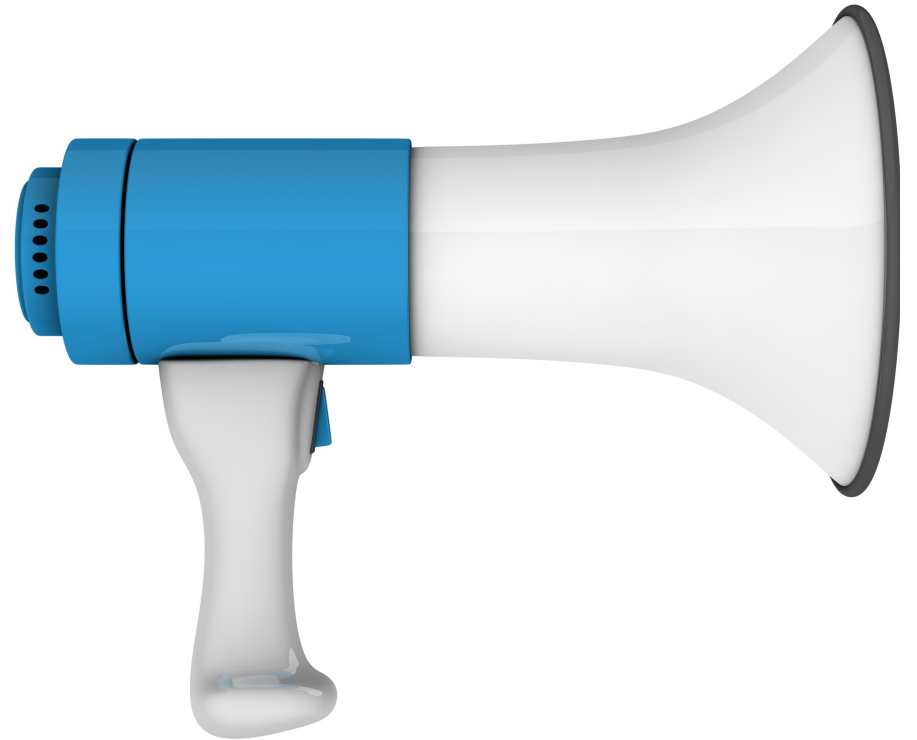


Getting the most out of your Automated Delivery System

- Leslie Eiland, MD
- Adult Endocrinologist, University of Nebraska Medical Center
- Associate Professor of Medicine, Division of Diabetes, Endocrinology & Metabolism
- Medical Director, Patient Experience & Telehealth – Nebraska Medicine

Disclaimers

- I see adult patients
 - But they used to be kids
- My parents have a child with diabetes (me), but I was never a child with diabetes
- I went wild with powerpoint stock images when preparing this presentation



Outline

AID/HCL basics

Overview of Available Systems

Tips for Success

Resources

Goals for people
with diabetes

Lucky for us:

AID systems assist with all
of these goals!

Evolution of "smart" systems

1

Shut off when
low

2

Shut off when
PREDICTED to
be low (low
prevention)

3

Increase basal
rates for highs
or predicted
highs

4

Auto correction
bolus for highs
or predicted
highs

Hopefully in the future?

Meal detection/automated boluses for food

Today's Hybrid Closed Loops

- Communication between pump & CGM
- The HCL system increases insulin automatically when glucose is rising and reduces or stops insulin automatically when levels are dropping and approaching the lower alert level
- The basal rate modulates up & down automatically 24/7 in an effort to improve time in range



Today's Hybrid Closed Loops

- Automatic insulin dosing is based on **predicted** glucose level plus:
 - insulin on board
 - insulin sensitivity/correction factor
 - duration of insulin action
 - carbs consumed
 - anticipated exercise or sleep
- Exercise/activity settings can be employed to avoid hypoglycemia
- You still need to enter carbs consumed (fully closed loop means you don't)



Why are
these
devices so
important?

- It's difficult to impossible to have consistent basal rates or carb ratios day to day
- Matching insulin to food intake is hard
 - So many variables, many out of our control
 - Variability of insulin absorption, days with different activity levels, illness/stress...



Why are
these
devices so
important?

