DIABETES MANAGEMENT TECH AND TOOLS

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TECHNOLOGY ADA STANDARDS OF CARE

Diabetes technology is the term used to describe the hardware, devices and software that people with diabetes use to help manage their condition, from lifestyle to blood glucose levels. Historically, diabetes technology has been divided into two main categories: insulin administration by syringe, pen, delivery devices or pump, and blood glucose monitoring as assessed by meter or continuous glucose monitor (CGM). More recently, diabetes technology has expanded to include hybrid devices that both monitor glucose and deliver insulin, some automatically, as well as software that serves as a medical device, providing diabetes self-management support.

Diabetes technology, when coupled with education and follow-up, can improve the lives and health of people with diabetes; however, the complexity and rapid change of the diabetes technology landscape can also be a barrier to patient and provider implementation.

INSULIN THROUGH THE YEARS

- Nobel Prize (1923) for the discovery of insulin, 1st dose given Jan 1922, was given to Banting and Collip and they sold the rights to make insulin for $1
- Eli Lilly Corp had 13 price decreases of making insulin, by 1941, at that time insulin cost each patient approximately 7.5 cents a day/$27 per year

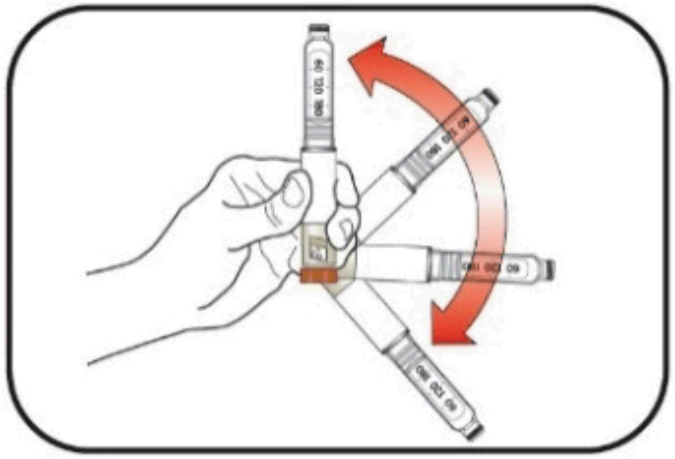
INSULIN THROUGH THE YEARS

- Each insulin company has picked different colors for their pens and their products to help both patients and providers tell them apart
- Humalog in 2009 was $93 and by 2018 it was closer to $275. If you drive to Canada it is over the counter approximately $32 today.
- Insulin is required for life and rationing it is life threatening.

INSULIN THROUGH THE YEARS

- Walmart has these 3 insulins today, the Relion Novolin Brand, that are $24.88 per vial and NO prescription is needed!!! They were/are taken 2 times a day mixing N and R at various ratio's or the premixed 70/30 which is 70% N and 30% R.
- Box of 5 Walmart Relion Insulin Pens are $42.88 which is only 3 cents more per unit of insulin (5 pens have 1500 units where 1 vial has 1000 units)

