MANAGING DIABETES IN THE PHYSICALLY ACTIVE POPULATION

DISCLOSURE

- No disclosure or conflicts to report

COURSE AUTHOR

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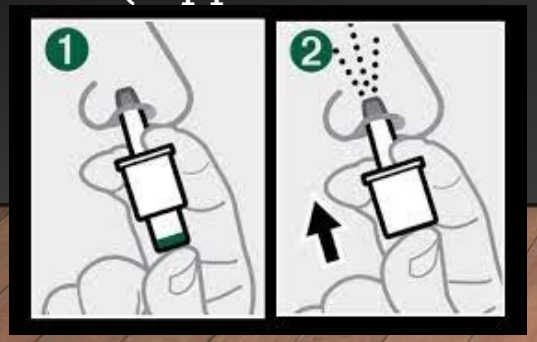
THE DIABETIC ATHLETE

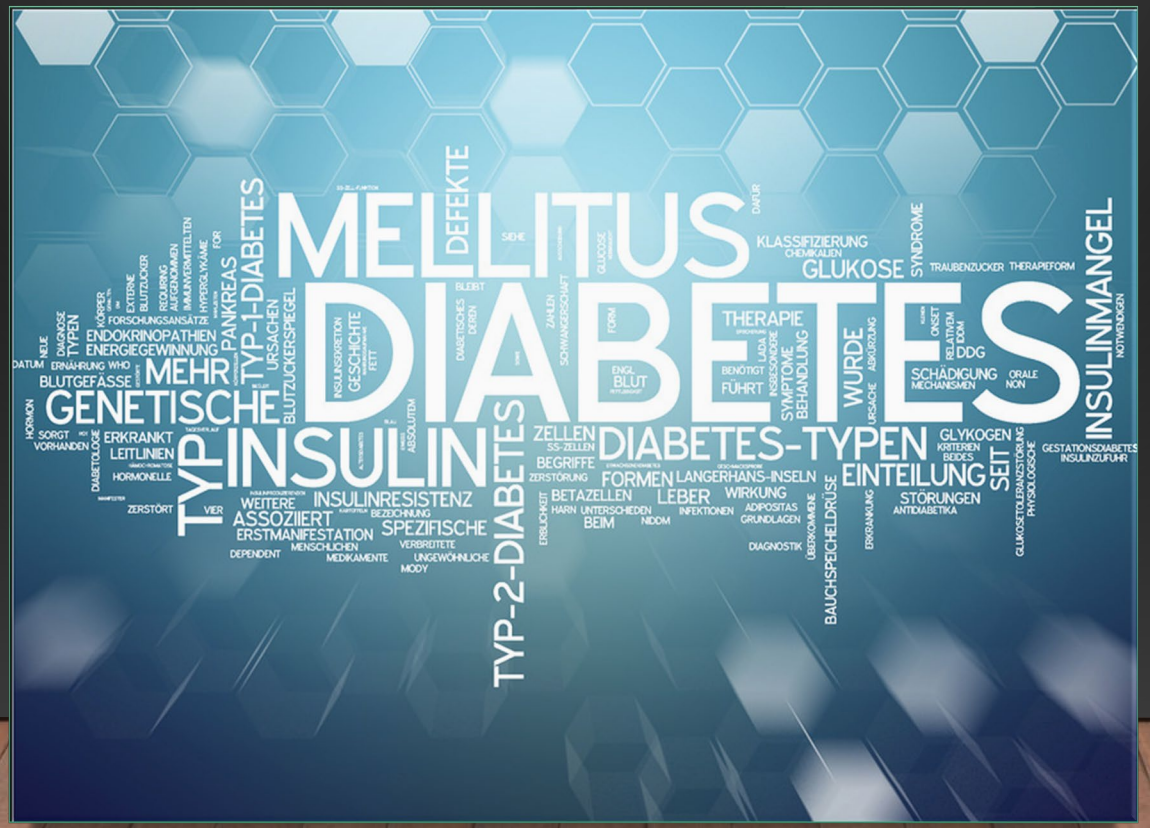
COURSE OBJECTIVES