- AID allows varying basal delivery and automated microboluses to adjust for day-to-day differences in insulin needs
- They are extremely safe – most issues due to human error
 - over/under estimating carbs, rage bolusing, site issues



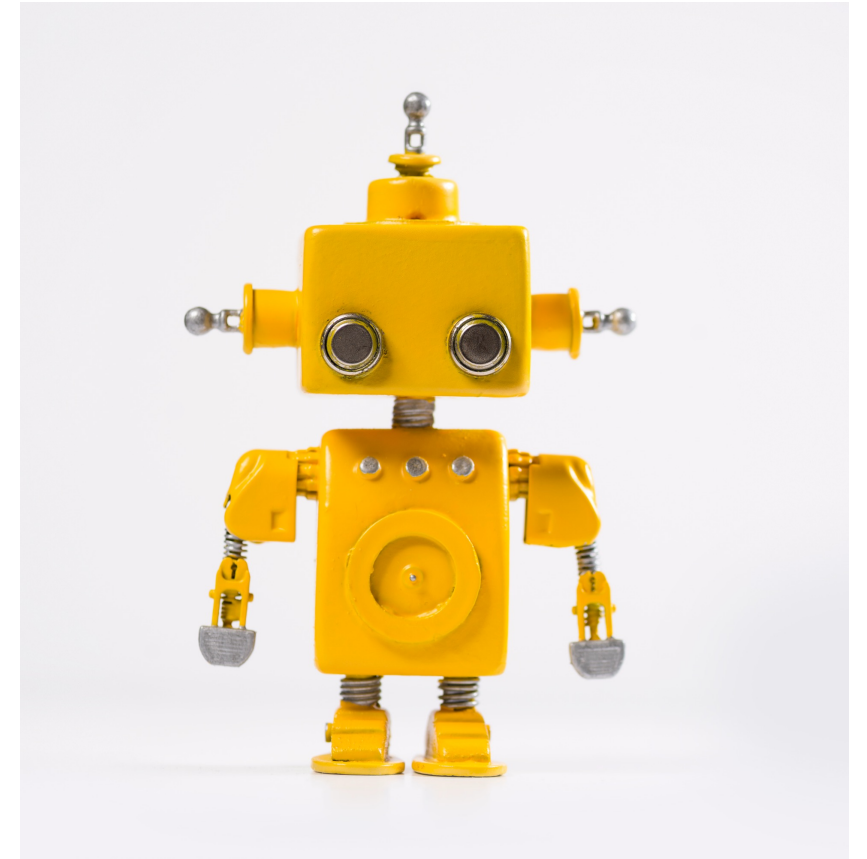
42

Factors That Affect BG

Food	Biological
<ul style="list-style-type: none">↑↑ 1. Carbohydrate quantity→↑ 2. Carbohydrate type→↑ 3. Fat→↑ 4. Protein→↑ 5. Caffeine↓↑ 6. Alcohol↓↑ 7. Meal timing↑ 8. Dehydration? 9. Personal microbiome	<ul style="list-style-type: none">↑ 20. Insufficient sleep↑ 21. Stress and illness↓ 22. Recent hypoglycemia→↑ 23. During-sleep blood sugars↑ 24. Dawn phenomenon↑ 25. Infusion set issues↑ 26. Scar tissue and lipodystrophy↓↓ 27. Intramuscular insulin delivery↑ 28. Allergies↑ 29. A higher glucose level↓↑ 30. Periods (menstruation)↑↑ 31. Puberty↓ 32. Celiac disease↑ 33. Smoking
Medication	
<ul style="list-style-type: none">→↓ 10. Medication dose↓↑ 11. Medication timing↓↑ 12. Medication interactions↑↑ 13. Steroid administration↑ 14. Niacin (Vitamin B3)	
Activity	Environmental
<ul style="list-style-type: none">→↓ 15. Light exercise↓↑ 16. High-intensity and moderate exercise→↓ 17. Level of fitness/training↓↑ 18. Time of day↓↑ 19. Food and insulin timing	<ul style="list-style-type: none">↑ 34. Expired insulin↑ 35. Inaccurate BG reading↓↑ 36. Outside temperature↑ 37. Sunburn? 38. Altitude
	Behavioral & Decision Making
	<ul style="list-style-type: none">↓ 39. Frequency of glucose checks↓↑ 40. Default options and choices↓↑ 41. Decision-making biases↓↑ 42. Family relationships and social pressures