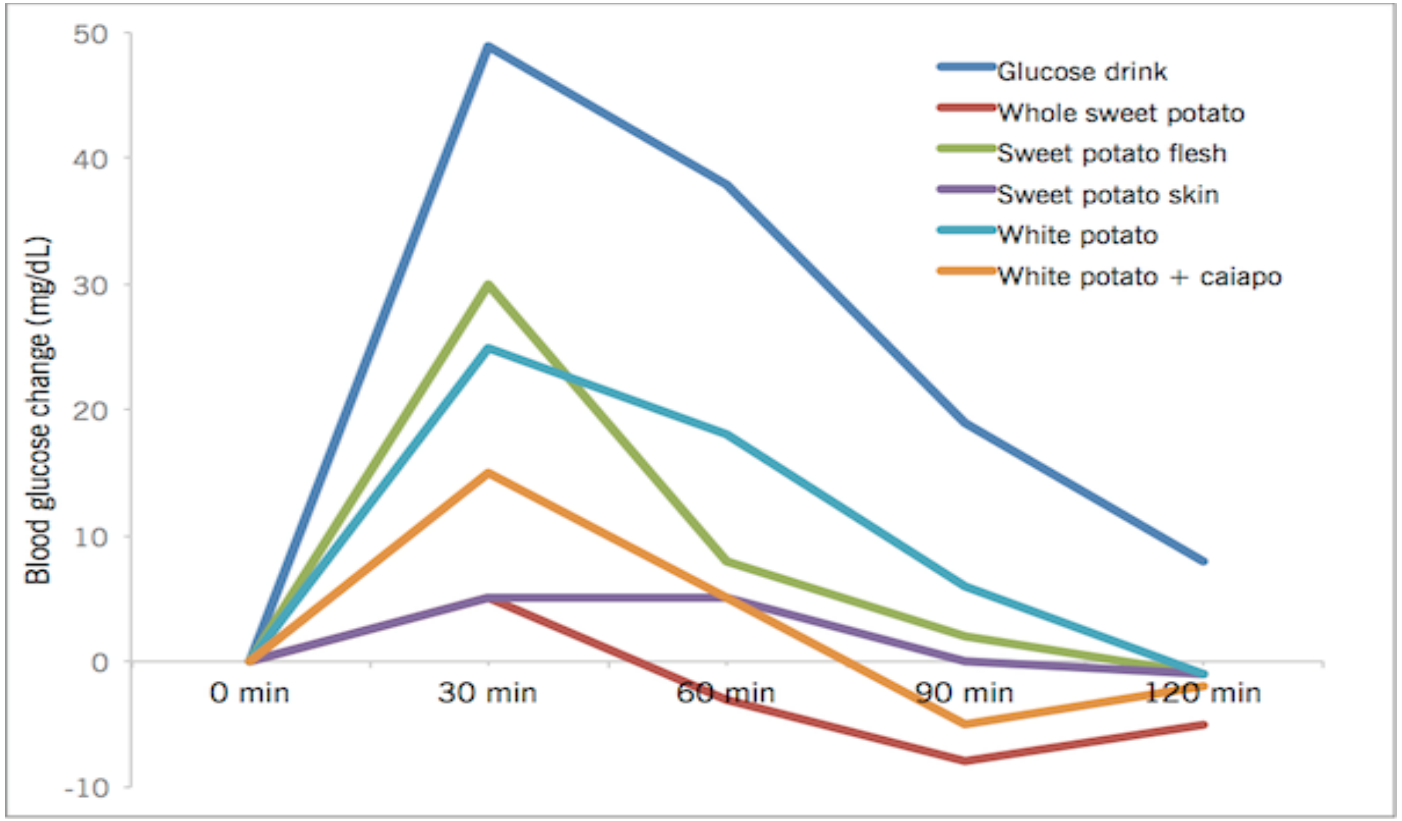
HOW TO MIX “CLOUDY” INSULIN PENS



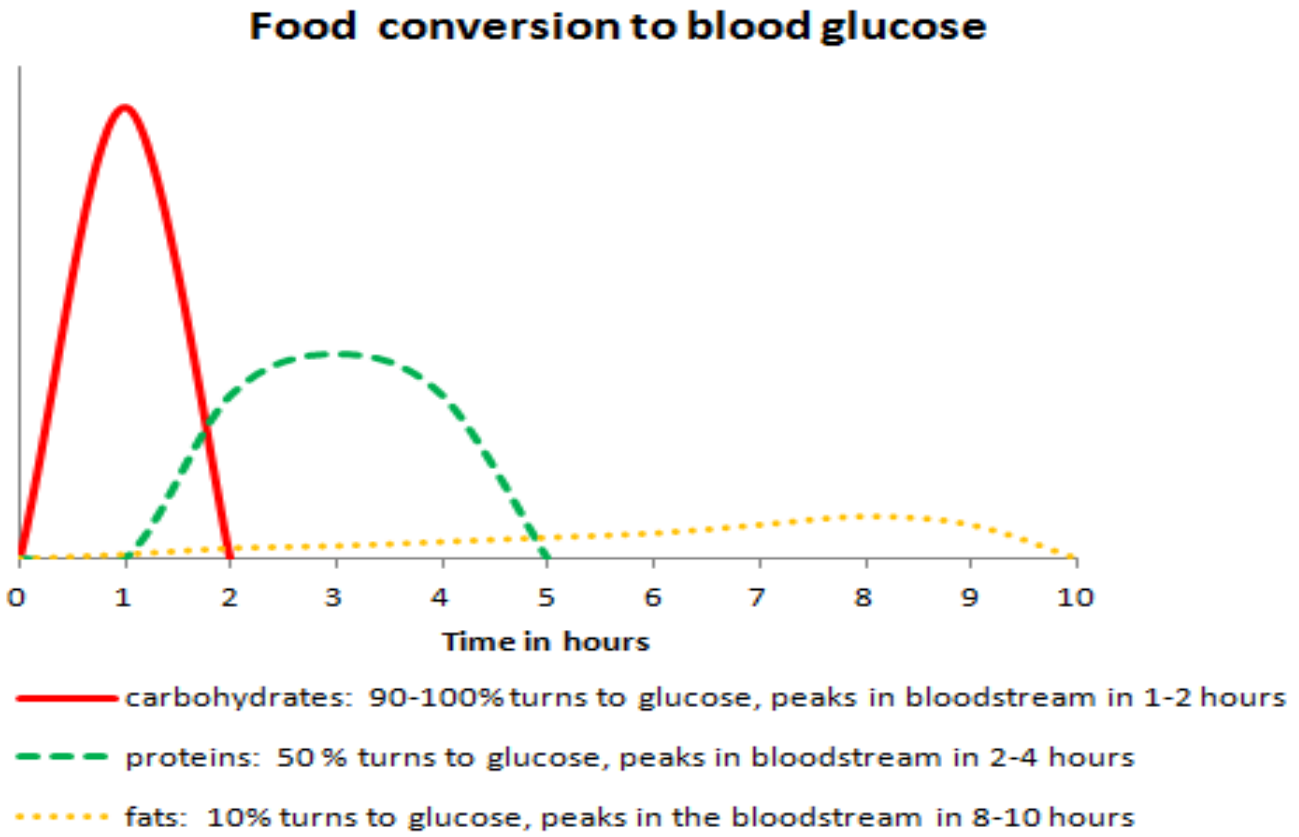
In addition to doing all the other steps of preparing and giving a dose of insulin with a pen, if patients are using the older N or 70/30 pens which have zinc in them, which is heavy and settles out like OJ with pulp, you not only roll the pen but you HAVE TO ALSO MOVE THE PEN UP AND DOWN (INVERT) A MINIMUM OF 10 TIMES and I recommend 20 times.

There is a tiny little ball in the pen that goes through the liquid as you turn it up and down which mixes this narrow tube well.