- 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



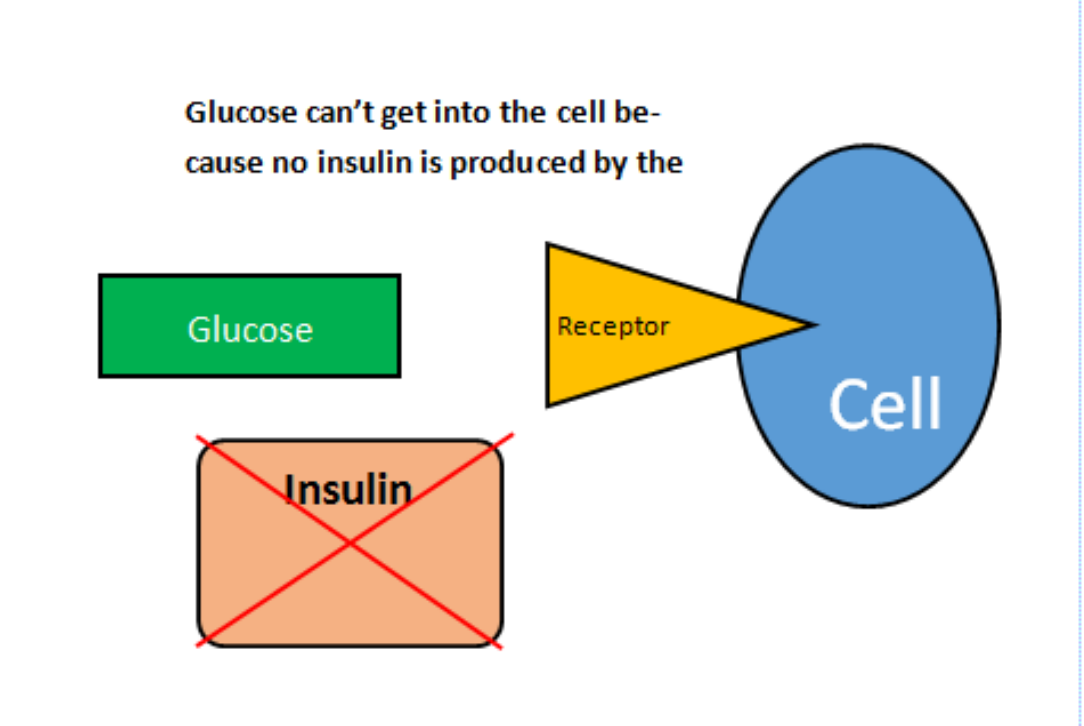
DIABETES – WHAT IS IT?

- 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

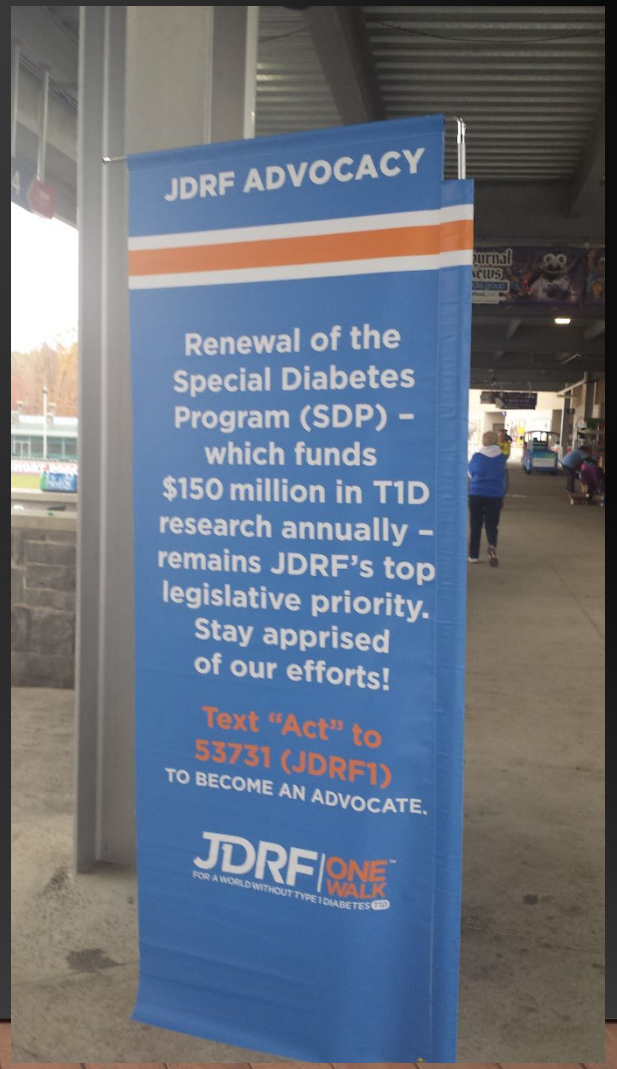
In diabetes, the pancreas does not make enough insulin (Type 1 Diabetes)