The value of automated basal rates

- Many people have incorrect basal settings
- Basal needs often vary from day to day
- An accurate basal rate allows us to sleep more soundly, eat when we want to eat
- It can help buffer highs/lows due to errors in bolus dosing, carb estimating
- **BUT** – it can't course correct quickly





Problem for patients and providers

- Current AID systems all work differently “under the hood”
- Similar concepts, but different algorithms (which are proprietary)
- Changing certain settings impacts some algorithms, not others (ie basal rates)
- Hard for endos to keep straight, let alone PCPs and patients

Available systems

- Medtronic 670G, 770G
- Tandem CIQ
- DIY Looping/Open APS
- Omnipod 5
- Upcoming mobi, iLet



[Omnipod 5 Cleared by the FDA \(diatribe.org\)](https://diatribe.org)

[MiniMed 770G Automated Insulin Delivery Cleared for Children \(diatribe.org\)](https://diatribe.org)

[Control-IQ Hybrid Closed-Loop System for People With Diabetes | Tandem Diabetes Care](https://diatribe.org)

[Omnipod First Insulin Pump Partner for Tidepool Loop \(diatribe.org\)](https://diatribe.org)

Medtronic 670/770G

- 770G has Bluetooth® (670G does not)
- 780G = 770G + new algorithm; updated sensor in some areas (Guardian 4)
- Basal rates completely automated, targeting 120
 - Temp target option of 150

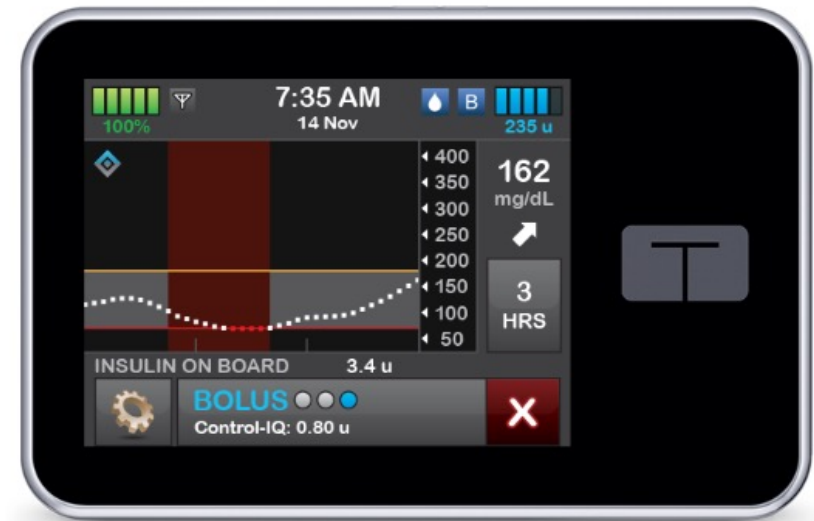


Medtronic 670/770G

- Can only change insulin action time & insulin:carb ratio
- Basals in pump only used in manual mode
- Requires regular calibration (2+/day) to stay in automode
- Exit auto mode if prolonged highs, if delivering max or min insulin for period of time or if concerns with CGM



Tandem's Control IQ (X2 pump + Dexcom G6)



- Automated delivery occurs unless as long as CGM data is available
- No calibrations
- Automatically increases/decreases programmed basal rates to maintain glucose 112.5-160mg/dL
- Basal modulation dependent on basals set in pump
- Autoboluses given for high BG not taken care of by more basal