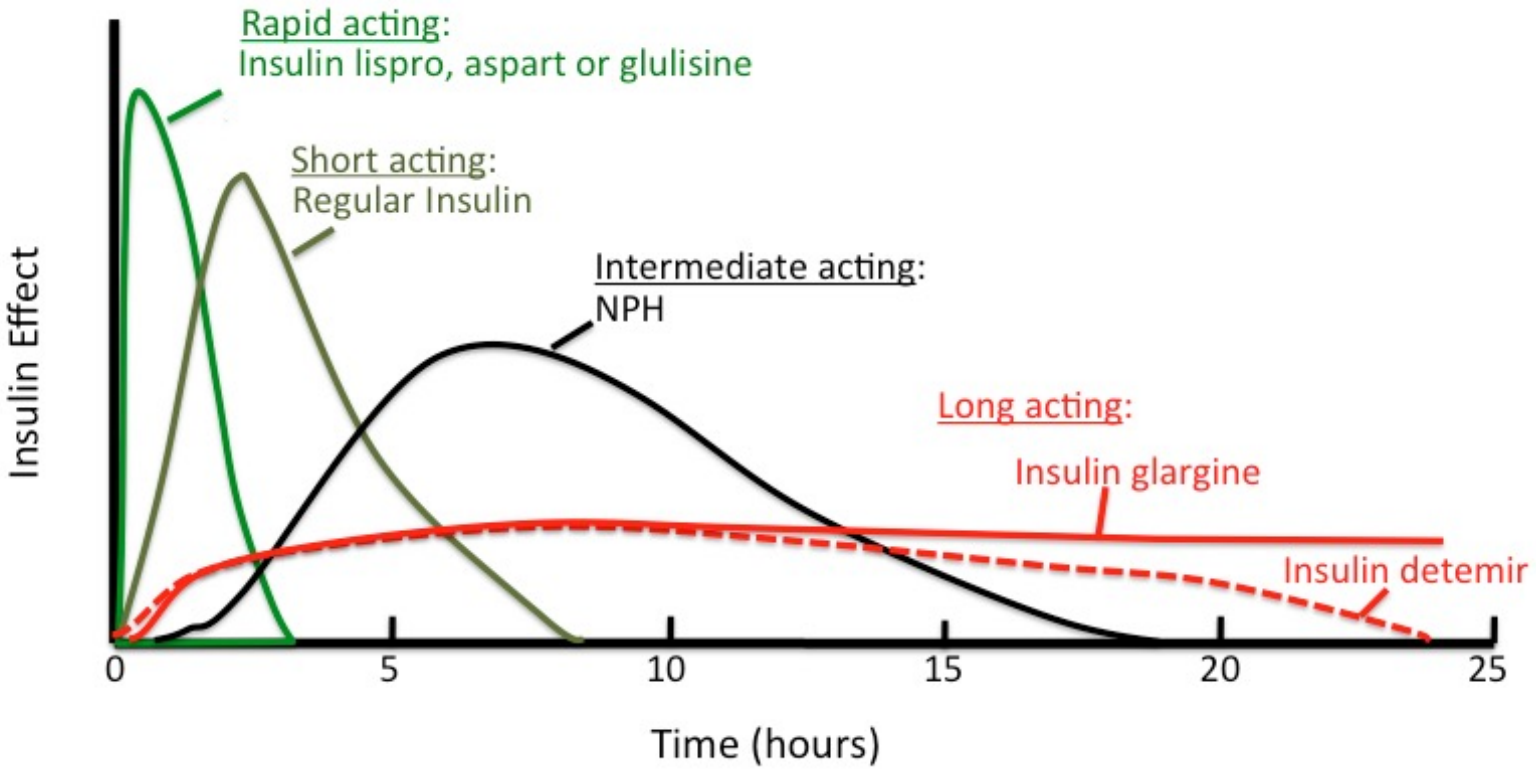
CARBOHYDRATE ABSORPTION/GLUCOSE CHANGES



CARB WITH PROTEIN



INSULIN ACTION TIMES

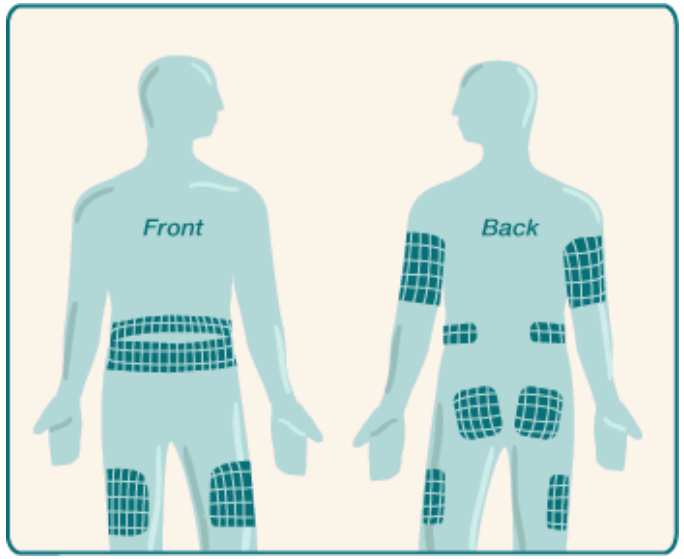


INSULIN ACTION TIMES

When Does My Insulin Peak and How Long Does It Last?

Action Times for Insulins					
Insulin	**Starts**	**Peaks**	**Ends**	**Low most likely at:**	**Usage**
Hum/Nov/Apidra	10-20 m	1.5-2.5 h	4.5-6 h	2-5 h	designed to peak, covers meals and lowers high BGs
Regular	30-45 m	2-3.5 h	5-7 h	3-7 h	
NPH	1-3 h	4-9 h	14-20 h	4-16 h	intermediate, less peaking, larger action
Lantus	1-2 h	6 hr	18-26 h	5-10 h	designed for flatter and longest action, background insulin action for keeping your BG flat when fasting
Levemir	1-3 h	8-10	18-26 h	8-16 h	

ABSORPTION PROBLEMS FROM OVERUSE

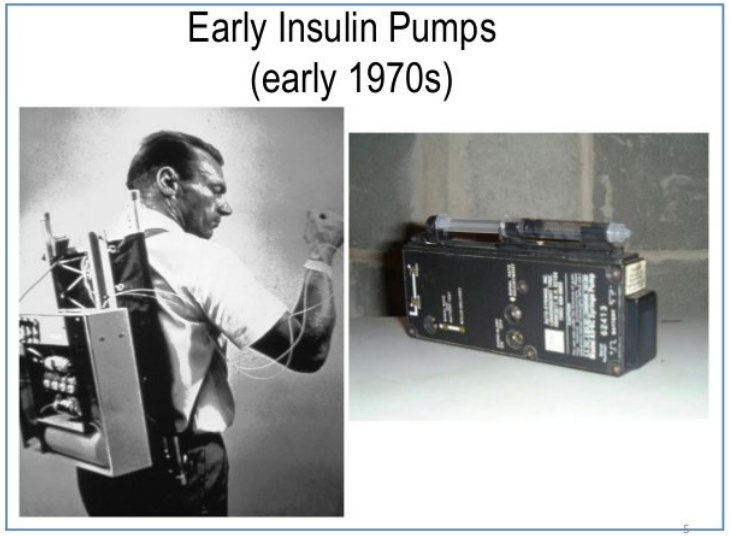


Lipohypertrophy is a medical term that refers to a lump under the skin caused by accumulation of extra fat at the site of many insulin injections. It may change the timing or completeness of insulin action. It is a common, minor, chronic complications of diabetes.

SMART PENS – IN PEN

1. Allows you to track dosing data that can be shared on digital platforms and integrated with other vital diabetes care information.
2. Pen cartridge in reusable pen
3. Can do ½ unit dosing
4. Can assist in determining doses with IC Ratio, ISF/ICF and target
5. Collects data/stores for up to 1 yr
6. Keeps up with “insulin on board”
7. Can have reminders
8. Can send to other people/share the data, including providers
9. Has temperature sensor alarm

INSULIN PUMPS



We have come a long way in the past 40 years on the ability to carry and use insulin pumps but some basics are the same, one kind of insulin, with basal and bolus doses, being deposited just under the skin in the subcutaneous area.

WHO SHOULD USE AN INSULIN PUMP

1. Patients with dawn phenomenon since we can't make basal insulin work harder just before the patient wakes up.
2. Patients who are physically active and a pump basal rate can be lowered or stopped for vigorous activity.
4. Someone willing to use a CGM or test BG's a minimum of 4 times a day, always testing fasting and before bed.
4. Someone willing to commit, as I like to say, "A pump is not magic" and you don't put it on and forget it! Patient MUST tell the pump when they eat!
5. Someone who has insurance coverage for ongoing cost of supplies.
6. Someone who wants to get rid of needles except once every 2-3 days. (This would be true if they use a CGM without the need for calibrations).

WE CURRENTLY HAVE 3 PUMPS ON THE MARKET - USA

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

HOW DO INSULIN PUMPS WORK?

Basal Rate - is the rate of continuous supply of some chemical or process. In the case of diabetes mellitus, it is a low rate of continuous insulin supply needed for such purposes as controlling cellular glucose and amino acid uptake when we are not eating. Replaces long acting insulins.

Rapid acting insulin is used most often and the pump can have multiple basal rates over the course of the 24 hour day.

Example 15.075 units/day

12a-4a 0.6 units/hour

4a-7a 0.85 units/hour

7a-2p 0.625 units/hour

2p-7p 0.55 units/hour

7p-12a 0.6 units/hour

HOW DO INSULIN PUMPS WORK?

Bolus - a single dose of a drug or other medicinal preparation given all at once (or can be extended with an insulin pump over X hours). To match carbs consumed or to lower hyperglycemia.

A single amount, ex 5 units, could be given but most often the pump uses calculations based on the patients target BG, insulin to carb ratio and correction or sensitivity factor.

HOW DO INSULIN PUMPS WORK?

Example settings:

Carb Ratio 1u:10 g

Correction Factor

Sensitivity Factor 1u:40 mg/dL

Target 120 mg/dL

Action Time 3 hours

If a patient is eating a Chick-fil-A chicken sandwich and a diet Dr Pepper it is 41 grams of carb so the pump would calculate 4.1u for the carb ratio.

HOW DO INSULIN PUMPS WORK?

Example settings:

Carb Ratio 1u:10 g

Correction Factor

Sensitivity Factor 1u:40 mg/dL

Target 120 mg/dL

Action Time 3 hours

If CGM shows a sensor glucose of 155 mg/dL the pump will add an additional 0.8 units (if there is no Insulin on Board) for a total bolus of 4.9u.

