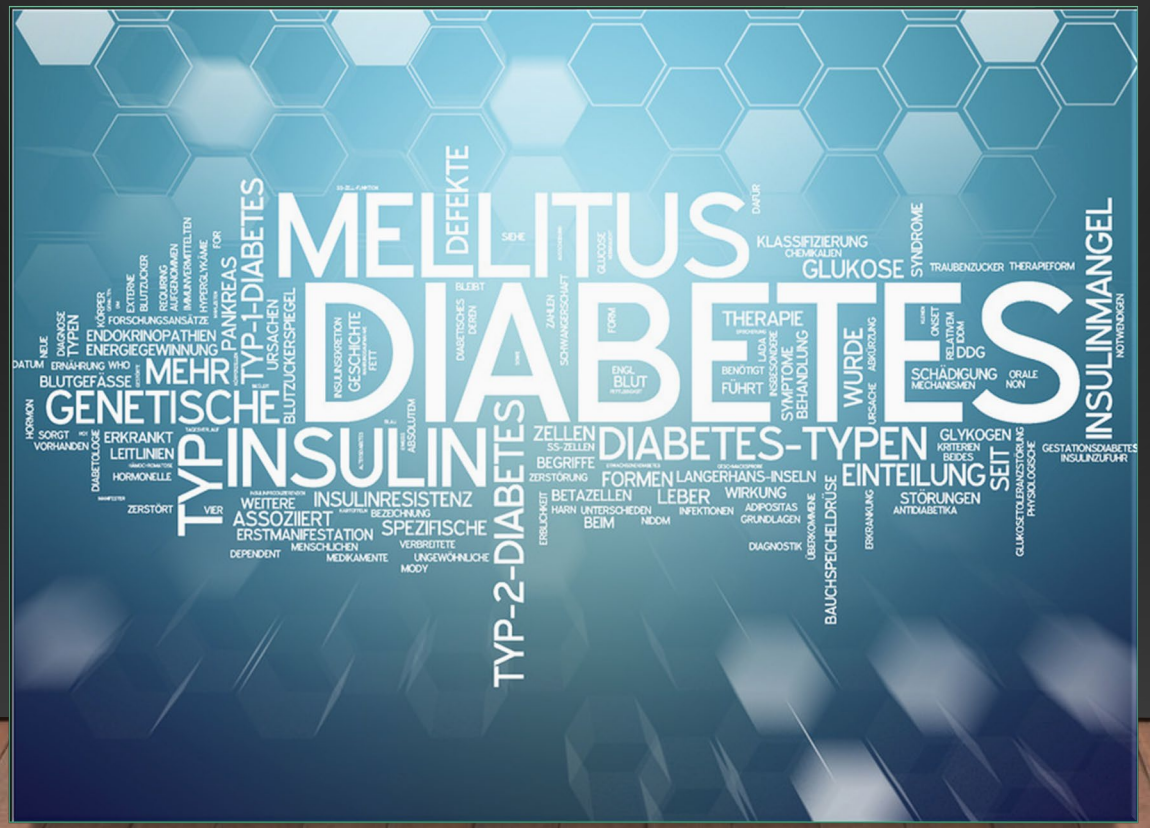
Pediatric (0-20 years of age)283,00 .35 % of the population

American Diabetes Association®

Breakthrough T1D™ Formerly JDRF

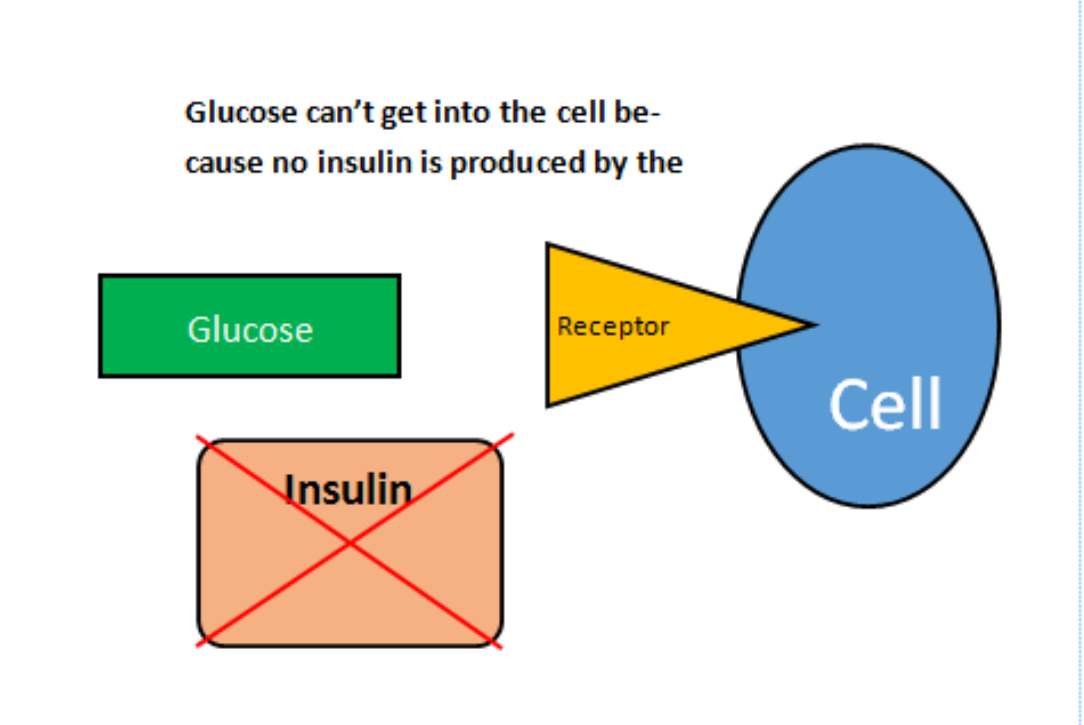
DIABETES – WHAT IS IT?

- Occurs when the body can't use glucose (a type of sugar) normally.
- The levels of glucose in the blood are controlled by a hormone called insulin, which is made by the pancreas. Insulin helps glucose enter the cells.



TYPE 1 DIABETES:
AKA CHILDHOOD, ADOLESCENT OR JUVENILE

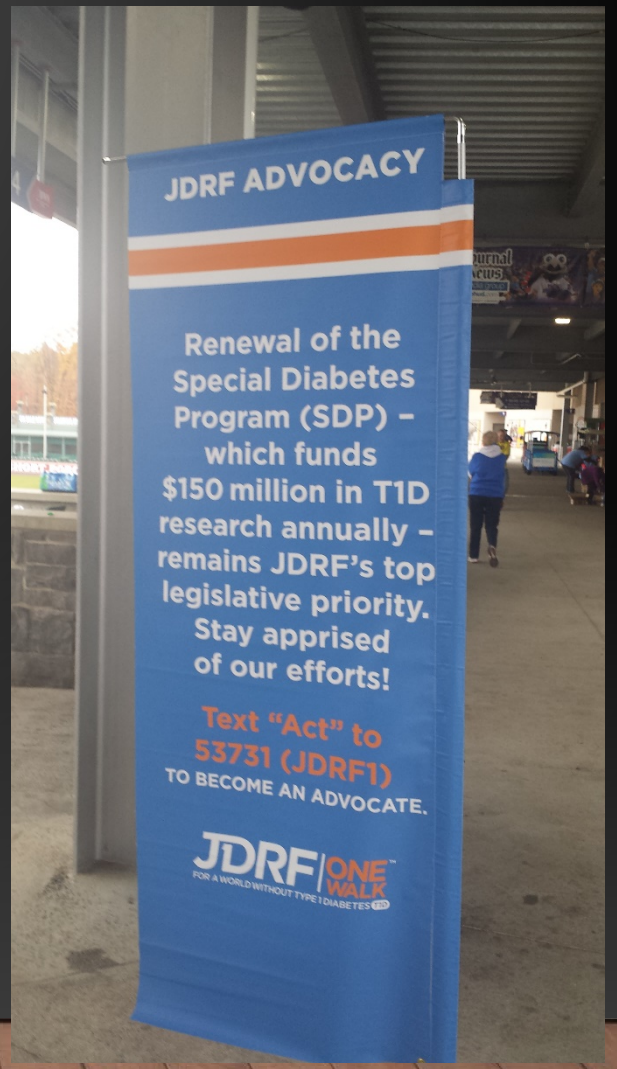
In diabetes, the pancreas does not make enough insulin (Type 1 Diabetes)