TYPE 1 DIABETES

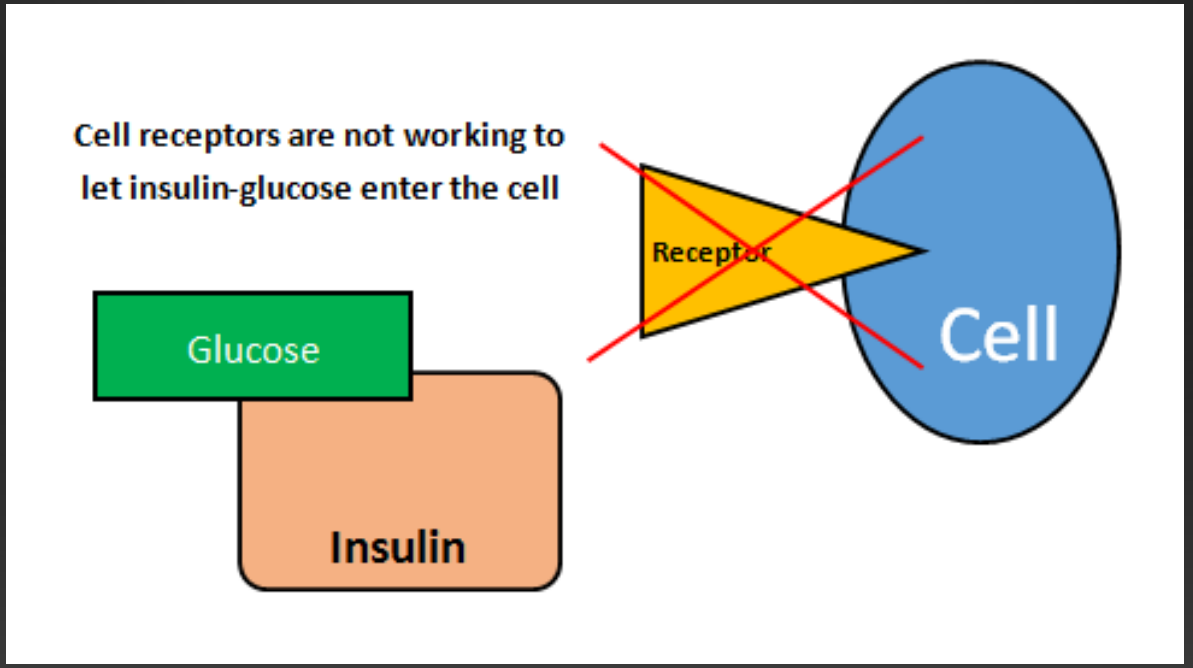
Mean age 8-12

- 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)