HOW DO INSULIN PUMPS WORK?

Example settings:

Carb Ratio 1u:10 g

Correction Factor

Sensitivity Factor 1u:40 mg/dL

Target 120 mg/dL

Action Time 3 hours

If I decide as I am leaving to treat myself to an Iced Vanilla Coffee (small) which has 30 grams of carb the pump will give me 3 more units even though I have insulin on board.

HOW DO INSULIN PUMPS WORK?

Example settings:

Carb Ratio 1u:10 g

Correction Factor

Sensitivity Factor 1u:40 mg/dL

Target 120 mg/dL

Action Time 3 hours

If I receive a rapid rise alert from my CGM and I enter that BG into the pump for a bolus, it may OR may not recommend more insulin due to insulin on board.

HOW DO INSULIN PUMPS WORK?

If in the previous example our BG before eating the chicken sandwich had been 89 mg/dL and our target was 120 mg/dL, if reverse correction is turned on, which is typical in newer pumps, then the insulin dose for the chicken sandwich would not have been 4.1 units because the pump would remove some of that dose of insulin due to need to allow the BG to rise from 89 up to 120 after the meal.

Extended bolus doses are another advantage of insulin pumps. That high fat meal, let's add the waffle fries to the meal and a milkshake instead of the coffee. The carbs will not all absorb within the typical 2 hours due to the high amount of fat. So I can extend the bolus, giving some now and some over 2 hours for example, and now instead of the peak of the rapid acting insulin working from 30 min to 90 min, the peak will last for three and a half hours on some of the insulin. Patients often need to use this on meals out like Chinese, pizza and holiday meals.

LET'S THINK BACK TO SMART PENS

In the app, the patient has an insulin to carb ratio, a correction factor and a target, just like the pumps. When the patient enters their BG & carb count (at the calculator on the screen) then the app recommends a dose of a whole or ½ unit bolus to be taken by the patient. Another "poor mans pump"!

WHAT SHOULD NURSES CONSIDER ON ADMITTED PATIENT?

1. Do you have an order that the patient can continue on their home pump?
2. Is the patient appropriate at this time? Are they on pain meds, confused, etc. Is there a family member who can stay 24/7 and take over for the patient? If Not, obtain 3 insulin orders from the provider, before disconnecting the pump.
3. Does the patient have all the supplies needed? We do not have supplies! Including their own vials of insulin.
4. Has the paperwork been filled out? VH *Patient Agreement, History Form,* 800 number on pump can help patient find settings
5. Document on the insulin pump insertion site q 12 hours
6. Enter the 24 basal doses into the MAR. This may confuse your patients. If asked what is your basal rate they tell you the current one. You need the 24 hour rate or the amount delivered yesterday in the history of pump.

WHAT SHOULD NURSES CONSIDER ON ADMITTED PATIENT?

7. Continue to test patients BG on our normal/ordered schedule, if BG not controlled, contact Dr follow your policy
8. Have the patient show you how to stop or suspend the pump in case of emergency (necessary with pods) or how to disconnect the pump from their site (tubing pumps only).
9. Do not use CGM data for BG's (VH),
10. At VH if BG over 250 mg/dL for over 8 hours, notify provider and obtain order for ketone testing, assess pump site, tubing, pump screen.
11. Enter all bolus doses into the MAR and if the patient took it before you arrive have them give you the time from history and back time the insulin dose.
12. If patient was put on Lantus, explain to restart pump at the time the next 24 hour dose of Lantus is due.

CGM'S HAVE 2-3 BASIC PARTS

In this example of a CGM system

1. Sensor – this large device is simply used to insert the small fiber under the skin. 1 needed for every change.
2. Transmitter – this smaller piece locks into the sensor. Replaced when battery weak or rechargeable. (One company has the transmitter built into their sensor.)
3. Receiver – either the once only purchased receiver/scanner and/OR the smart phone/watch.

HOW DO CONTINUOUS GLUCOSE MONITORS WORK?

1. CGM's helps patients avoid the "stick" of monitoring your blood glucose. It measures the glucose in the interstitial fluid though a tiny sensor inserted under the skin. It records the glucose every one to five minutes giving us 1440 or 288 data points a day, instead of the 4-6 with AC/HS BG monitoring. The results are going to either a scanner (intermittently scanned by patient), or automatically sending out this information (real time) to a CGM receiver, insulin pump, smart phone or watch/via phone!
2. They are very accurate and most treatment decisions, ex insulin doses, can be made directly from the sensor glucose WITHOUT needing a blood glucose verification. Patients should verify if they question the glucose.
3. CGM's can also give you a direction arrow of the glucose change. There are 3-7 direction arrows. Some only show up, steady or down but the ones with more than 3 tell you the speed of the glucose changes.

EX. OF DROPPING GLUCOSE

In this example you can see the pattern of the last 3 hours of glucose data, at the bottom display, on the receiver. The current glucose is 103 and has the down arrow (bird beak). The next result, 5 min later glucose, will likely be between 88-93 mg/dL, as this down arrow tells me that the glucose is falling 2-3 mg/dL PER MINUTE.

HOW DO CGM'S WORK? CONTINUED

4. Both Type 1 and Type 2 patients use CGM's and the use is often dependent on the insurance coverage and the out of pocket costs.
5. Most CGM's can alarm to alert you of glucose readings that are too high or too low for you. This is particularly helpful to my patients with hypoglycemic unawareness, as it is a safety net, to their loss of ability to detect low blood glucose readings. It can also alert pumpers their pump site may not be working correctly, alerting them up to several hours, before their next planned BG test or began having N&V due to DKA.
6. These products offer us wonderful statistics that we can base our treatment decisions off of. Patients can add event markers that help to understand what might be impacting the daily glucose data lines we see.
7. Valley Health Nurses – you cannot use CGM data for inpatient treatment decisions. The patient can wear a CGM but we make all insulin decisions off of the BLOOD glucose!

LAG TIME OF CGM COMPARED TO BG

Remember that the sensor for CGM's is not in the blood but in the interstitial fluid. So the BG changes first. This cog rail train is headed up the mountain very slowly. Imagine the first people in the front rail car get to any point about 5-20 min before the engineer in the engine (back) reaches the same point. The blood glucose flows from the blood stream into and through the interstitial fluid, so the blood glucose is always changing (either up or down) ahead of the CGM.