TYPE 1 DIABETES

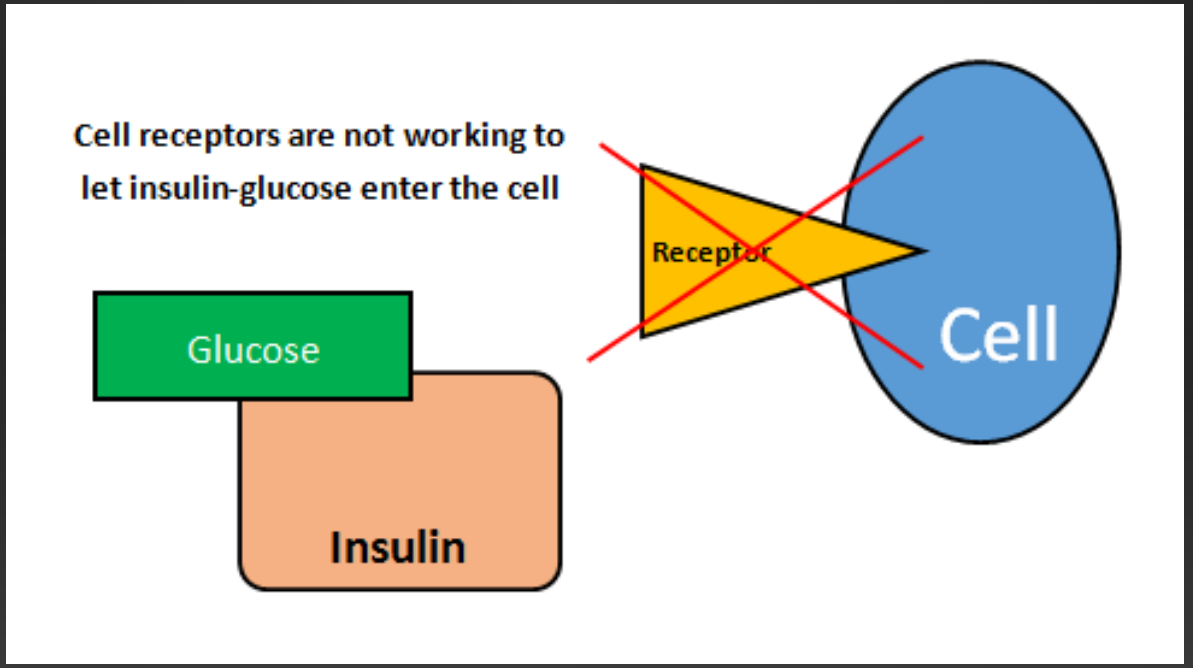
Mean age 8-12

- Autoimmune disease
- Unknown trigger causes alteration in immune response
- The immune system attacks the insulin –producing beta cells in the pancreas



TYPE 2 DIABETES: AKA ADULT-ONSET DIABETES

- The body can't respond normally to the insulin that is made (Type 2 Diabetes)



ONSET OF TYPE 2 DIABETES

- No noticeable symptoms during early stages.
- Subtle symptoms that may arise include:
  - Feeling of fatigue
  - Dry, itchy skin
  - Tingling or numbness in hands and/or feet
  - Blurred vision
  - Increased hunger and/or thirst
  - Increased urination
  - Problems with sexual function
  - More frequent infections
  - Slow healing wounds

EXERCISE WITH TYPE 2 DIABETES

- Do NOT need to postpone exercise because of hyperglycemia
  - Provided that they are feeling well
  - Adequately hydrated

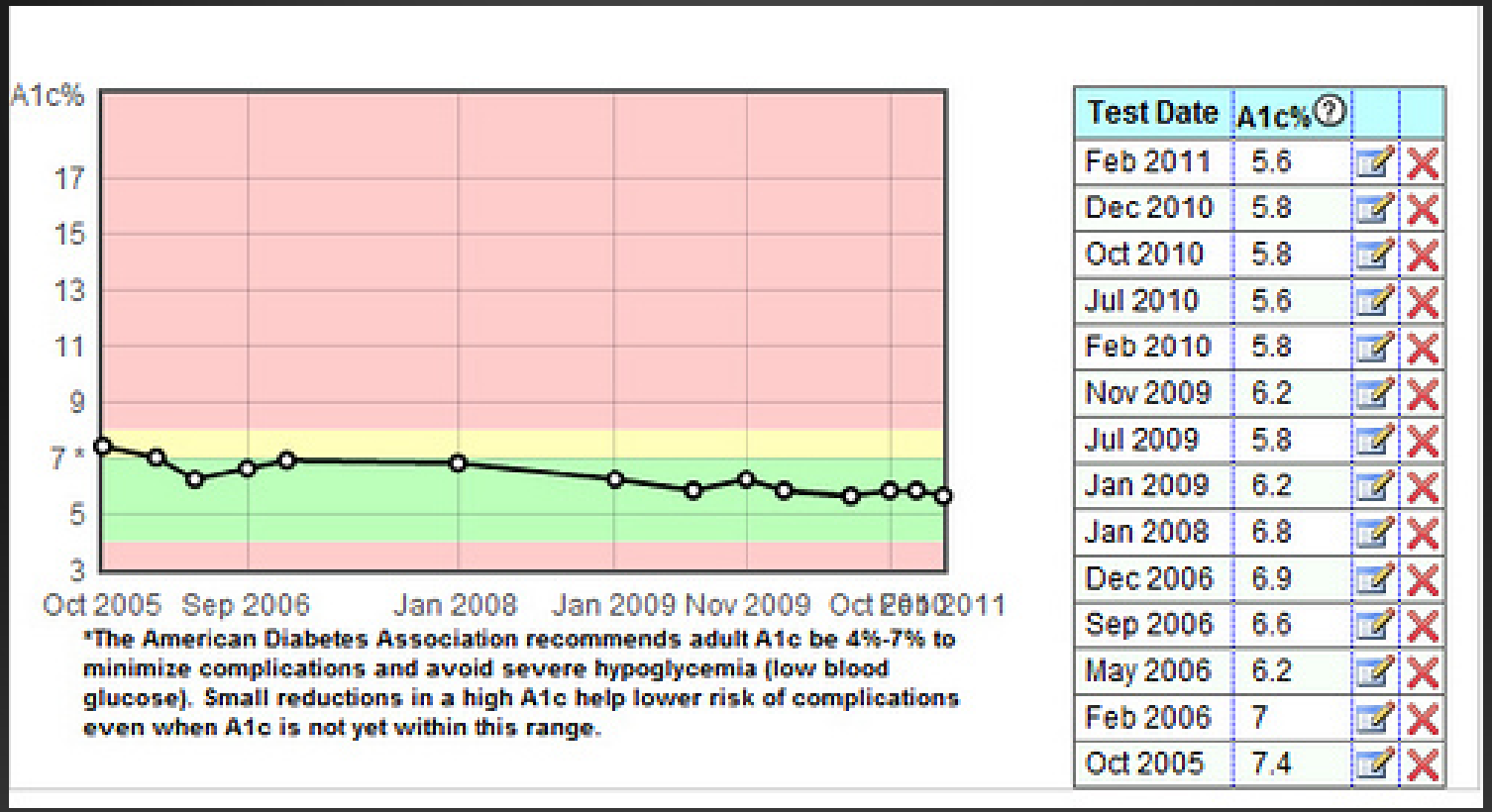
- Patients with Type 2 Diabetes not using insulin are unlikely to experience hypoglycemia related to physical activity
  - Users of insulin are advised to supplement with carbohydrate to prevent hypoglycemia during and after exercise

DIABETES COMPARISON

	Type 1	Type 2
Diagnosis	Typically diagnosed in early childhood , adolescence or early adulthood. **5-10% of cases**	Usually diagnosed in adulthood but this is changing. **90-95% of cases**
Mechanism	Insulin Deficiency	Decreased Insulin utilization
Complications	Hyperglycemia, weight loss, DKA	Obesity, hypertension, hyperlipidemia
Demographics	Younger more fit population	More common in older, overweight individuals. Rare in competitive athletes.

DIAGNOSING DIABETES MELLITUS

- Hemoglobin A1C (test that looks at BS over last 3 months)

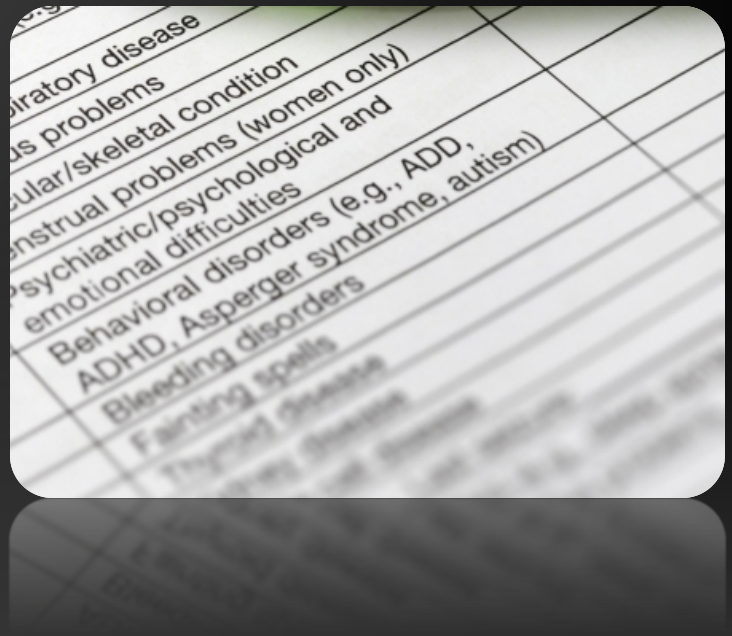


Test Date	A1c%
Feb 2011	5.6
Dec 2010	5.8
Oct 2010	5.8
Jul 2010	5.6
Feb 2010	5.8
Nov 2009	6.2
Jul 2009	5.8
Jan 2009	6.2
Jan 2008	6.8
Dec 2006	6.9
Sep 2006	6.6
May 2006	6.2
Feb 2006	7
Oct 2005	7.4