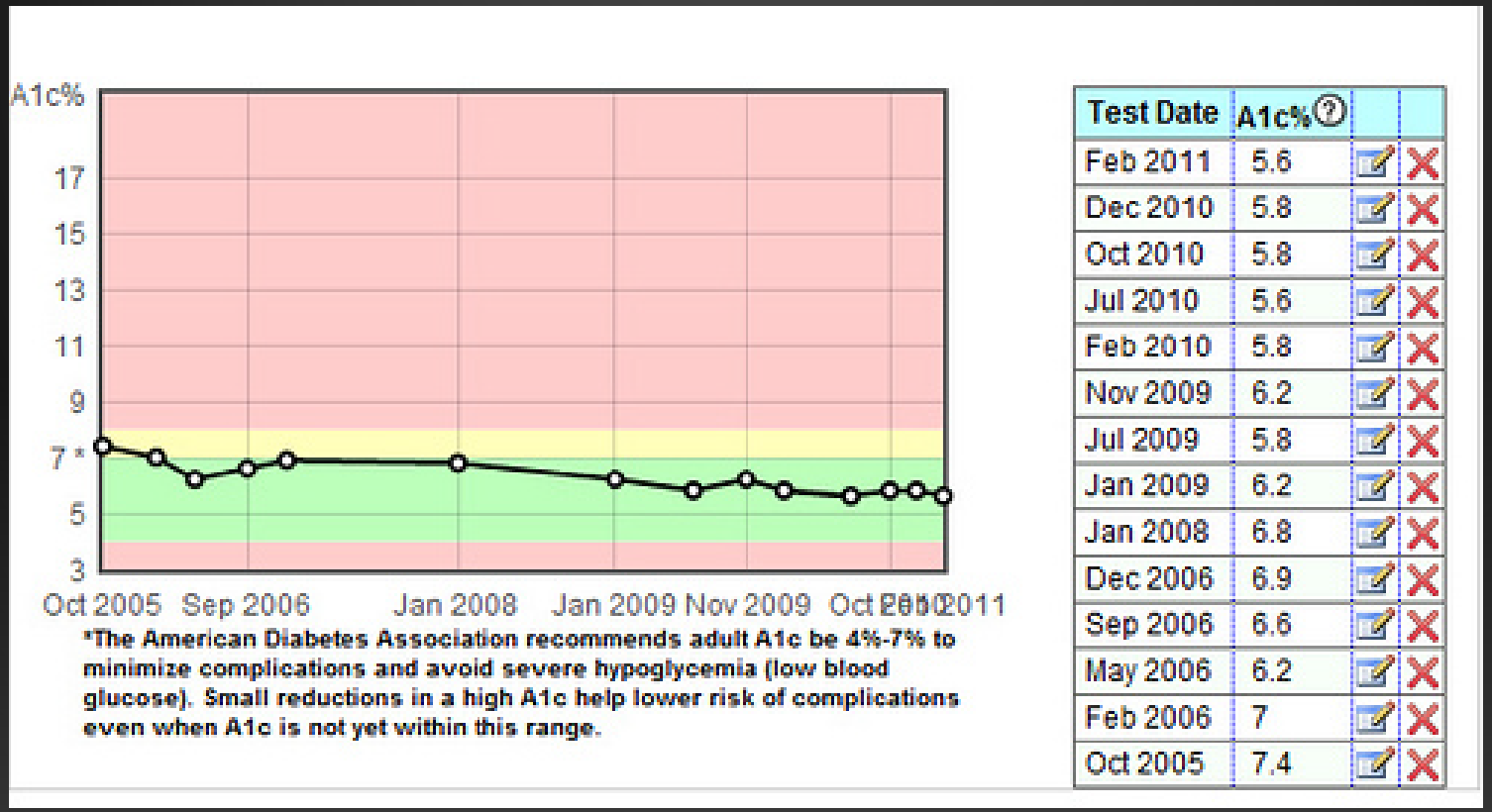


DIABETES COMPARISON

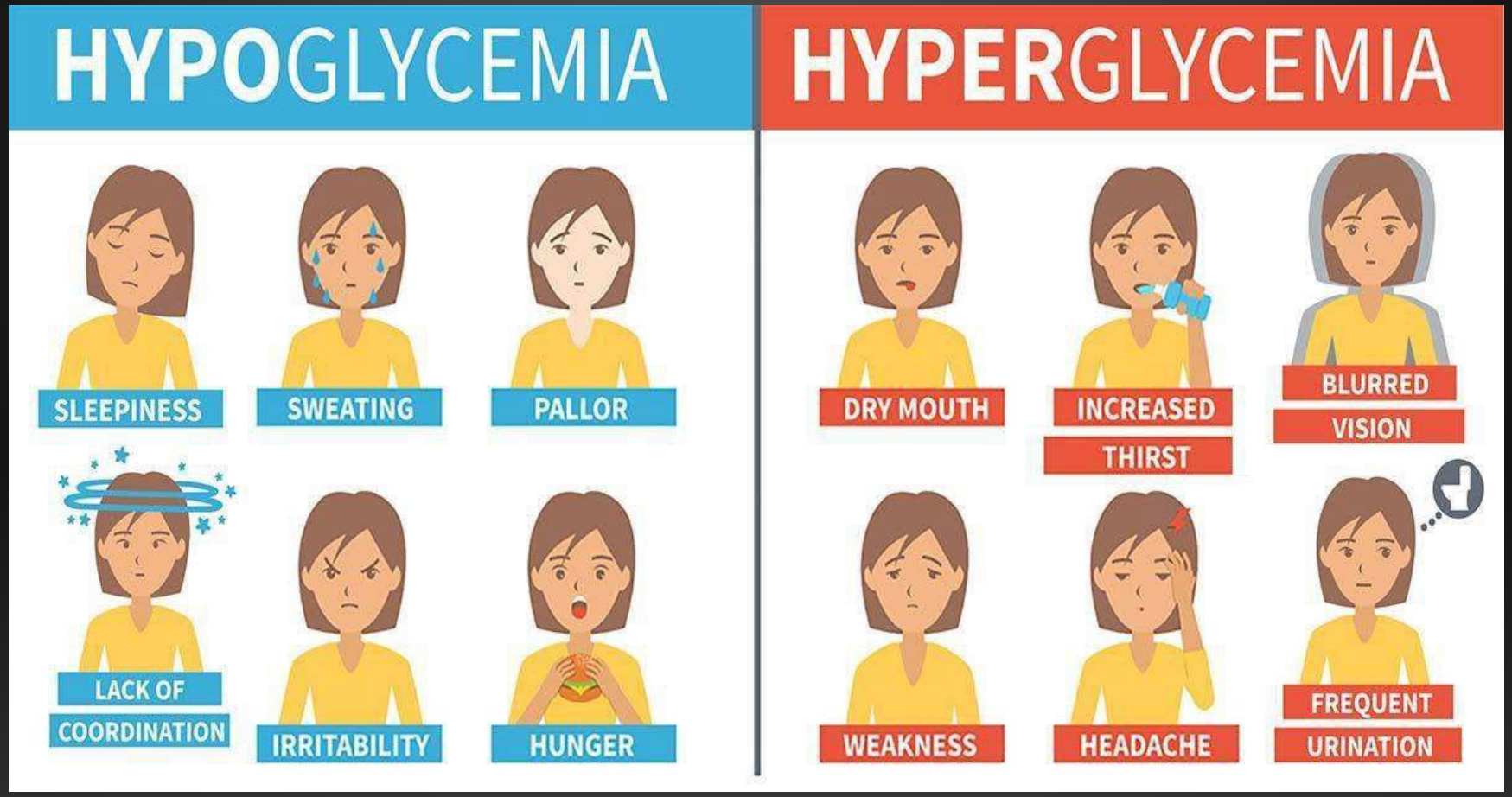
	Type 1	Type 2
Diagnosis	Typically diagnosed in early childhood , adolescence or early adulthood. **5-10% of cases**	Usually diagnosed in adulthood but this is changing. **90-95% of cases**
Mechanism	Insulin Deficiency	Decreased Insulin utilization
Complications	Hyperglycemia, weight loss, DKA	Obesity, 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