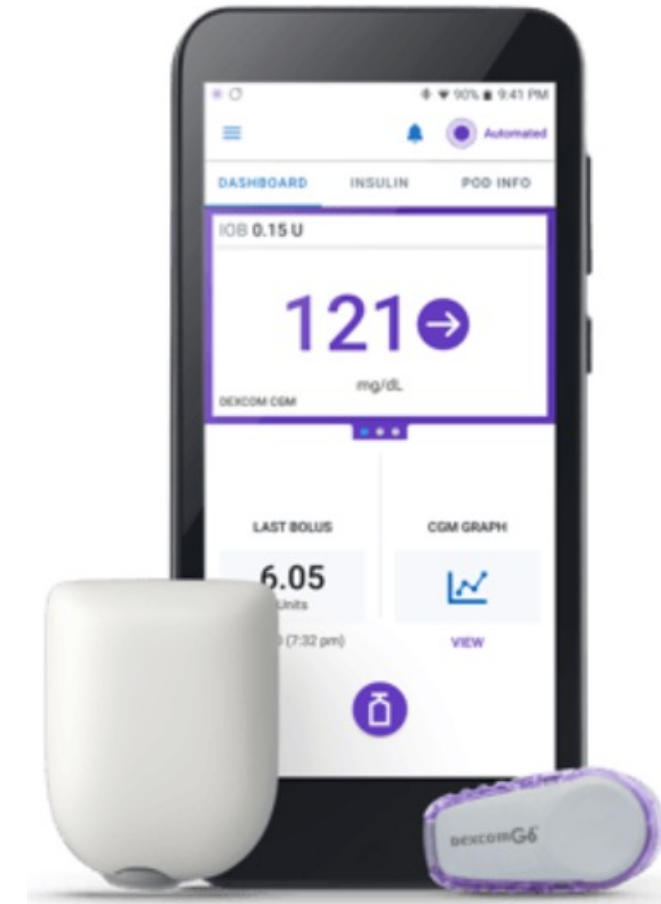
Tandem's Control IQ (X2 pump + Dexcom G6)



- Can change insulin:carb ratio, correction factor, basal rates (all used in algorithm)
- Active Insulin Time set at 5hrs
- Glucose targets can be indirectly changed by usual mode, sleep, exercise mode

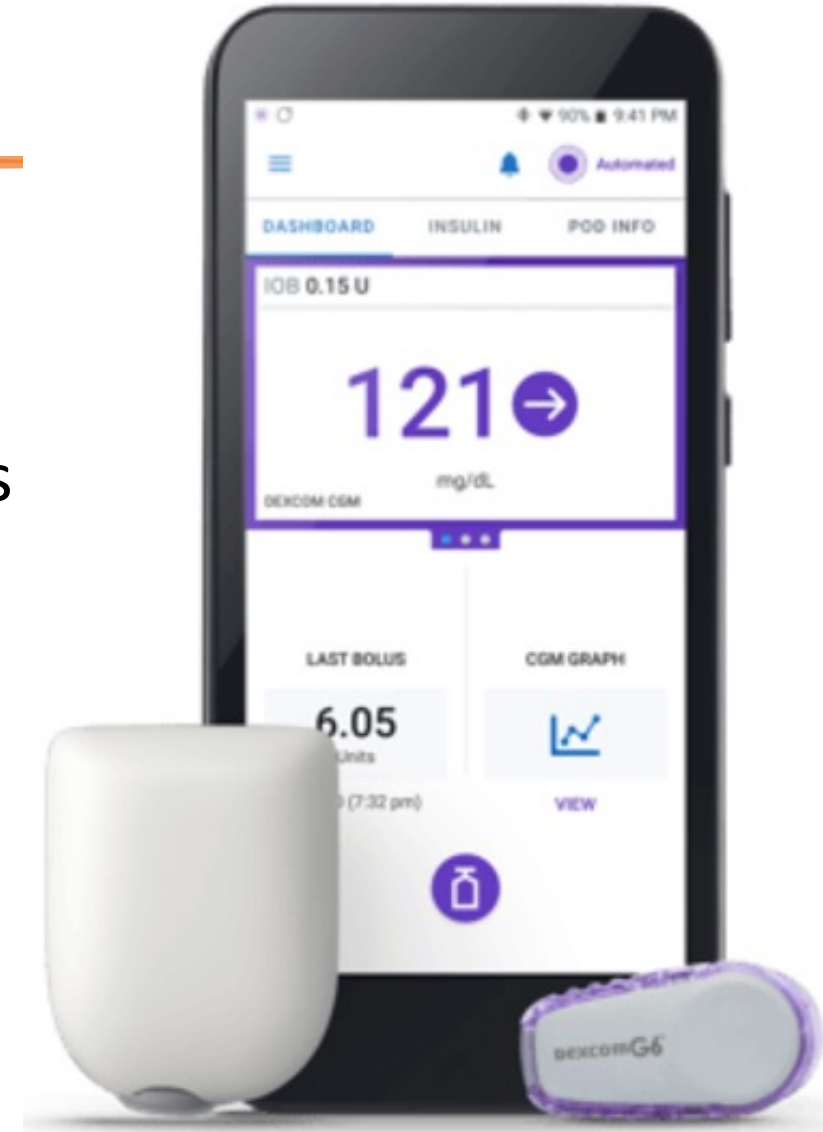
Omnipod 5

- Uses Dexcom G6, no calibration needed
- Bluetooth, algorithm is in the pod
- Need controller to bolus
- Set basal rates inform the first automated delivery, subsequent pods rely on total daily insulin (TDI) to generate adaptive basal rates
- Calculates basal insulin every 5 min based on CGM glucose trends and prior TDI needs, updated with each pod change