PRE-PARTICIPATION EXAM

- Athlete's endocrinologist or primary care physician should provide an assessment of the current level of glycemic control

- Assess overall long-term glycemic control. Hemoglobin A1C test every 3-4 months

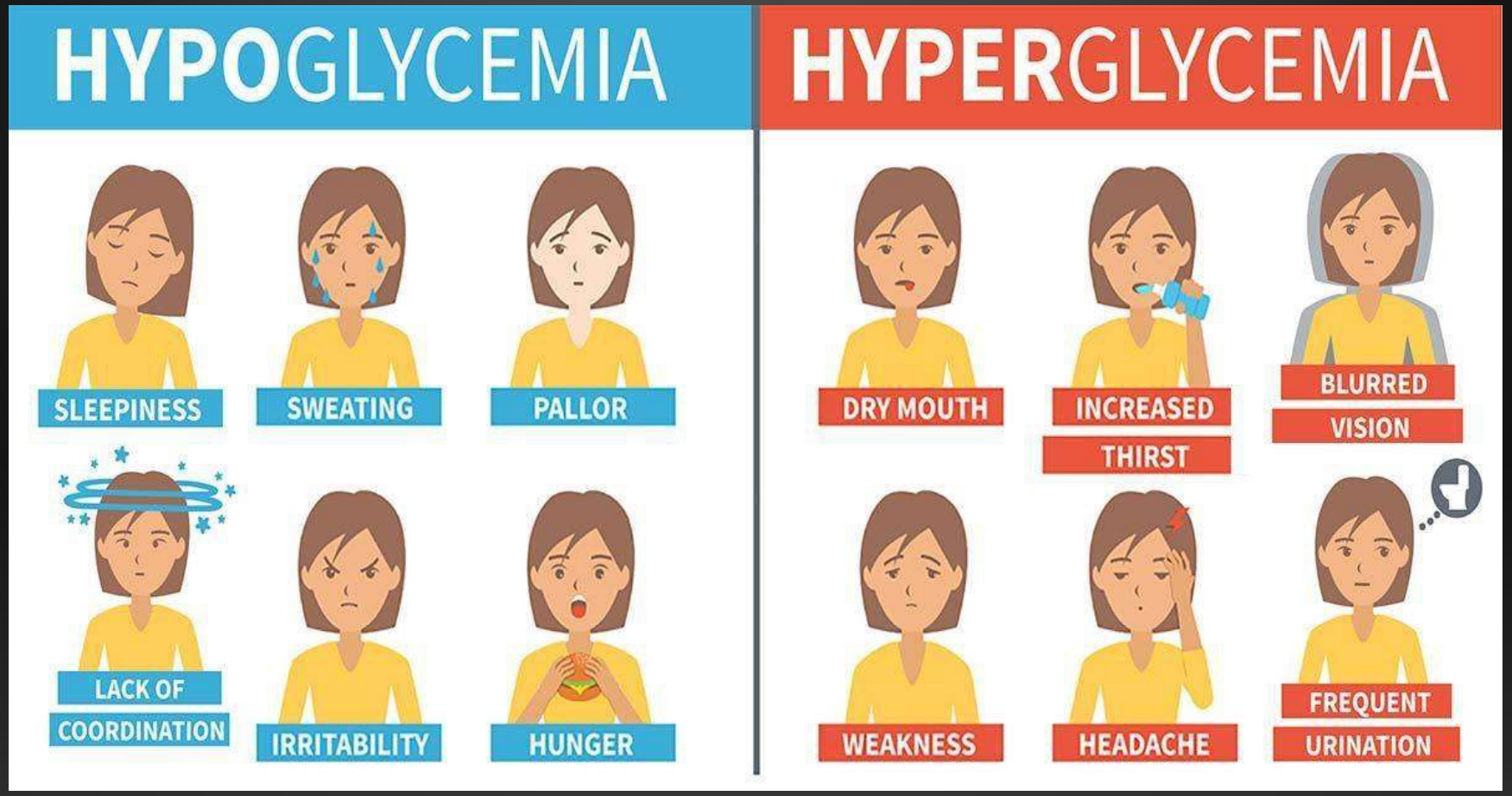


- Annual examinations and screenings for:
  - Retinopathy
  - Nephropathy
  - Neuropathy
  - Foot examination to check sensory and reflexes.

- Exercise limitations or restrictions for athletes with diabetes-related complications should be determined by the athlete's physician

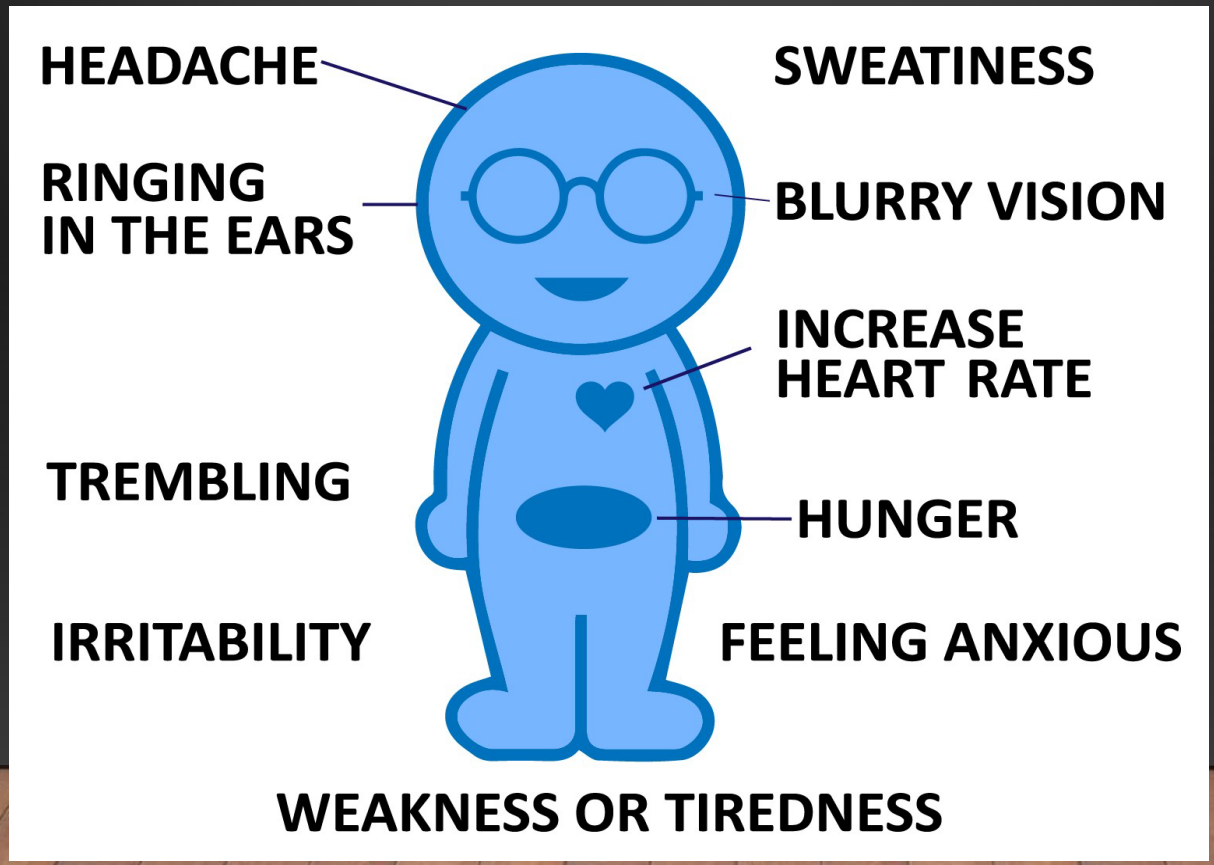
BLOOD GLUCOSE MONITORING

- Frequent testing of blood sugar
- <110mg/dL before meals
- <140mg/dL after meals
- Hemoglobin A1C test every 3-4 months
- Continue to monitor:
  - Blood pressure
  - Cholesterol
  - Vision
  - Skin


HYPOGLYCEMIA
SLEEPINESS
SWEATING
PALLOR
LACK OF COORDINATION
IRRITABILITY
HUNGER
HYPERGLYCEMIA
DRY MOUTH
INCREASED THIRST
BLURRED VISION
WEAKNESS
HEADACHE
FREQUENT URINATION

HYPOGLYCEMIA

- A low BG is classified as any number 70 mg/dl and below



HYPOGLYCEMIA

- Causes insulin therapy & exercise (#1)
- Signs and symptoms occur when blood glucose levels fall below 70 mg/dL but can be different pending the size and makeup of your athlete.