BLOOD GLUCOSE LOG BOOK

BG'S FROM 1 DAY FOR YOUR PATIENT AT OFFICE

ACB 155

Humalog 7 units

ACL 135

Humalog 5 units

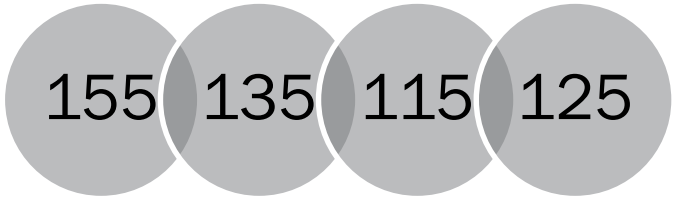
ACS 115

Humalog 8 units

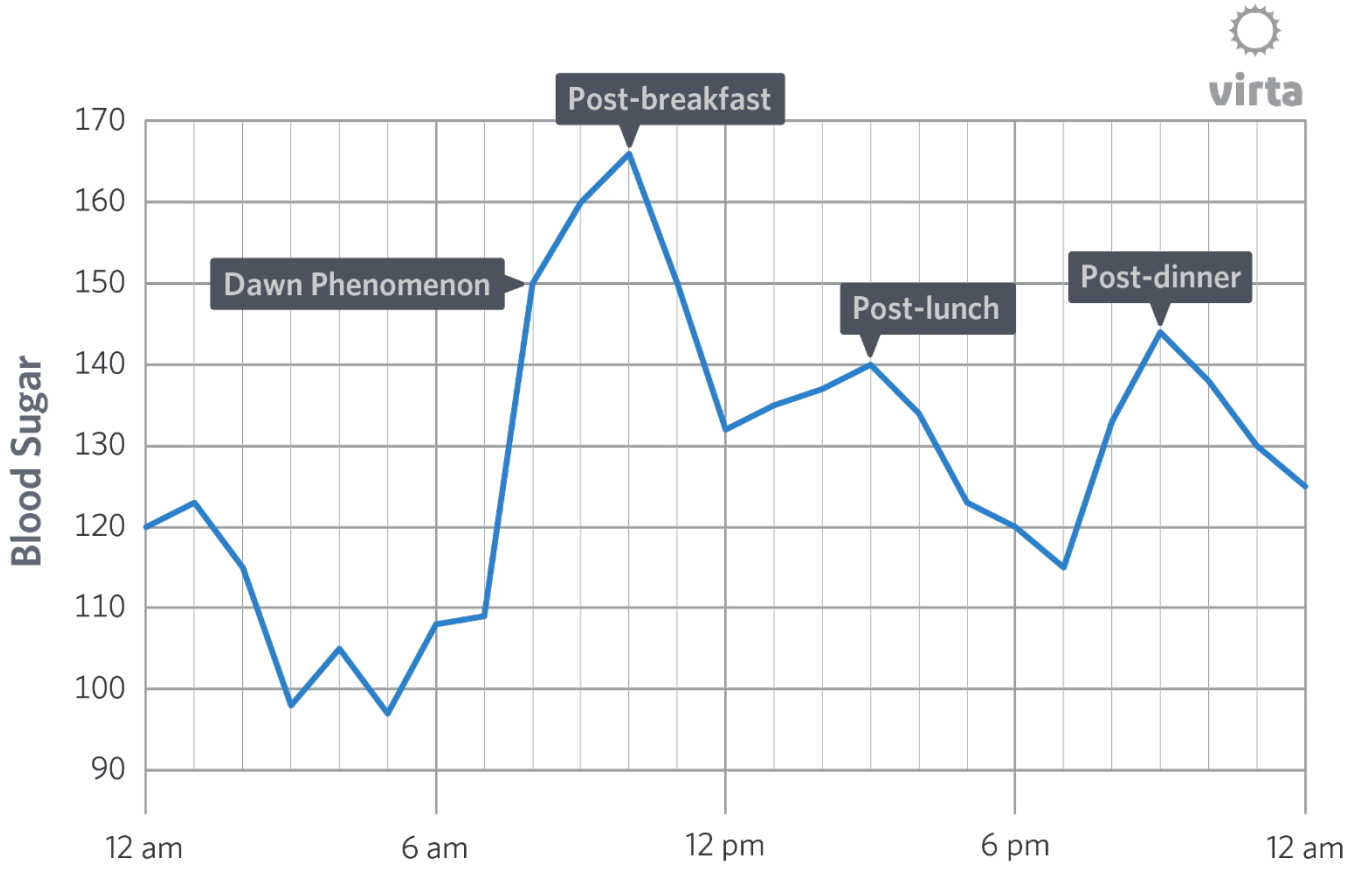
ACHS 125

Lantus 22 units

4 BG'S RECORDED TODAY



BLOOD GLUCOSE GRAPH 1 DAY



INSULIN PUMPS AND CGMS WORKING TOGETHER

Released	Company	Advances in hybrid closed loop pumps
2013	Medtronic	530G 1st Hybrid Closed Loop pump with 2 hour thresh suspend for hypoglycemia prevention
2016	Medtronic	630G alerts predictive technology 30 min ahead, color screen, insulin on board on main screen
2017	Medtronic	670G Smartguard technology can speed up or slow down basal in addition to stopping/starting basal, continues to need 2 times a day BG calibrations
2018	Tandem	With Dexcom G6 CGM (no BG's needed) has Basal IQ technology, can stop basal rate 30 min before low and restart as soon as BG begins to rise
2019	Tandem	Control IQ technology can speed up or slow down basal, stop/start basal and give an additional bolus hourly for predicted hyperglycemia in 30 min
Late 2020	Medtronic	770G added Bluetooth technology can view data on phone, upload on phone, share with Dr, ages 2 years and up, still 2 times a day finger sticks needed

BASICS OF HOW HYBRID CLOSED LOOPS WORK

The pump and the CGM are interacting 24 hours a day.

The pump is using the recent changes in the CGM and calculating out if the trend continues what will the sensor glucose be in ex. 30 min.

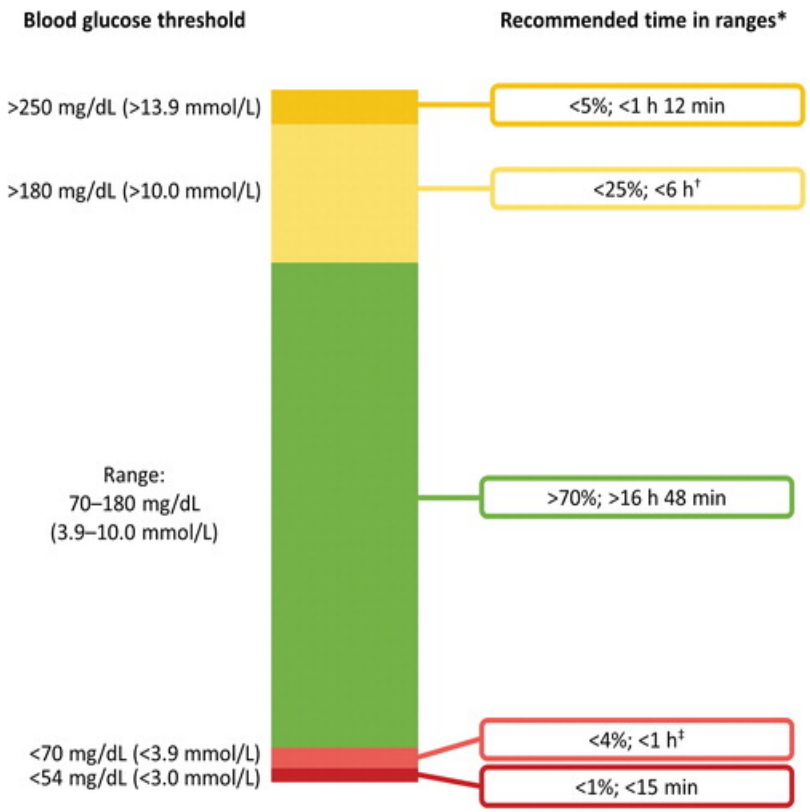
If the sensor glucose will be too low, under ex 70, the pump will stop the basal rate completely and once the glucose turns and begins to rise it will turn it back on.