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

RECOGNITION, TREATMENT, AND PREVENTION OF HYPOGLYCEMIA

PREVENT IT!!!

- Blood glucose monitoring
  - Before exercise
  - During exercise every 30 min(minimum)
  - After exercise every 2 hours x 2
  - SENSOR CGM – is a game changer

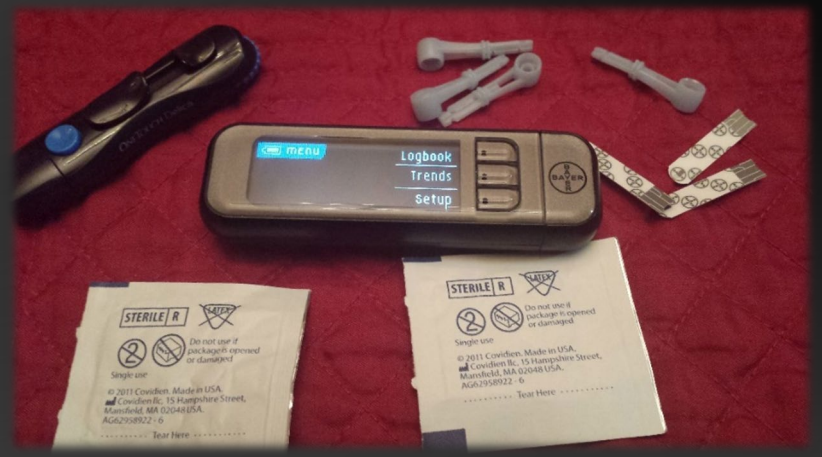
- Carbohydrate supplementation: Rule of 15

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

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.

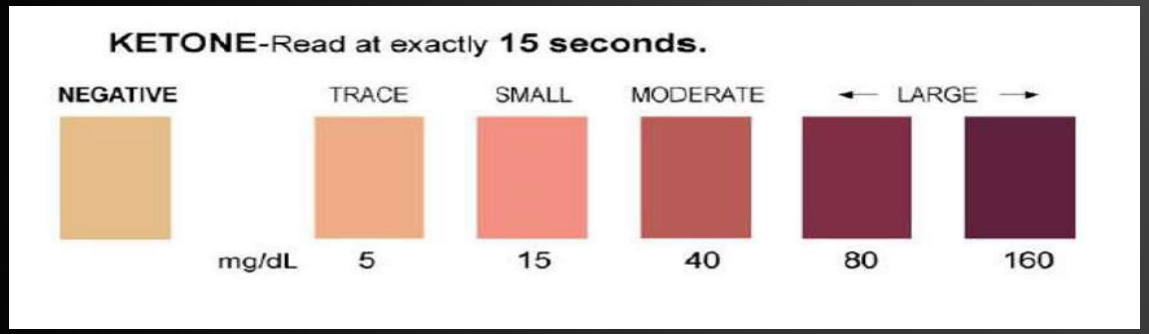
Blood Glucose Levels	Action
≥ 250 mg/dl x 2	Check urine of blood for ketones Ketone = no exercise No ketones = exercise w/ caution
≥ 300 mg/dl	Check for Ketones Exercise in regardless of presence of ketones