RECOGNITION, TREATMENT, AND PREVENTION OF HYPOGLYCEMIA

PREVENT IT!!!

- Blood glucose monitoring
  - Before exercise 2-3 times
  - During exercise every 30 min(minimum)
  - After exercise every 2hours x 2

- Carbohydrate supplementation: Rule of 15

RECOGNITION, TREATMENT, AND PREVENTION OF HYPOGLYCEMIA

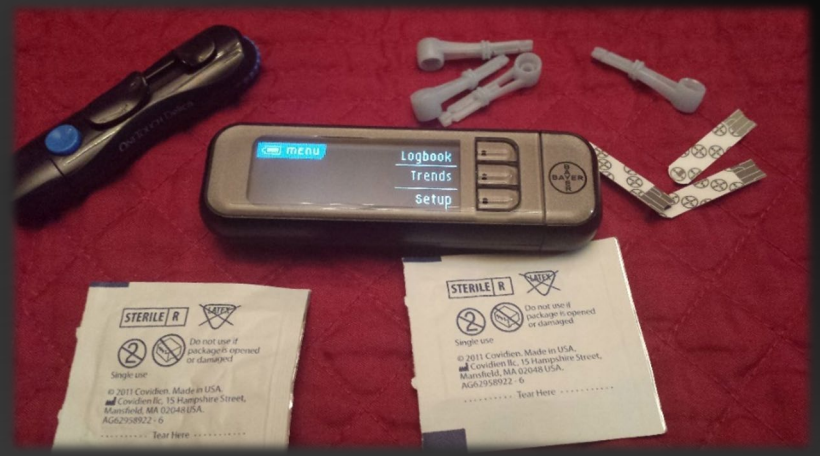
- Insulin adjustments (consult a physician)
- Mild Hypoglycemia - if the athlete is conscious and able to swallow and follow directions
- Severe Hypoglycemia - if the athletes is unable to swallow, follow directions, eat as directed or is unconscious
  - Treatment requires a requires emergency glucagon

WHY WOULD AN ATHLETE GET HYPERGLYCEMIC?

1. It can occur with high intensity exercise
2. A decrease in insulin combined with an increase of hepatic glucose production (gluconeogenesis) during high intensity exercise
3. ↑ psychological stress =

   ↑ in counter regulatory hormones =

   ↑ blood glucose



HYPERGLYCEMIA: HOW DOES IT EFFECT PERFORMANCE?

Competing in a hyperglycemic state:

1. ↑Risk of dehydration
2. ↓Performance
3. ↑Ketosis
4. Does NOT ↓ Risk of Hypoglycemia

RECOGNITION, TREATMENT, AND PREVENTION OF HYPERGLYCEMIA

- Should avoid exercise during periods of hyperglycemia w/ ketones
- Should consult with their physician
- Athletes should drink non-carbohydrate fluids
- Athletes should test for ketones when:
  - Consecutive reading over 250

HYPERGLYCEMIA TREATMENT

The treatment plan focuses on a self-care plan predicated on:

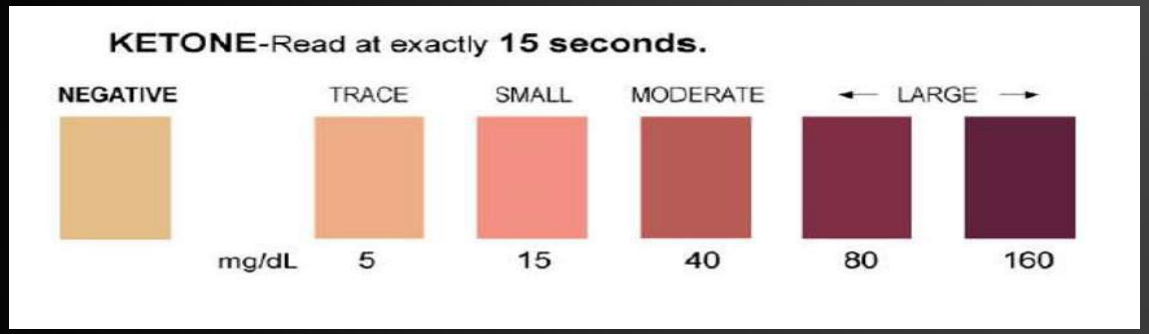
- ✓Monitoring of blood glucose
- ✓Drinking of noncarbohydrate fluids when blood glucose levels exceed renal glucose threshold
- ✓ Consultation with physician to evaluate the athlete's basal rate if hyperglycemia continues to occur during short-term, intense and stressful periods of exercise

HYPERGLYCEMIA - GUIDELINES

Ketones occur: When there is not enough insulin to match the body's energy needs and the body starts metabolizing fat for energy instead of glucose. Most common cause of ketones: MISSED INSULIN.

Blood Glucose Levels	Action
≥ 250 mg/dl x 2	Check urine of blood for ketones Ketone = no exercise No ketones = exercise w/ caution
≥ 300 mg/dl	Check for Ketones Exercise in regardless of presence of ketones

KETONE TREATMENT



TRACE OR SMALL

- Give 8-16 oz of water per hour
- Give insulin as ordered
- Recheck ketones every 2-3 hours
- Safe to return to class

- MODERATE OR LARGE
- Give 8-16 oz of water per hour (sip if nauseous)
- Call family (patient needs be sent home with adult supervision)
- Call clinic if unable to reach family
- Extra insulin is required (See HCP)
- Patient should rest and not participate in physical activities

INSULIN

BASAL OR LOG LASTING INSULIN

- Background insulin that keeps blood glucose levels stable throughout th day, night and between meals:
- Examples: Lantus, Basaglar, Levemir, Semglee, or Glargine.

BOLUS OR RAPID ACTING INSULIN

- Insulin used to correct elevated glucose levels and cover carbohydrate consumption. Examples: Novolog or Humalog.

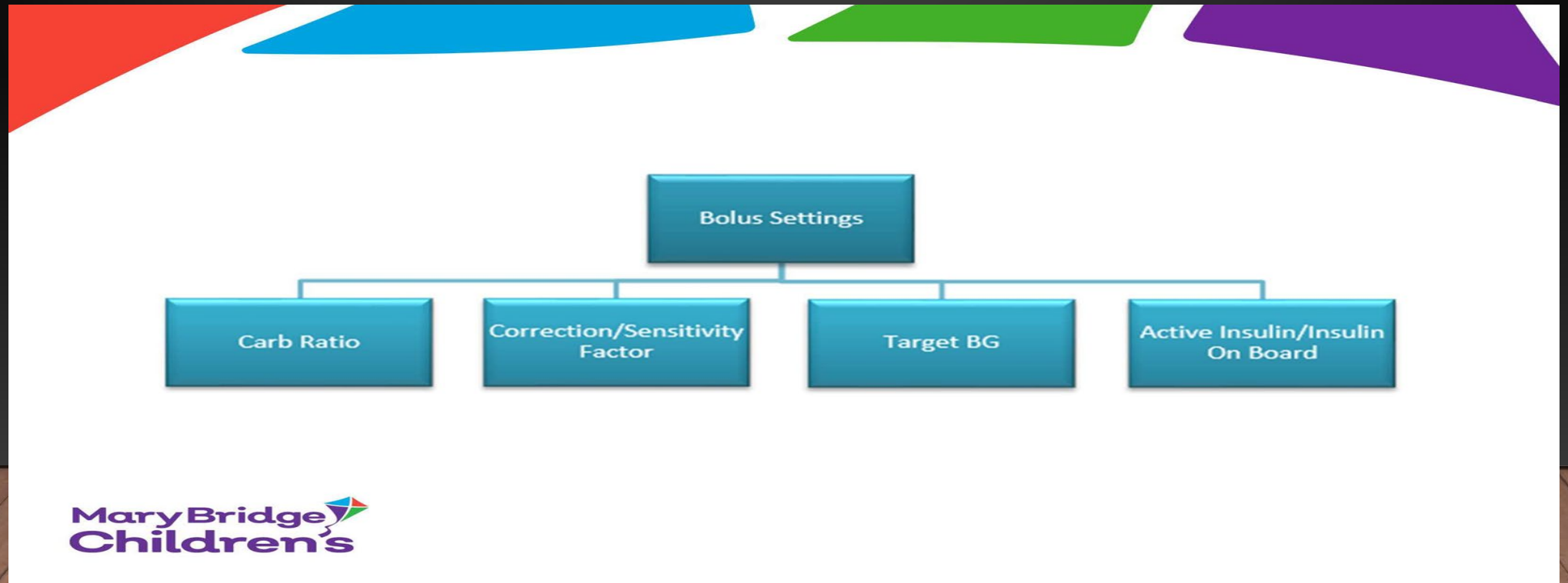
HYPERGLYCEMIA TREATMENT
INSULIN ADMINISTRATION

THE PUMP

INJECTIONS

BOLUS

- **Carbohydrate Ratio:** How many grams of carbohydrates per 1 unit of insulin
- **Sensitivity Factor:** How much 1 unit of insulin will lower blood sugar
- **Target BG:** Used in calculation as a goal for where blood sugar should be
- **Active Insulin or Insulin on Board:** How much insulin is still working in the body
- PUMPS ARE SMART: they will use all of these settings and calculate the dose for you. If they are using a sensor, it will take the CGM data into consideration as well as the insulin on board.