If the sensor glucose will be under the target, ex 105, the basal rate will not stop but it will decrease the rate.

If the sensor glucose is predicted to be above a certain number, ex 160 mg/dL then the basal rate can increase the amount of insulin it is providing.

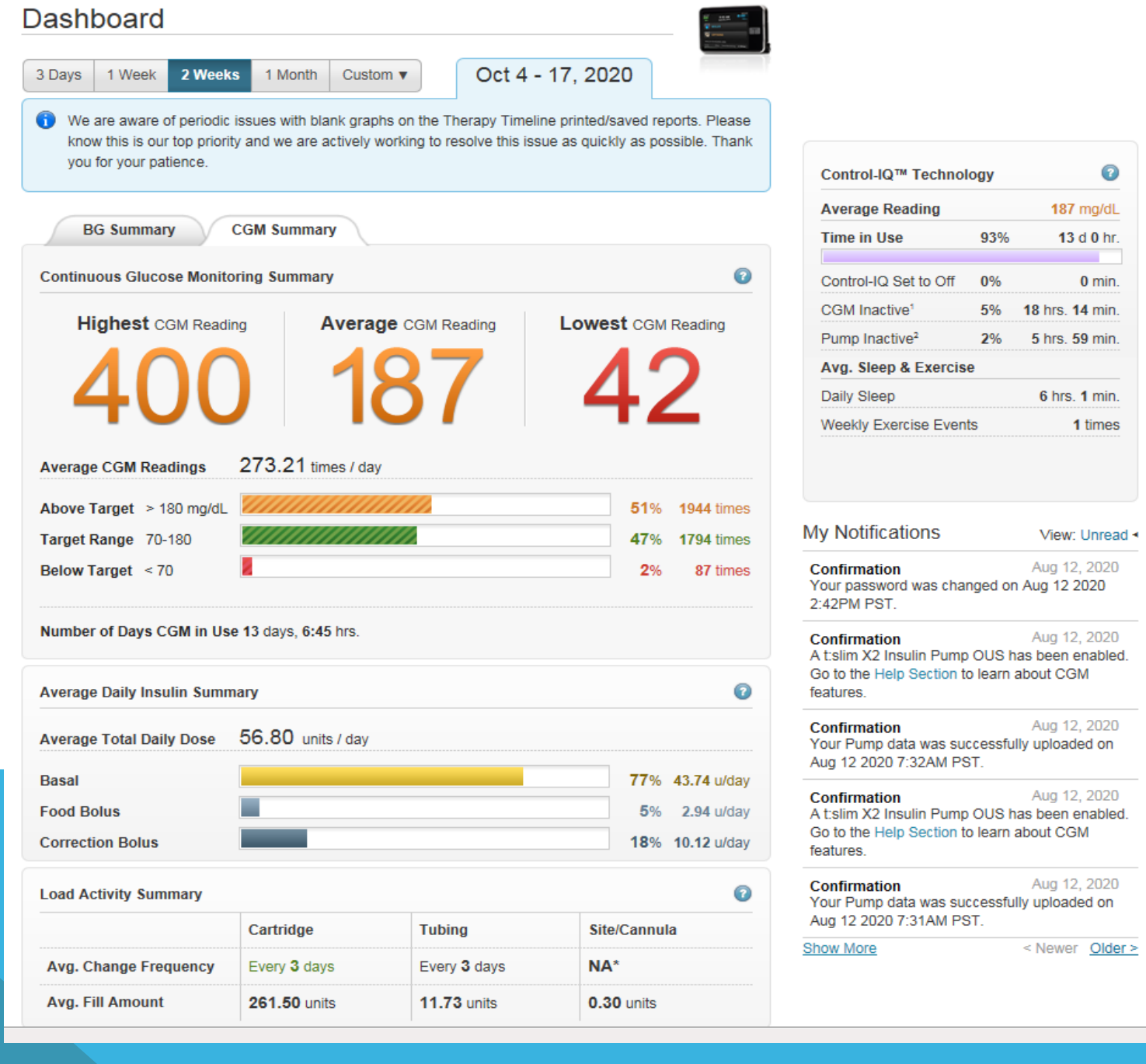
If the sensor glucose for example is predicted to be above 180 mg/dL then the pump may give an automatic bolus on it's own to prevent hyperglycemia (depending on how much insulin is on board or active of course).

DATA DRIVEN CARE



1. I begin with the lows and if they are above the goals below I try to find a pattern of what occurs prior to the hypoglycemia and adjust. For Ex. I may see lows always occur after the lunch meal. This may mean the lunch insulin to carb ratio is too strong. If I notice the higher the carb meal the lower the glucose goes I will weaken the carb ratio.
2. Then I try to find a pattern on the very high range above 250mg/dl. Is this usually after breakfast, if so the breakfast carb ratio may be too weak so I would strengthen that carb ratio.
3. As I decrease the minutes spent too low or highs, the time spend in the range of 70-180 mg/dl increases.

SUCCESS STORIES



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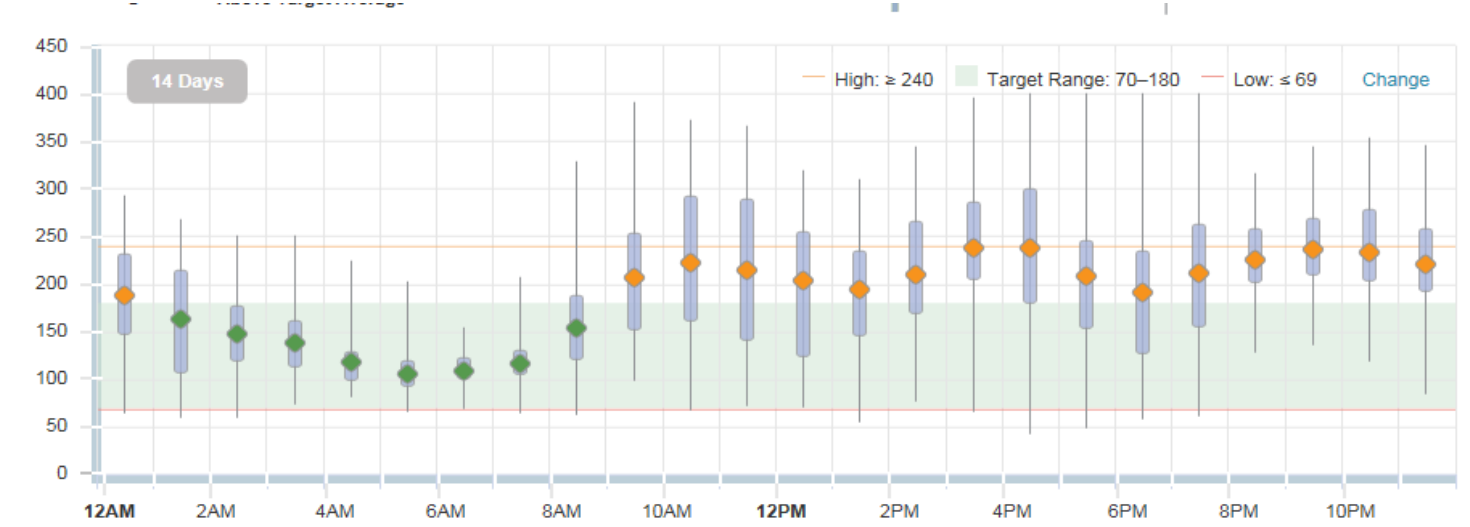