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

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

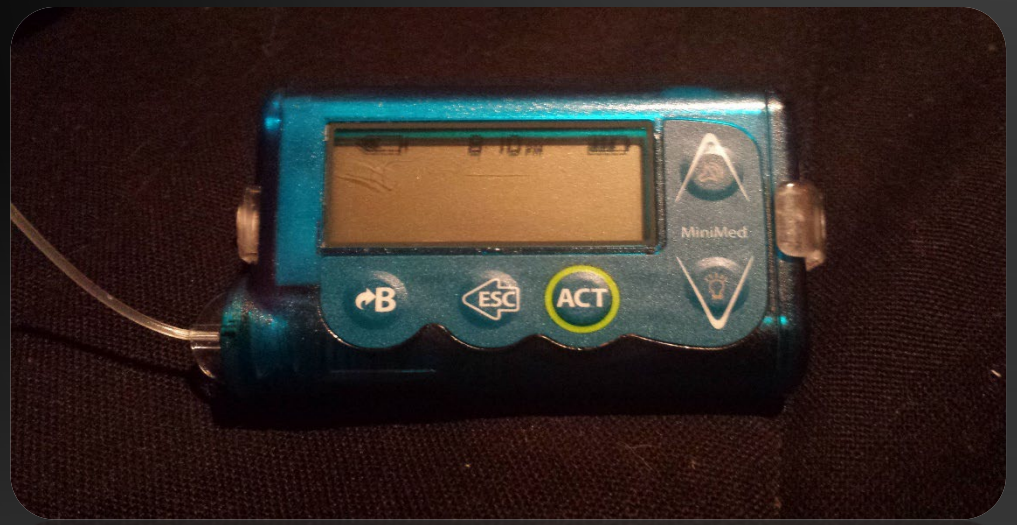
- Insulin used to correct elevated glucose levels and cover carbohydrate consumption. Examples: Novolog or Humalog.