TIME TO BOLUS FOR LUNCH

STEP ONE

BOLUSING

Go to pump
options push
Bolus
enter carbs and
blood sugar

STEP TWO

IOB- INSULIN ON BOARD

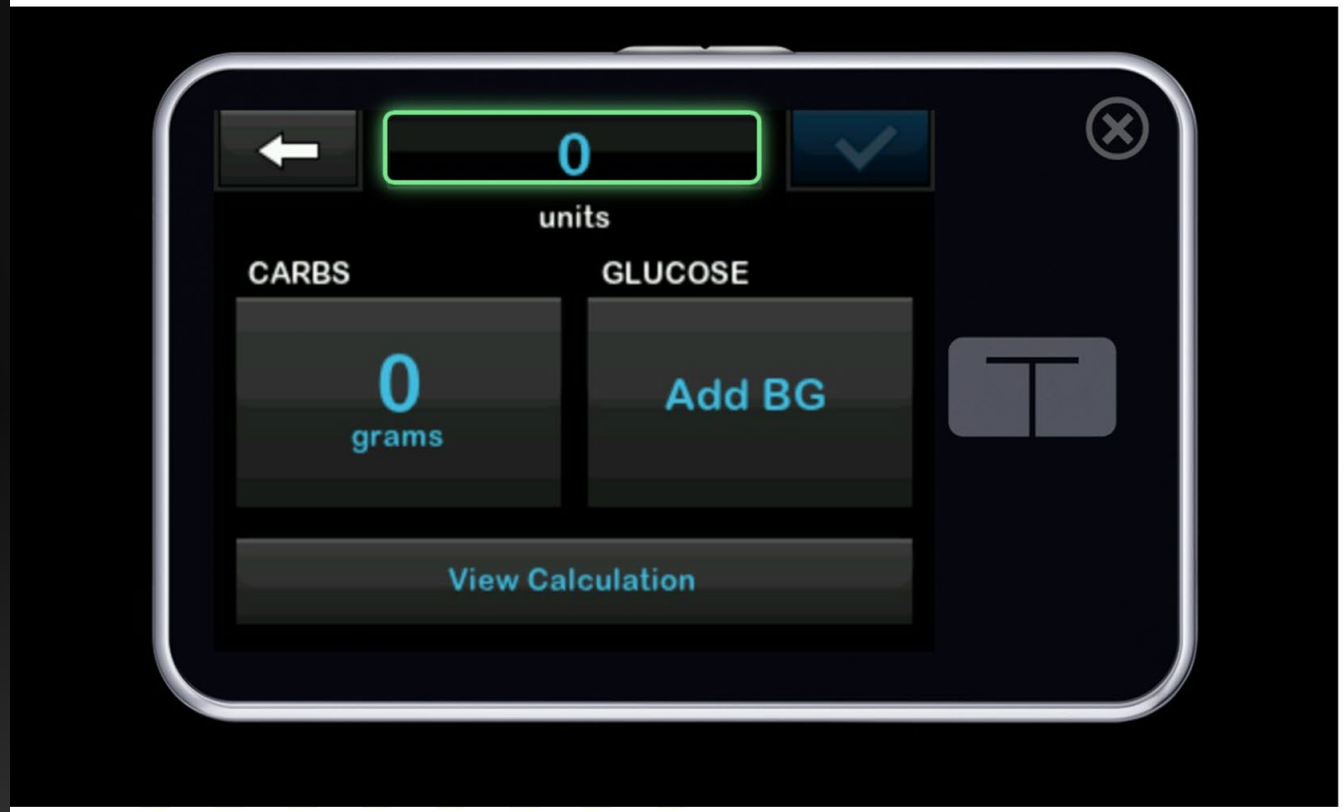
All of the pumps
keep track of IOB
(active insulin) and
will calculate dose
using that
information (to avoid
stacking insulin)

STEP THREE

COMPLETE BOLUS

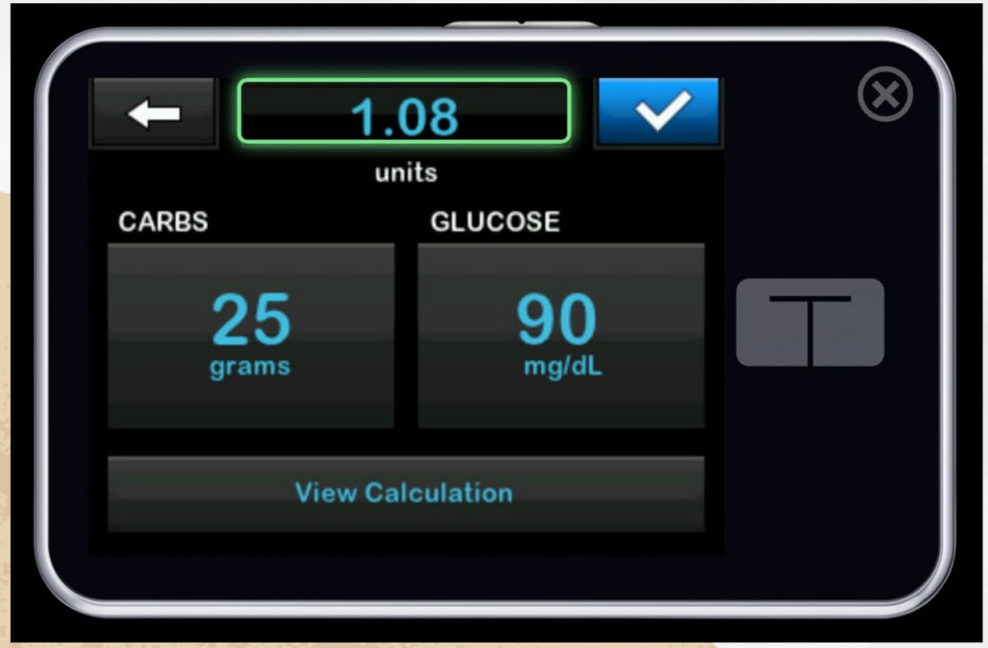
Before you complete
the bolus, you will be
given the breakdown
of CHO coverage
and correction
coverage. This
should be verified
before bolus is

2.



Enter carbs
If student is using CGM, the blood sugar should automatically carry over into the bolus screen.
If it doesn't, enter BG there.
Hit view calculation....

3.



The pump has calculated the insulin dose using ICR, blood sugar target, IOB, and sensitivity.

Recommended dose is 1.08 units.

Enter

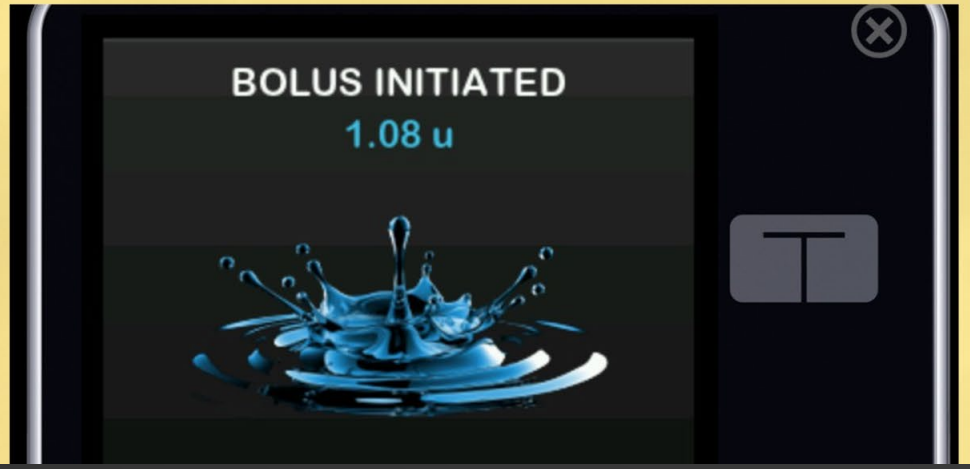
4

Confirm Request

This is a great time to double check that the blood sugar and carbs have been entered correctly. We have found patients entering 200 carbs vs 20 carbs.