Omnipod 5

- If CGM not available, static basal rate delivered based on recent insulin delivery
- Target can be set 110-150 in 10 mg/dL increments
- Activity feature --> raises target to 150; restricts insulin delivery
- Android users can use phone as controller
- can adjust insulin:carb ratios, correction factors, target glucose and active insulin time – but not basal rates



Loop

- Open-source and do-it-yourself (DIY). You take full responsibility for building and running this system
- Loop app runs on iPhone, receives CGM values q5 min
- Older versions required bridging device (Riley Link)



Loop

- Targets customizable glucose value or range by adjusting basal rates
- Pays attention to underlying basal rates
- Custom temporary overrides
- Options to label bolus as slow/medium/fast absorbing





Let's be realistic

- Overall, these systems are amazing –
 - Improved QOL due to better sleep
 - Mitigates high highs and low lows
 - Provides a buffer for carb counting inaccuracies
 - More confidence/trust in the system

BUT:

- This is not a pancreas
- It still requires effort
- You still have to pay attention
- You still have to bolus
- It doesn't erase lows
- You can still get crazy high
- I feel like it's mentally harder when something breaks and you have to resort to a back up



Usually things go great



- But when they don't, it's often because:
 - You were gaming the system prior to the new system and your endo wasn't aware of this
 - You are micro-managing too much
 - Over treating lows
 - Entering fake carbs
 - Not trusting the system
 - Most 'safety issues' in these systems are due to human error

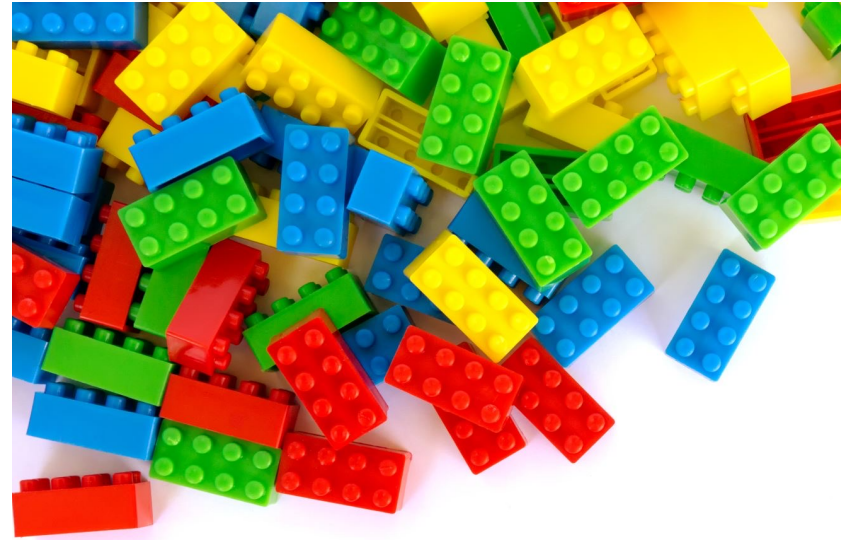


Tips for Success



Get your underlying rates right (?)

- More important for some algorithms, less so in others
- Try to nail down carb ratios
- But even if you do this - not uncommon to strengthen carb ratios, correction factors after starting



Feed the system accurate, on-time information

- Accurate, continuous CGM data
- Enter all carb intake (accuracy is debatable)
- Enter carbs prior to the meal
 - Consider decreasing amount delivered for a late bolus
- Suspend when disconnected



Trust the process (especially early on)

- Do what the system recommends
- Override with care
- Be patient



Control What You Can

- Insulin Stability
- Absorption
 - Set type
 - Rotation of sites
 - Site change frequency