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

HYPERGLYCEMIA TREATMENT
INSULIN ADMINISTRATION

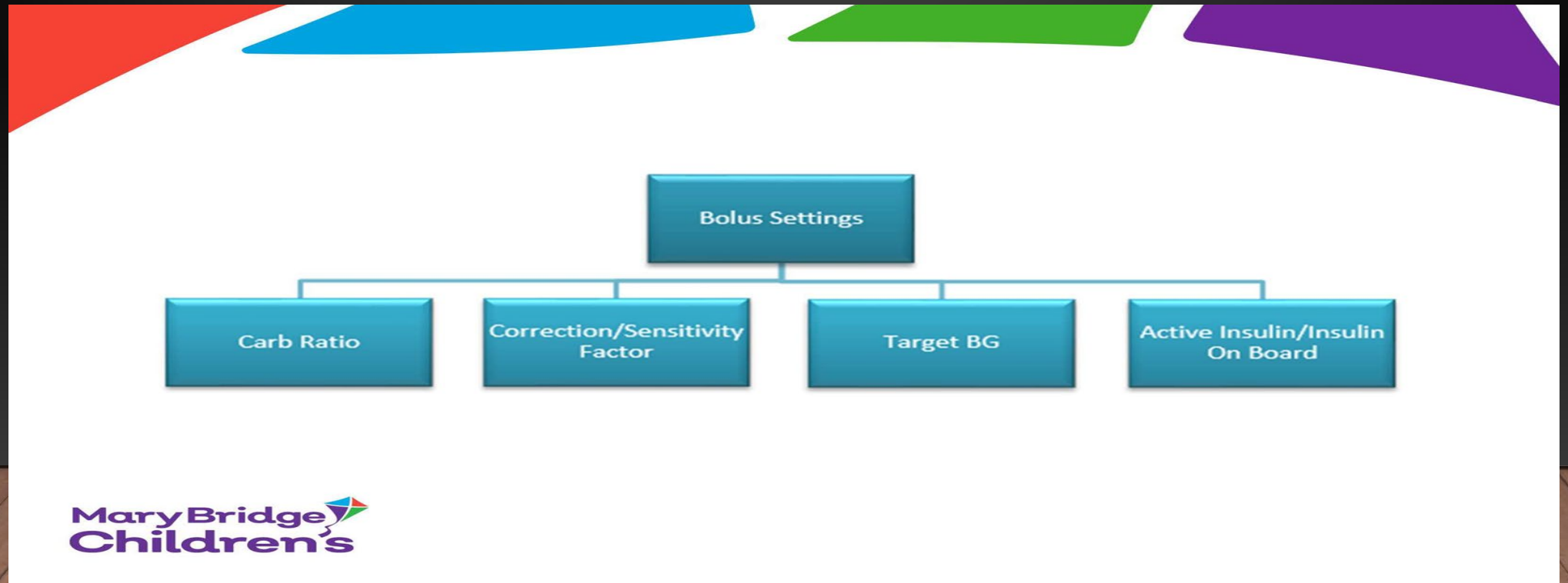
THE PUMP



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.



INSULIN DOSING

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)

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)