When confirmed, enter

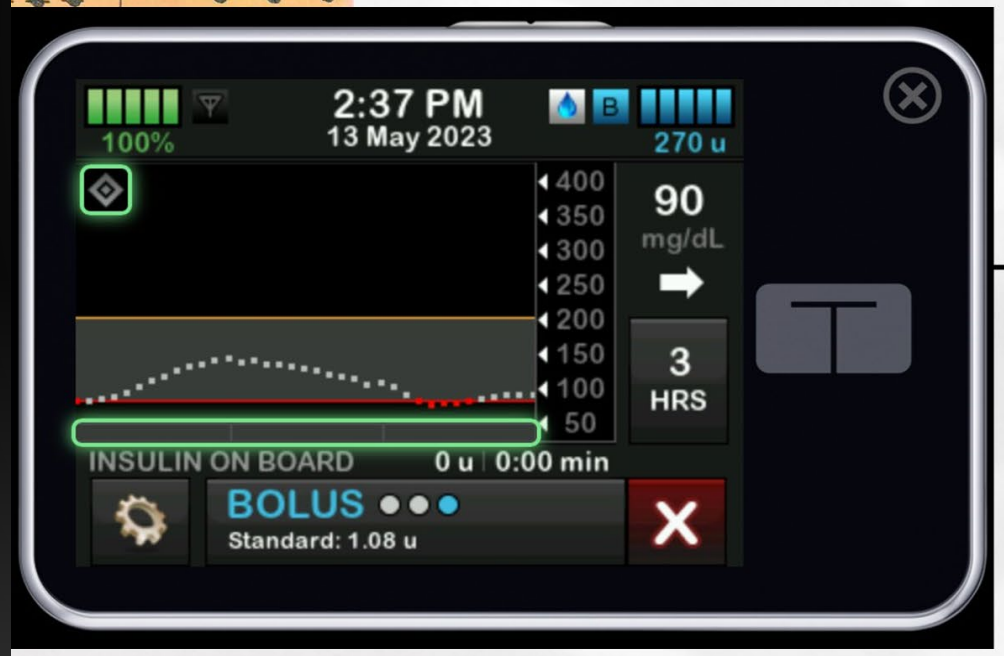
Bolus Initiated



Before bolus is initiated, it will provide the calculation and an option to use the extended bolus. The extended bolus is often used when a patient is eating a high fat meal (pizza/pasta) or during holidays like Thanksgiving or Christmas when there is a lot of grazing. This will deliver the recommended bolus over a period of time.

To initiate bolus, enter ✓

Bolus Complete!



<--- Insulin is being delivered

If you notice an error, hit X to stop bolus.

IOB

Once delivered, it will show 1.08 units on board.

BASAL RATES

Constant infusion of rapid acting insulins

- Basal rate settings replace the long acting insulin that was needed before starting pump therapy.
- There can be different rates at different times of the day (acts more like a pancreas)
- Provides more flexibility for the person with diabetes
- Pumps that are integrated with sensors will adjust the basal rates

based on trending sensor

TYPES OF INSULIN

Insulin	Action	How to Use	Length
Humalog	Rapid	Bolus (Inj)	Minutes
Novalog	Rapid	Bolus (Inj)	Minutes
Humilin	Fast	Bolus (Inj)	2-4 hours
Novolin	Fast	Basal / Bolus (P)	2-4 hours
Humulin N	Intermediate	Basal Dose INJ	4-10 hours
Novolin N	Intermediate	Basal Dose INJ	4-10 hours
Lantus	Long	Basal	24 hours
Levimar	Long	Basal	24 hours

INSULIN: DOSING

- **Corrections:** The estimate of how much insulin it will take to get to the target blood sugar.

- **Insulin Sensitivity Factor (ISF):** Identifies how sensitive a patient is to 1 unit of insulin. (Example: If the ISF is 50 that means 1 unit of insulin will drop the blood sugar 50 points)

- This can be expressed in either a correction scale or correction equation
- **NOTE: The targets and ISF will vary from patient to patient**

INSULIN DOSING

Correction Scale:

- Target 100 Correction (insulin Sensitivity factor) 50
- BG 150-200: 1 unit of insulin
- BG 201-250: 2 units of insulin
- BG 251-300: 3 units of insulin
- BG 301-350: 4 units of insulin
- BG 351-400: 5 units of insulin
- BG >401: 6 units of insulin

Correction Equation

- Target 100 Correction Insulin Sensitivity Factor: 50
- Current BG – Target 100/ISF/50
- Example 350-100/50= 5 units

INSULIN: DOSING

- **Insulin Carb Ratio (ICR):** How many carbs are covered by 1 unit of insulin

- This is based on the child's insulin sensitivity, size, and may vary from meal to meal (most children are more insulin resistant in the morning)

- Example: 1 unit of insulin for every 15 grams of carbs (1:15)

INSULIN: PUTTING IT TOGETHER

- Poppy presents to the school nurse with a blood glucose of 231 mg/dl. Poppy's mother packed her a ham sandwich with 2 slices of bread (40 gram), a medium apple (30 grams), and a granola bar (15 grams). Poppy always eats her full lunch and always gets her insulin before she eats.

- **Her insulin orders are: Inslin Bolus Rate**

: 1:10

- **ISF: 1:50**
- **Target: 100**

- Poppy will get 8.5 units of rapid acting insulin for her carbs and 2.5 units for her blood sugar to equal a **total of 11 units of insulin**

INSULIN: STACKING

- Rapid acting insulin is active in the body for about 3 hours. Therefore, insulin to correct blood glucose should NOT be given sooner than 3 hours from the last insulin dose.

- However, insulin for carbohydrates can be safely given at anytime and is not considered stacking.

- Example: If a student had lunch an hour ago and they are now celebrating a classmates birthday and sharing cupcakes, you cannot check a blood sugar because it will not be accurate...you will just count and cover the carbohydrates using their ICR.

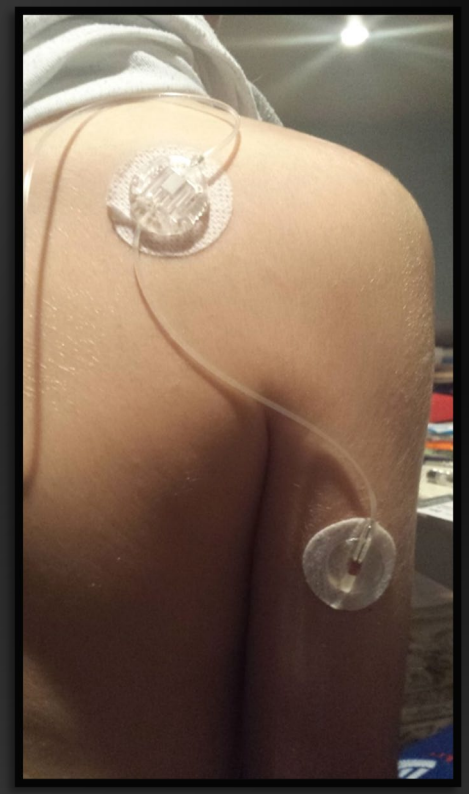
INJECTION SITES

- Should be administered into subcutaneous tissue.
- Avoid intramuscular injections.
- Avoid heat or cold for 1-3 hours after injection of rapid acting insulin
- Avoid heat or cold for up to 4 hours after fast acting insulin