Night 12am - 6am				
Low	Below	Target	Above	High
4%	0%	70%	19%	6%

Morning 6am - 12pm				
Low	Below	Target	Above	High
1%	0%	65%	14%	20%

Afternoon 12pm - 6pm				
Low	Below	Target	Above	High
2%	0%	28%	31%	38%

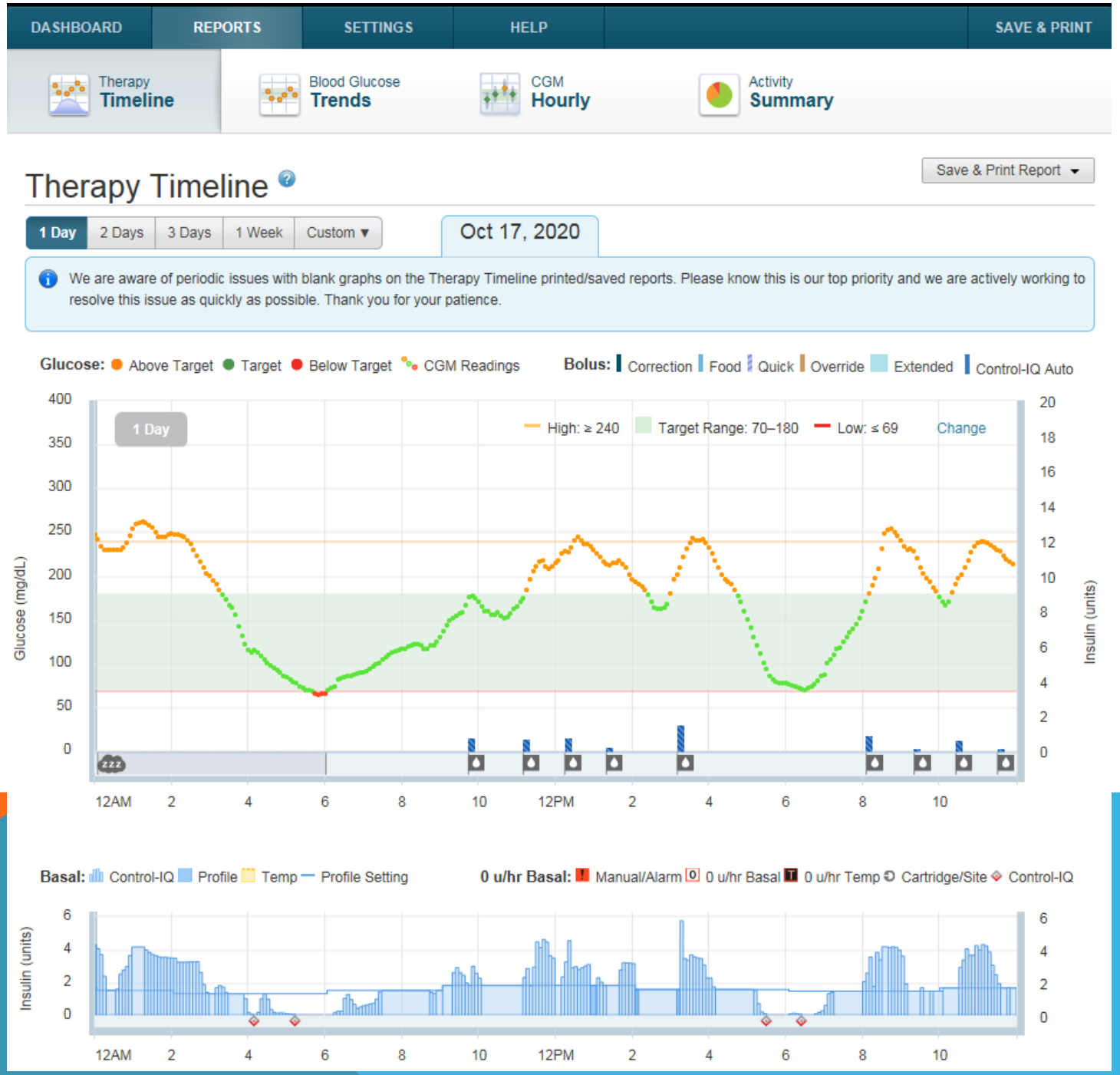
Evening 6pm - 12am				
Low	Below	Target	Above	High
1%	0%	22%	39%	38%