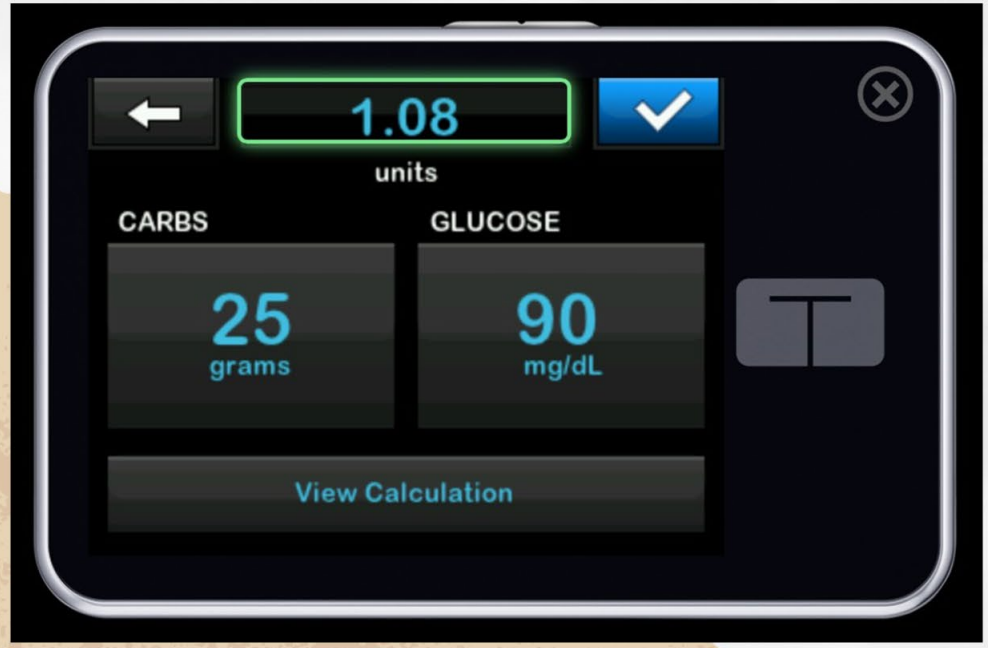
STEP THREE

COMPLETE BOLUS

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

100
100
100

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

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

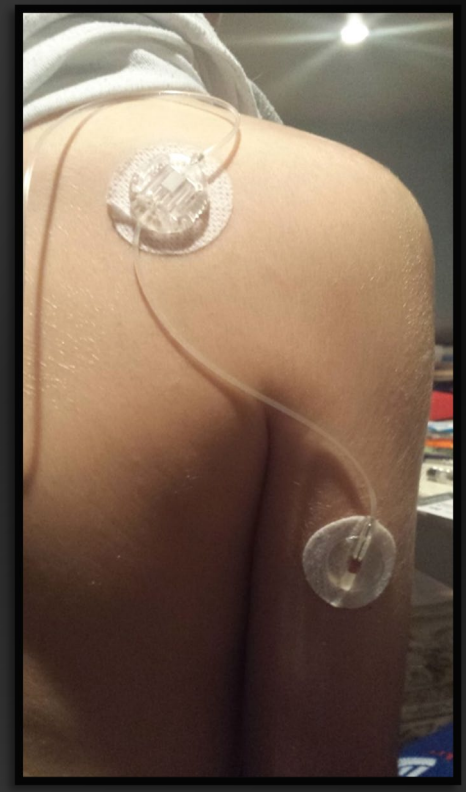
INJECTION SITES

- 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



PUMP COMPONENTS

Insulin vial to fill reservoir

Reservoir

Insulin Pump

Infusion set before insertion

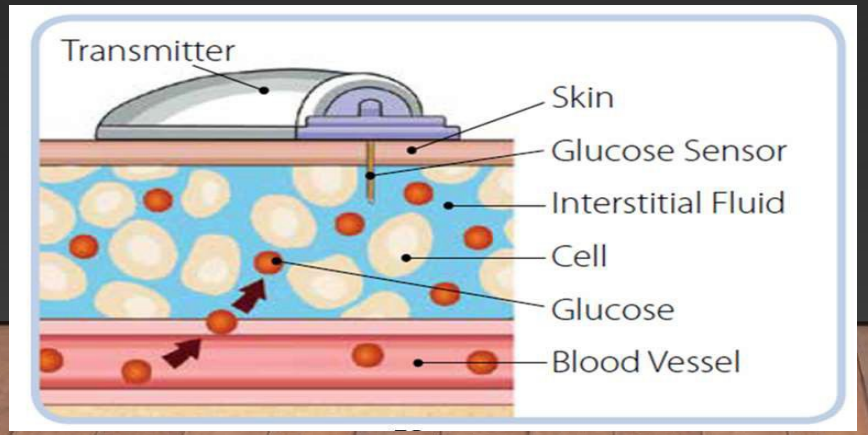
Infusion set after insertion

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**



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.

DIABETES TECHNOLOGY

OMNIPOD 5 WITH DEXCOM G6

- Integrates with Dexcom G6 and Libre 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
- Uses requires compatible smart device to connect Dexcom to Pump.
- Pods are changed every 3 days

DIABETES TECHNOLOGY

TANDEM T-SLIM X2

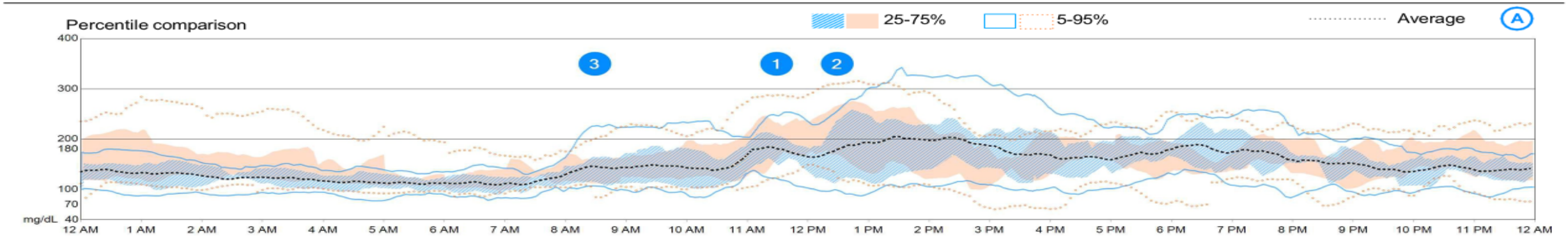
- Interacts with Dexcom G6 & Libre (CGM data appears on the pump)
- Control IQ: The Dexcom and T-Slim X2 predict high and low blood glucose. It will decrease insulin or suspend insulin delivery to avoid hypoglycemia if the sensor is predicting low. The pump will also deliver micro boluses and/or increase 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.

DIABETES TECHNOLOGY

MEDTRONIC

- 630G and 670G (older models, using guardian sensor 3 that requires calibration and also has automode option)
- New: 780G 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.

Percentile comparison



Carb Ratio (g/U)	12 AM	5 AM	8 AM	11 AM	3 PM	7 PM
Ⓐ	8.0	5.0	3.3	3.6	3.6	
Ⓑ	8.0	5.0	3.3	3.6	3.6	

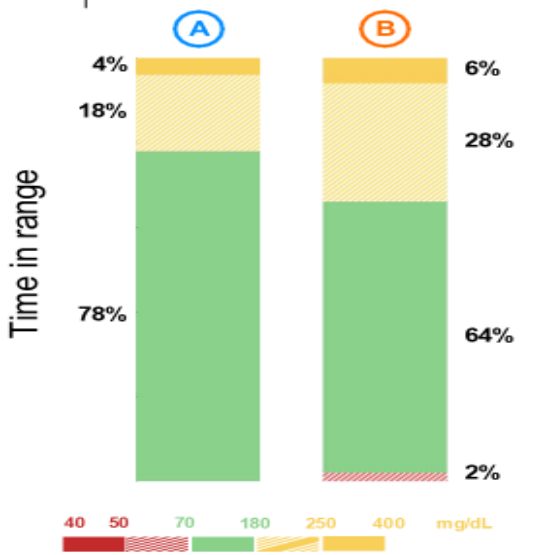
Ⓐ

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%)

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

Tegaderm Film

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!