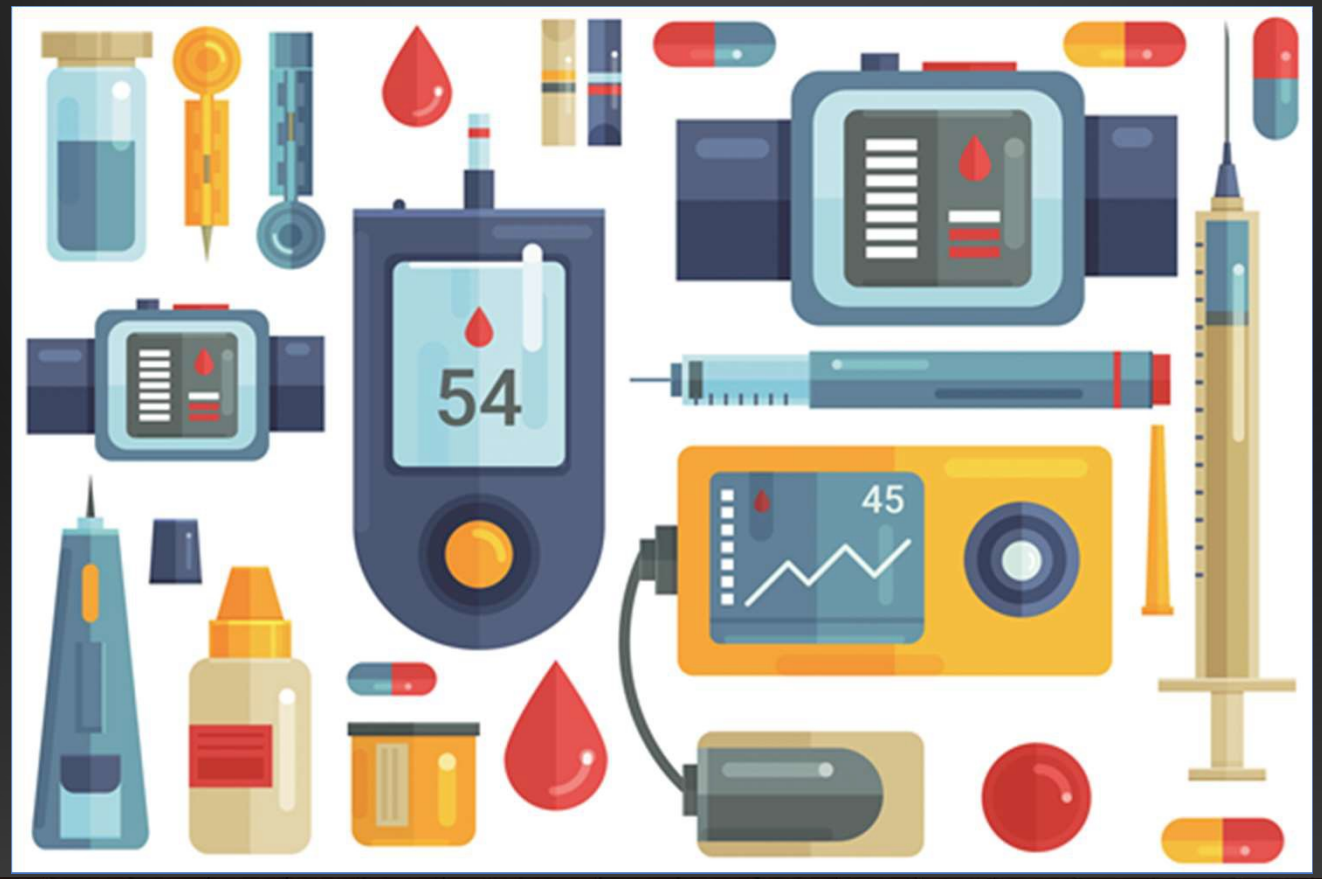
INJECTION SITES

NOTE WHEN USING A PUMP INJECTION SITES SHOULD BE REPLACED EVERY 2 TO 3 DAYS TO REDUCE SKIN AND INFUSION SITE IRRITATION

- Abdomen
- Buttock
- Outer Thigh
- Upper Arm



DIABETES TECHNOLOGY

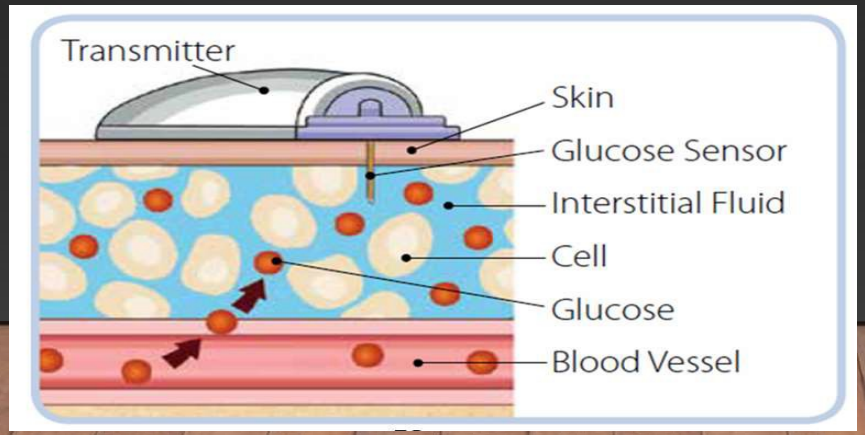


CONTINUOUS GLUCOSE MONITOR (CGM)

- BG meters measure glucose in your BLOOD and a sensor measures glucose levels in the INTERSTITIAL FLUID in the subcutaneous tissue

- NOW we are talking about sensor glucose (SG) instead of Blood Glucose (BG)

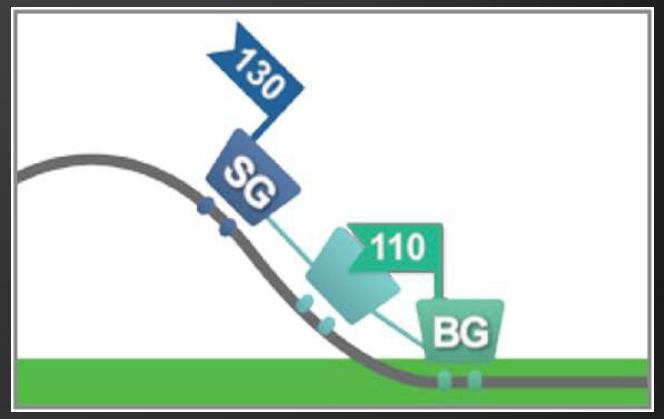
- CGMs have downloadable data that allows families and clinics to review **time in range**



SENSOR GLUCOSE VS. BLOOD GLUCOSE

- Blood Glucose tends to be ahead of the Sensor Glucose
- BG and SG reading will be similar when glucose is stable

- When glucose is rising, BG will be higher than SG



- When glucose is falling, BG will be lower than SG

The difference between SG and BG will tend to be greater after meals or taking insulin, during and after exercise, and when arrows are on pump screen.

THE CGM

- **COMPONENTS**
- **Sensors** - measure the glucose levels under the skin

Transmitters - secured to sensor and sends glucose wirelessly to a receiver (Dexcom G7/Freestyle Libre have sensor & transmitter in 1 piece)

- **Receiver/Pump/Phone or Smart Device** –displays sensor glucose every 3-5 minutes.

Mary Bridge Children's
MultiCare

CGM TYPES

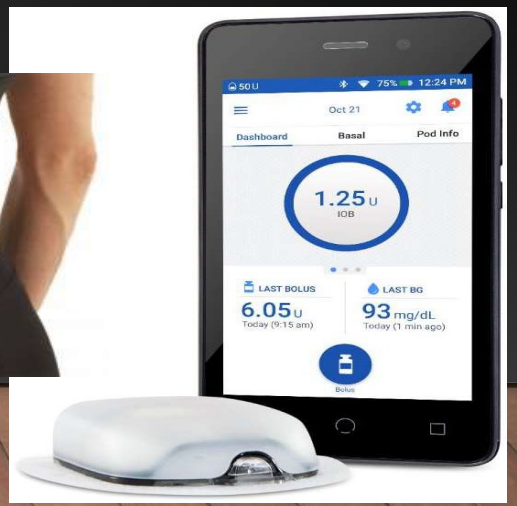
CONTINUOUS GLUCOSE MONITORS

- Can be stand-alone device (no pump) transmits data to Apple Products, Android smart phones, receiver
- Has sharing capability if student uses a smart device.
- No calibration needed for Dexcom, Freestyle Libre, or Guardian 4.
- Dexcom G6: Integrates with both Tslim X2 and Omnipod 5 pumps.
- New Medtronic 780 pump integrates with Guardian 4 sensor.
- Freestyle Libre 2 and 3 is currently a stand-alone sensor.

PUMP COMPONENTS

OMNIPOD 5 WITH DEXCOM G6

- Recently integrated with Dexcom G6 for hybrid closed loop automation.
- Dexcom sensor gets changed every 10 days.. Transmitter
- changed every 90 days
- Will increase and decrease insulin based on sensor data
- Pod is the only tubeless pump we have currently
- Uses requires compatible smart device to connect Dexcom to Pump.
- Pods are changed every 2-3 days



TANDEM T-SLIM X2

- Interacts with Dexcom G6 (CGM data appears on the pump)
- Control IQ: The Dexcom and T-Slim X2 predict high and low blood glucose. It will decrease insulin or suspend insulin delivery to avoid hypoglycemia if the sensor is predicting low. The pump will also deliver micro boluses and/or increase basal rates when blood glucose is predicted to rise and when running high.
- Smallest available pump
- Rechargeable battery
- It is not uncommon for a student to have the Dexcom data on a pump and phone/smart device so that the parents can follow the sensor data.

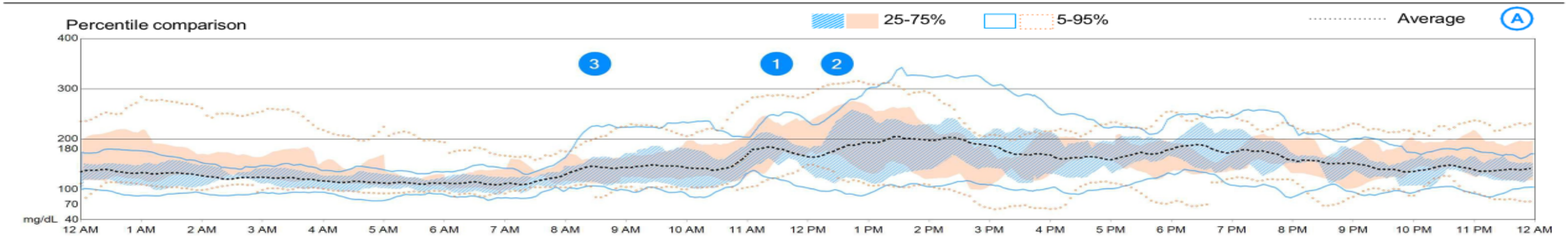
MEDTRONIC

- 630G and 670G (older models, using guardian sensor 3 that requires calibration and also has automode option)
- New: 780 model uses Guardian 4 sensor and is also hybrid closed loop pump (automode)
- This pump will also suspend insulin if low glucose is predicted and auto bolus if blood glucose is rising.
- **Extended wear infusion sets 7 days**!! All other pumps are 2-3 day infusion set changes.