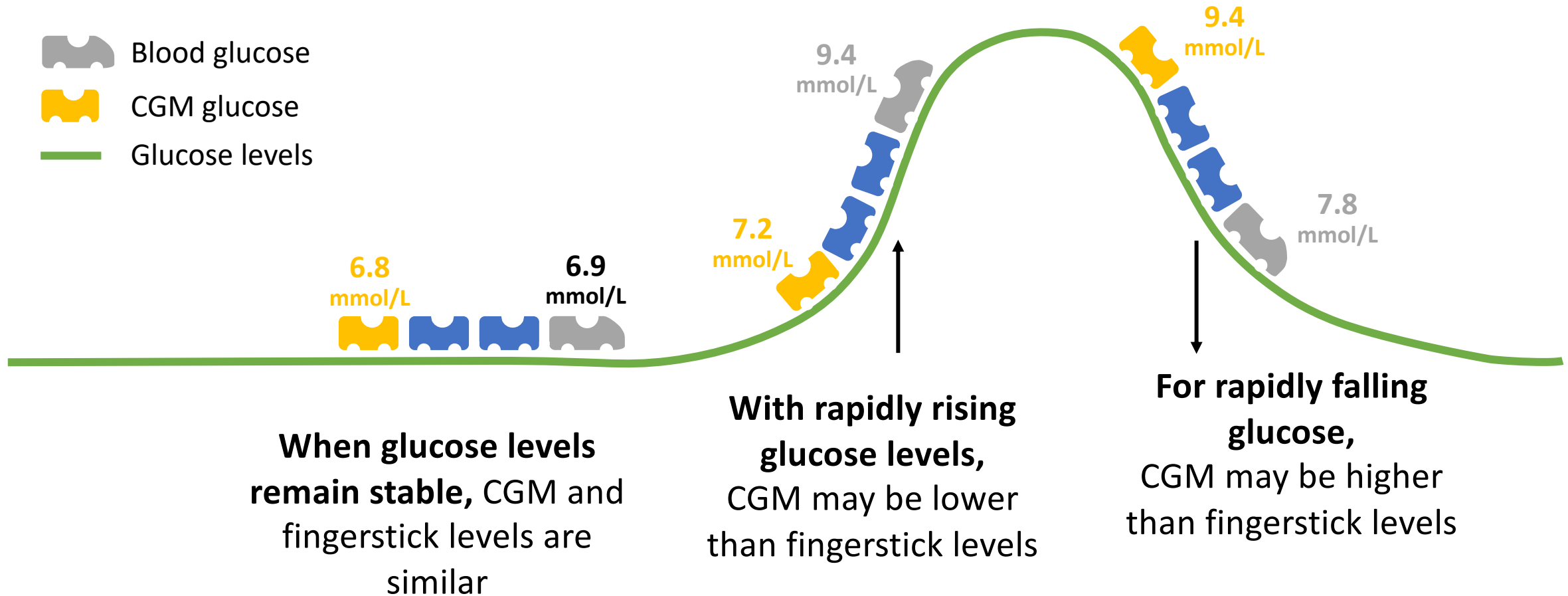


Ease up on the fruit snacks

- Treating a low with your pre-HCL amount will cause a rebound high
- Remember your basal is being decreased/shut off, also helping treat the low
- Don't trust CGM during recovery of a low - significant lag time with rapidly changing glucose levels



There Is a “Lag” Between Fingertstick and CGM Values



Use activity/exercise features

- Specifics depend on HCL system
- Medtronic --> temp target
- Control IQ --> exercise mode
- OmniPod 5 --> Activity mode
- Loop --> custom presets
- Make the change minimum 1 hr before
- Use for more than just exercise
- These often aren't enough for an intense workout



Skin Considerations

- Appropriate site placement
- Prevent skin irritation
- Ensure things stay stuck
- Easy removal, skin healing

- Panther Program Skin Solutions
 - Great tips, pictures and shopping links to favorite products



FIVE TIPS FOR DEVICE PLACEMENT

CHOOSE HEALTHY SKIN

Avoid broken skin, scabs, cuts, and scrapes, and any area of healing irritation. Wait at least a week before reusing a site.



NO BENDY AREAS

Do not place devices in areas where the skin creases with bending, like the waistline.



SWOLLEN TISSUE

Insulin infusion can cause swelling under the skin called lipohypertrophy. If this is present, try not to inject insulin/place infusion sets in this tissue. CGM sensors are okay.