More Details

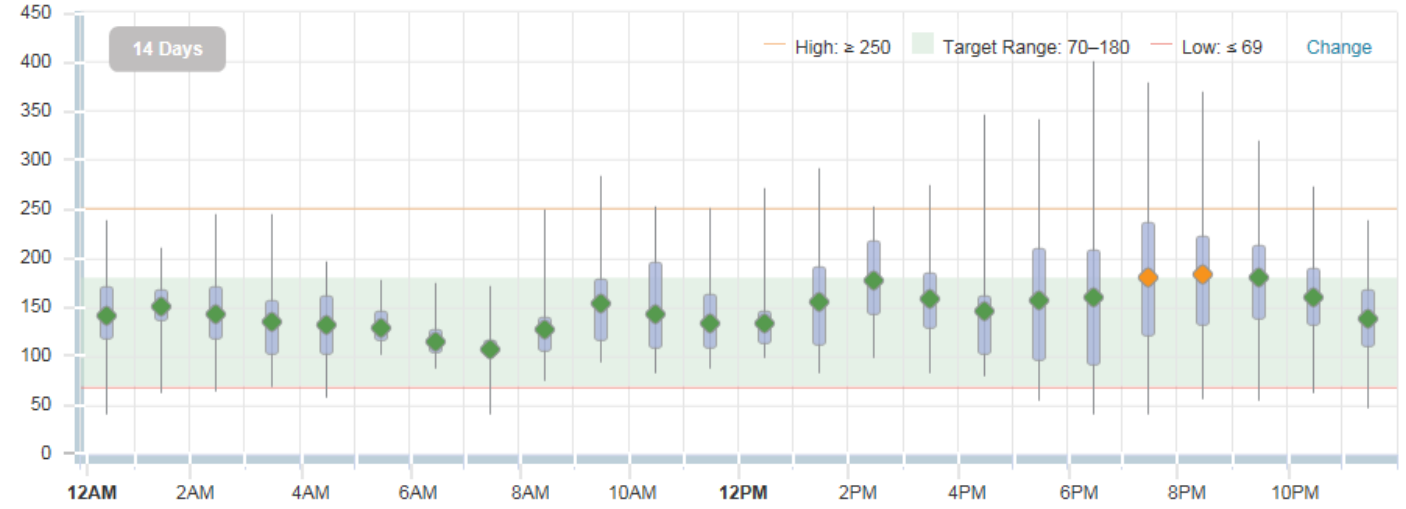
Logbook

Above Target Below Target Calibration

	12AM	1	2	3	4	5	6	7	8	9	10	11	12PM	1	2	3	4	5	6	7	8	9	10	11
Oct 4, 2020 - Sunday																								
Glucose (mg/dL)																								
Carbs (g)																								
Bolus (u)										0.86	1.22				2.94	1.46	0.34		0.47	0.70	0.36	0.23	1.29	0.06
Basal Total Delivered (u)	3.556	2.899	2.182	1.625	1.541	0.735	1.196	1.047	1.801	2.061	2.194	1.913	0.685	1.850	1.991	2.333	1.658	3.392	3.162	2.866	2.381	1.569	3.485	1.982
Basal Profile Setting (u/hr)	1.550	→	1.350	→	→	→	1.550	→	→	1.850	→	→	→	→	1.600	→	→	→	1.500	→	→	→	1.700	→
Avg. CGM (mg/dL)	273	243	186	143	134	109	105	112	141	161	167	149	100		315	283	242	231	259	259	247	194	271	247
# Readings	12	12	12	12	12	12	12	12	12	12	12	12	7		4	12	12	12	12	12	12	12	12	12
Oct 5, 2020 - Monday																								


DASHBOARD
REPORTS
SETTINGS
HELP
SAVE & PRINT
Therapy Timeline
Blood Glucose Trends
CGM Hourly
Activity Summary
Therapy Timeline
Save & Print Report
1 Day
2 Days
3 Days
1 Week
Custom
Oct 17, 2020
We are aware of periodic issues with blank graphs on the Therapy Timeline printed/saved reports. Please know this is our top priority and we are actively working to resolve this issue as quickly as possible. Thank you for your patience.
Glucose: Above Target Target Below Target CGM Readings
Bolus: Correction Food Quick Override Extended Control-IQ Auto
1 Day
High: ≥ 240
Target Range: 70–180
Low: ≤ 69
Change
Glucose (mg/dL)
Insulin (units)
12AM 2 4 6 8 10 12PM 2 4 6 8 10
Basal: Control-IQ Profile Temp Profile Setting
0 u/hr Basal: Manual/Alarm 0 u/hr Basal 0 u/hr Temp Cartridge/Site Control-IQ
Insulin (units)
12AM 2 4 6 8 10 12PM 2 4 6 8 10

CGM Readings: Above Target Average | Target Average | Below Target Average | Mid Range (25/75% - IQR) | Highest-Lowest Reading



Night 12am - 6am				
Low	Below	Target	Above	High
1%	0%	87%	11%	0%

Morning 6am - 12pm				
Low	Below	Target	Above	High
0%	0%	86%	11%	2%

Afternoon 12pm - 6pm				
Low	Below	Target	Above	High
1%	0%	70%	22%	7%

Evening 6pm - 12am				
Low	Below	Target	Above	High
7%	0%	58%	22%	13%

More Details

Logbook

Above Target | Below Target | Calibration

	12AM	1	2	3	4	5	6	7	8	9	10	11	12PM	1	2	3	4	5	6	7	8	9	10	11
Aug 10, 2020 - Monday																								
Glucose (mg/dL)										183				168										
Carbs (g)														10										
Bolus (u)									0.91	0.82	0.21			2.65	0.24				0.99		0.05	1.13		
Basal Total Delivered (u)	1.701	0.786	0.673	1.000	0.965	1.648	0.784	0.622	1.857	2.280	2.130	1.585	1.596	2.043	1.982	1.798	0.239	0.737	0.404	3.754	2.489	2.897	2.700	1.569
Basal Profile Setting (u/hr)	2.000	→	→	1.500	→	1.650	→	→	→	1.550	→	→	1.600	→	1.800	→	→	1.750	→	→	2.700	→	→	→
Avg. CGM (mg/dL)	128	102	91	100	101	113	104	96	134	197	224	185	161	201	217	155	105	112	65	214	173	165	176	121
# Readings	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

DASHBOARD | REPORTS | SETTINGS | HELP | SAVE & PRINT

Dashboard

3 Days | 1 Week | 2 Weeks | 1 Month | Custom ▾

Aug 10 - 23, 2020

We are aware of periodic issues with blank graphs on the Therapy Timeline printed/saved reports. Please know this is our top priority and we are actively working to resolve this issue as quickly as possible. Thank you for your patience.

BG Summary | CGM Summary

Continuous Glucose Monitoring Summary

Highest CGM Reading	Average CGM Reading	Lowest CGM Reading
400	150	40

Average CGM Readings 282.79 times / day

Above Target > 180 mg/dL	23%	905 times
Target Range 70-180	75%	2960 times
Below Target < 70	2%	94 times

Number of Days CGM in Use 13 days, **17:55** hrs.

Average Daily Insulin Summary

Average Total Daily Dose 55.23 units / day

Basal	78%	43.13 u/day
Food Bolus	12%	6.51 u/day
Correction Bolus	10%	5.59 u/day

Load Activity Summary

	Cartridge	Tubing	Site/Cannula

Control-IQ™ Technology

Average Reading

Time in Use

Control-IQ Set to Off

CGM Inactive[1]

Pump Inactive[2]

Avg. Sleep & Exercise

Daily Sleep

Weekly Exercise Events

My Notifications

View: Unread ◂

Confirmation Oct 12, 2020
A t:slim X2 Insulin Pump has been enabled. Go to the Help Section to learn about CGM features.

Confirmation Oct 12, 2020
Your Pump data was successfully uploaded on Oct 12 2020 6:48AM PST.

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Show More < Newer Older >

FUTURE OF INSULIN PUMPS, GLUCAGON INFO

Automated, closed loop system, artificial pancreas which would have a CGM constantly checking glucose and an algorithm to determine whether you need insulin to lower or need glucagon to raise your glucose 24/7.

Insulin is shelf stable, glucagon has not been. In the old days we only have a syringe preloaded with saline and a vial of glucagon powder which was reconstituted just before injecting. Now we have glucagon nasal sprays Baqsimi and Gvoke “Epi pen” like syringe, that is a 2 step process for hypoglycemic emergencies.

REFERRAL TO OUR VH DIABETES PROGRAM

Pre-Diabetes Program is a free program that does not require an provider referral. Call the VH hospital closest to you for information on the next session start date.

We are Certified by the American Diabetes Association.

Diabetes Education – we do require a referral from a provider for diabetes education as this is a billed service. We see patients for education on Diabetes or Gestational Diabetes, Advanced Carb Counting (dietitian), Insulin Initiation, Insulin Management, Insulin Pump Training, Continuous Glucose Monitoring temp placement (wearing our G6 Dexcom for 10 days) or training on the patient owned CGM.

We do have to verify the patient has diabetes with labwork.

We see patients ongoing over a lifetime with a providers ongoing referral. Diabetes Education is not usually, should not be, a one and done event!