MEDTRONIC – AUTO MODE

- If there is a blue shield the pump is in Auto Mode
- Auto Mode adjust basal rates based on Guardian CGM data
- In Auto Mode the pump user will need to respond to alerts in order to stay in Auto Mode
- If alerts are not addressed in a timely manner or if the glucose level is above or below target for too long, the pump will exit Auto Mode
- IT'S OKAY if the patient exits auto mode. The pump will return to manual mode settings prescribed by the doctor.
- It is the clinic's responsibility to make sure the manual mode settings are appropriate for the student
- The pump will list what is needed to reenter Auto Mode

Percentile comparison



Carb Ratio (g/U)	12 AM	5 AM	11 AM	3 PM	9 PM
Ⓐ	8.0	5.0	3.3	3.6	3.6
Ⓑ	8.0	5.0	3.3	3.6	3.6

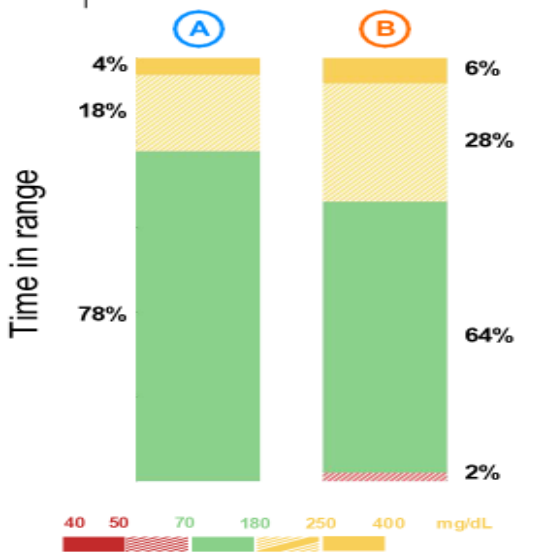
Ⓐ

Hypoglycemic patterns (0) — # Episodes (per day): 0

None

Hyperglycemic patterns (5)² — # Episodes (per day): 1.4

1. 11:00 AM - 11:59 AM (4 occurrences)
2. 12:00 PM - 12:59 PM (3 occurrences)
3. 8:00 AM - 8:59 AM (2 occurrences)



2 Only highest priority shown.
3 Glucose Management Indicator
4 24hr total according to active basal pattern setting for manual mode

SmartGuard Exits

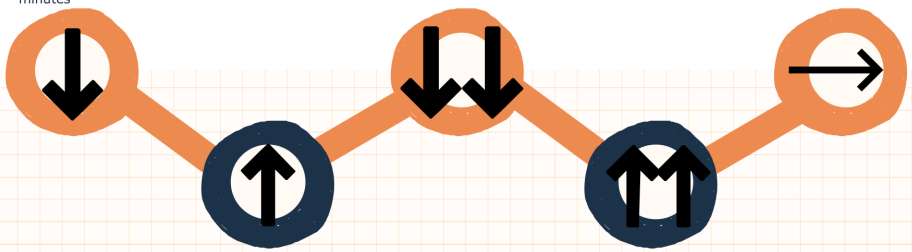
	Ⓐ	Ⓑ
No Calibration	0	0
SmartGuard max delivery	0	0
SmartGuard min delivery	0	0
BG required for SmartGuard	0	0
Sensor Algorithm Underread	0	0
Sensor Updating	1	1
No SG values	0	0
Sensor Expired	1	1
SmartGuard disabled by user	0	0
Prolonged Suspend	0	0
SmartGuard Warm Up	0	0
Unidentified	0	0

Statistics

	Ⓐ	Ⓑ
SmartGuard (per week)	72% (5d 01h)	75% (5d 07h)
Manual Mode (per week)	22% (1d 13h)	25% (1d 17h)
Sensor Wear (per week)	70% (4d 21h)	72% (5d 01h)
Average SG ± SD	150 ± 51 mg/dL	162 ± 54 mg/dL
GMI³	--	7.2%
Coefficient of Variation (%)	34.3%	33.5%
Low / High SG Alerts (per day)	1.2 / 2.1	3.2 / 3.6
Average BG	127 ± 64 mg/dL	184 ± 68 mg/dL
BG / Calibration (per day)	0.1 / 0.1	0.3 / 0.2
Total daily dose (per day)	59.8 units	77.5 units
Bolus amount (per day)	26.1U (44%)	43.2U (56%)
Auto Correction amount (per day)	11.8U (45%)	18.3U (42%)
Auto Basal / Basal amount (per day)	33.7U (56%)	34.3U (44%)
Set / Reservoir Change	4.5 / 0.8 days	9.0 / 1.8 days
Carbs entered / Meal (per day)	51 ± 33 g / 3.9	95 ± 45 g / 6.4
Active Insulin time	2:00 hrs	2:00 hrs
24 hr Manual Basal (% TDD)⁴	48.000U (80%)	48.000U (62%)

What do the arrows mean?

Arrows are giving you the direction and speed in which the glucose is trending.



Arrow Down

Blood sugar may drop 60 points in the next 30 minutes

Arrow Up

Blood sugar may rise 60 points in the next 30 minutes

Double arrow down

Blood sugar may drop 90 points in the next 30 minutes

Double arrow up

Blood sugar may rise 90 points in the next 30 minutes

Straight arrow

Blood sugar is steady, no anticipated drop or rise

Arrows continued:

Side arrow down

Blood sugar may drop 30 points in the next 30 minutes

Side arrow up

Blood sugar may rise 30 points in the next 30 minutes

We can go over questions on trends in just a few minutes.

WHAT CAUSES FAST RISE/FALL?

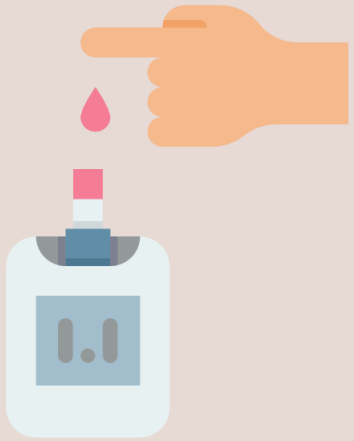
FAST RISE

THIS IS NORMAL AFTER THE START OF A MEAL OR SNACK. THE BLOOD SUGAR IS RISING AS SOON AS THEY START EATING. THE INSULIN TAKES 1.5 HOURS TO START WORKING. EXAMPLE: IF STUDENT ARRIVES TO SCHOOL WITH A HIGH BLOOD SUGAR, THIS IS LIKELY DUE TO BREAKFAST. I WOULD RECOMMEND ASKING STUDENT WHEN THEY ATE AND WHEN THEY RECEIVED INSULIN. THEY CAN NOT CORRECT BLOOD SUGAR ANY SOONER THAN 3 HOURS SINCE LAST INSULIN DOSE WAS ADMINISTERED. IF BLOOD SUGAR IS STILL HIGH AT THE 3 HOUR MARK AND THEY HAVEN'T EATEN ANYTHING IN THAT TIME, CORRECTION CAN BE GIVEN.

FAST DROP

THIS TYPICALLY HAPPENS WHEN THE INSULIN IS PEAKING (1.5 TO 2 HOURS). THIS CAN ALSO HAPPEN DURING PHYSICAL ACTIVITY. THE ARROW OR DOUBLE ARROW DOWN DOES NOT ALWAYS REQUIRE INTERVENTION BUT IF THEY ARE DROPPING AND LOW BLOOD SUGAR IS PREDICTED, FOLLOW HYPOGLYCEMIA ORDERS. PARENTS MAY ALSO CALL TO ASK THAT YOU ASSESS. IF THEY ARE INDEPENDENT, THE PARENTS SHOULD CONTACT STUDENT DIRECTLY AND IF THEY ARE UNABLE TO REACH THEM, YOU SHOULD ENGAGE AND ASSESS SITUATION.

WHEN IN DOUBT, GET THE METER OUT



SYMPTOMATIC → If the sensor says glucose is normal but student has symptoms of either high or low blood sugar

NO DATA → If the sensor is not working, no data is available

UNEXPLAINED → If the blood sugar is unexplained HIGH or LOW and not symptomatic

DELAYED DATA → The sensor is reading changes in ISF and not in blood. This means the sensor data will be delayed compared to the finger stick.

DIABETIC CARE PLAN

- Athletes with diabetes should have a medic alert tag

NEEDS

- A copy of the diabetes care plan
- Blood glucose monitoring equipment and supplies
- Supplies to treat hypoglycemia (glucose products / sugary food/drinks)
- Supplies for urine or blood ketone testing
- A "sharps" container for syringes and lancets
- Spare batteries /Spare infusion sets and reservoirs for insulin pumps

Thank You!