PINCH IT UP

People wear sensors on many different parts of the body—abdomen, buttocks, hips, legs, arms, forearm. Choose an area that has enough fat to “pinch”, and an area that is comfortable for you.



ROTATE

Try to use as many sites as possible! Even if you use only one or two areas of the body, make sure to rotate sites 1-2 inches away from other sites.



FIVE TIPS PREVENTING **SKIN IRRITATION**



CLEAN!

**NO
ALCOHOL**

**SKIN
PREPS**

**HYDROCOLLOIDS
FOR ALLERGY**

**STERIOD FOR
ALLERGY**

In the clinic

- Share CGM and pump data
 - Getting connected in advance improves visit efficiency
- During the visit – be honest about what you are doing – this is a judgement free zone
 - Rage bolusing, fake carbs, overtreating lows
- Tell us what you love/don't about current system
- Ask about in-warranty upgrades to current system, logistics of the upgrade



In the clinic, part 2

- Consider 1:1 education visit a few months after starting a new system
 - Do a deeper dive of the data
 - Ensure appropriate use of advanced features
 - Fine tune settings
 - Learn to review & interpret data on your own
- Plan far in advance of warranty expiring
 - Ask about new systems approved or close to approval
 - Planned upgrades to current system
 - Weigh pros/cons of switching
- Know what you want and why – 4 years is a long commitment



Resources



T1D: DEVICES



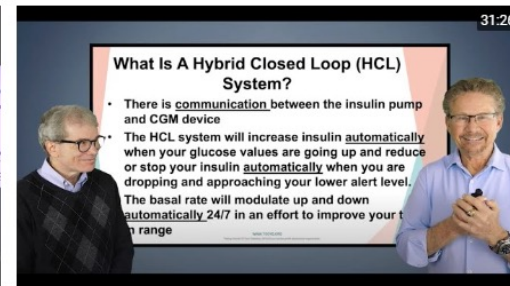
The Only Type 1 Lecture You'll Ever Need! Top Tips from Three Endos ...

Dr. Steve Edelman, Dr. Jeremy Pettus and Dr. Leslie Eiland have a combined 100 years of living with diabetes, and 60 years of treating people with diabetes. They share their most important lessons and tricks for living with type 1 (stuff you won't



The Newest Type 1 Technology - Launched or Launching Soon!

Ten years ago, who would have thought we could download our blood glucose numbers onto our smart phones? The times they are a changing, and thankfully so are the life expectancies of those living with type 1. Hear about all the innovations



Hybrid Closed Loop Systems: Revolutionizing T1D


Create some technological magic by marrying your pump with your CGM. Learn how to use a computer program called an "algorithm" to take data from both your pump and CGM to adjust your pump's insulin delivery automatically.


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 Comfort

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Dexcom G6 & Omnipod



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Medtronic 770G



Control IQ



Summary

The Medtronic Minimed 770G has SmartGuard technology, taking action if sensor glucose levels go below the preset level. The hybrid closed-loop system adjusts basal insulin levels up



This system is loved by many and is the furthest ahead in terms of getting connected systems to more people. Combines the Tandem t: slim x2 with the Dexcom continuous glucose

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Hybrid Closed Loop Comparisons & Options

Home / What is a Hybrid Closed Loop System? / Hybrid Closed Loop Comparisons & Option

Hybrid Closed Loop Systems

> What is a Hybrid Closed Loop System?

> Hybrid Closed Loop Comparisons & Options

Understanding your options and how they compare can help you decide which hybrid closed loop system would best meet your needs. **Not your doctor's. Not your health insurance's. YOURS.**

There are several HCL systems available: some that have been approved by government authorities

Essential resources and guidance for health care professionals working with diabetes technology.

[Point-of-Care Clinic Tools >](#)

[Device Comparison Chart >](#)

[Skin Solutions >](#)

[Device Info-Sheets >](#)



	MiniMed 670G / 770G	MiniMed 780G	Insulin X2 Control-IQ	Omnipod 5
CALCULATE	Auto Mode	SmartGuard	Control-IQ	
What is automation called?	Automated basal insulin delivery calculated based on total daily insulin from past 2-6 days (Fixed basal)	Automated basal insulin delivery calculated based on total daily insulin from past 2-6 days (Fixed basal)	Automated basal insulin delivery that is or decreases programmed basal rate	
Basal automation?				
Bolus automation?	No (Auto basal only to respond to hypoglycemia)	Auto-correction bolus if glucose > 120 mg/dL and at maximum "auto basal" delivery	Auto-correction bolus (max 1-hour) if predicted to be > 130 mg/dL, delivers calculated bolus	
Algorithm target (IC range)?	120 mg/dL	"80 Target" 100, 110, 120 mg/dL	110-160 mg/dL (range)	
ADJUST	MiniMed 670G / 770G	MiniMed 780G	Insulin X2 Control-IQ	
Can users adjust Basal rates?	X	X	✓	
Can users adjust IC ratios?	✓	✓	✓	
Can users adjust correction factor (sensitivity)?	X	X	✓	
Can users adjust active insulin time?	✓	✓	No, fixed at 5 hours	
Can users adjust correction target?	No, fixed at 150 mg/dL	No, fixed at 120 mg/dL	No, fixed at 110 mg/dL	
Can user give override boluses?	X	X	Yes (limited up to 2 hours)	
Can user (change/override) recommended bolus doses?	X	X	✓	
What are the special features in automation?	Temp Target, Changes target glucose to 150 mg/dL for set duration (30 min - 12 hr)	Temp Target, Changing target glucose to 150 mg/dL for set duration (30 min - 24 hr)	Exercise Activity Changes target range 160 mg/dL (manual start/stop only), Active, Exercise target range to 150 mg/dL, and prevents auto corrections, or to be used during sleep	

Automated Insulin Delivery

OMNIPOD 5

What does the Omnipod 5 system do?

Automatically deliver basal insulin, aiming for the target glucose value you choose. You can choose a target glucose from 100-150 mg/dL (in 10 mg/dL increments) and can program different target glucose values for different hours of the day. Calculates basal insulin delivery every 5 minutes based on CGM glucose trends and your total daily insulin (TDI) needs. The pod tracks your TDI and updates it with each pod change.

When will it revert to regular pump mode (manual mode)?

Will stay in automated mode as long as the pod and CGM are connected and CGM data is available. If CGM data is not available (e.g. sensor warm up or sensor error), the system will deliver a static basal rate (Automated Mode: Limited). Based on recent insulin delivery. When CGM data returns, full insulin automation will resume. Users should revert to manual mode if ketones are elevated, or desire to use temporary basal rates (e.g. illness).

Which CGM does it use?

Dexcom G6: Factory calibrated CGM (does not require calibration)
Users must use the Dexcom G6 mobile app on a compatible phone (cannot use the G6 receiver). Sensor sessions are started on the Dexcom G6 mobile app and then the transmitter ID is entered into the Omnipod 5 app to "pair" the CGM to the

FIVE TIPS FOR DEVICE PLACEMENT

CHOOSE HEALTHY SKIN

Avoid broken skin, scabs, cuts, and scrapes, and any area of healing irritation. Wait at least a week before reusing a site.



NO BENDY AREAS

Do not place devices in areas where the skin creases with bending, like the waistline.



PINCH IT UP

People wear sensors on many different parts of the body—abdomen, buttocks, hips, legs, arms, forearms. Choose an area that has enough fat to "pinch", and an area that is comfortable for you.



ROTATE

Rotate sites as many times as possible! Even if you use only one or two areas of the body, make sure to rotate sites 1-2 inches away from other sites.



How can I use it best?

Wear pod and CGM sensor on the same plane of the body (within "line of sight") to optimize communication between the pod and the CGM.

Pre-bolus for all meals, especially breakfast. There is often very little insulin on board leading into mealtime, making pre-bolusing especially important to reduce big spikes in blood sugar after eating.

Follow the bolus calculator recommendations for correction boluses for high glucose as there may be a lot of insulin-on-board from automated insulin delivery—giving more insulin than recommended may result in low blood sugars.

You can adjust your IC ratios, correction factors, Target Glucose and active insulin time to improve glucose control in automated mode, but you cannot adjust basal rates.

In Summary, currently available AID systems:

- Reduce lows
- Improve time in range
- Allow you to get your A1c below your goal without excess hypoglycemia
- Help but won't prevent post-meal highs
- Improve glucose fluctuation/variability
- **Most** experience improved quality of life



Questions?

