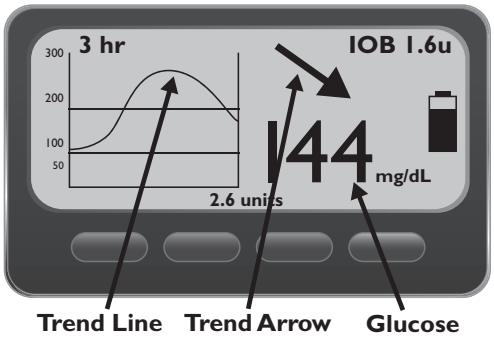
1.1 Recommended Goals

- A1c 7.0% or less, or 14-day average glucose of 154 mg/dL (8.5 mmol/L) or less
- Time in range over 70%
- Time below range less than 3% and none below 54 mg/dL (3 mmol/L)
- Glucose variability below 30%

1.2 Pump with CGM Receiver



1. **Glucose values** are updated every 5 min.
2. **A glucose trend line** on the screen shows glucose direction and change rate over 1, 3, 6, 12, and 24 hours.
3. **Trend arrows** with an approximate direction and rate of change in glucose.
4. **IOB** – units of active insulin on board.

1.3 How a Manual Insulin Pump Delivers Insulin

Basal Rates	Steady, around-the-clock basal insulin delivery matches background insulin needs to keep glucose levels steady and in range when fasting. Basal rates provide about half of the **total daily dose (TDD) of insulin**.
Carb Boluses	Spurts (boluses) of insulin are manually entered and delivered to counterbalance the glucose rise from carbs (and some fat and protein) after food.
Correction Boluses	Spurts of insulin that correct for insulin deficits in basal rates or carb boluses.

1.4 Why Wear a CGM?

- Better glucose outcomes
- Alerts warning of lows and highs
- Avoid frequent lows & hypo unawareness
- Seeing the impact of food and exercise
- Know ahead of time a child is going low
- Lower glucose before & during pregnancy
- Security while asleep or living alone
- Safer driving, travel, high-risk profession
- Sharing glucose data
- AID systems require CGM readings

1.5 Check Your CGM Reading

Before breakfast - Start the day well to improve the rest of the day. Testing the night basal improves breakfast readings.

Before lunch and dinner - Shows how carb boluses cover the carbs eaten at breakfast and lunch, respectively.

After meals - Correct highs or lows sooner.

At Bedtime - Cover dinner better and prevent night lows.

Before driving and during long trips - Keeps you and others safe.

Before, during, and after increased activity - Better performance and safety.

Any time you may be low or high - Stop lows and correct highs faster.

1.6 CGM Calibration Tips:

- Use the most accurate glucose meter available.,
- Use clean fingers and non-expired strips.
- Enter meter readings into the CGM receiver right away.
- Calibrate when the glucose is flat.

Replace CGM sensor if readings don't improve after 2 cals.

1.7 When to Verify a CGM Reading with a Fingerstick

- Calibrate your CGM any time the CGM reading differs from a finger-stick reading by over 20 mg/dL (1.1 mmol/L) at a glucose below 200 mg/dL (11.1 mmol/L) or by 30 mg/dL (1.7 mmol/L) for readings above 200 mg/dL.
- Any time your symptoms differ from the CGM's reading.
- When recent CGM readings have been erratic.
- When a correction bolus does not lower a high glucose within 3 hours.
- Before driving, especially if your trend line or arrow is falling.
- When the CGM reads low at night but the sensor was possibly compressed by sleeping on it.

After treating a low glucose, fingerstick readings are more accurate than the CGM for 20 to 30 minutes.

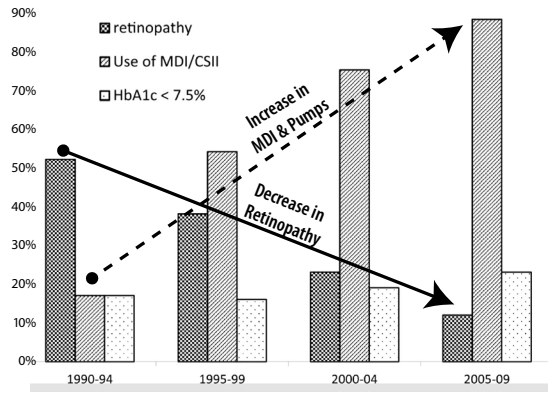
1.8 U.C. Panther Program Compares AIDs

The University of Colorado Barbara Davis Center for Diabetes provides complete information about available AID systems at www.pantherprogram.org/device-comparison.

1.9 Considerations When Choosing a Pump, CGM, and AID System

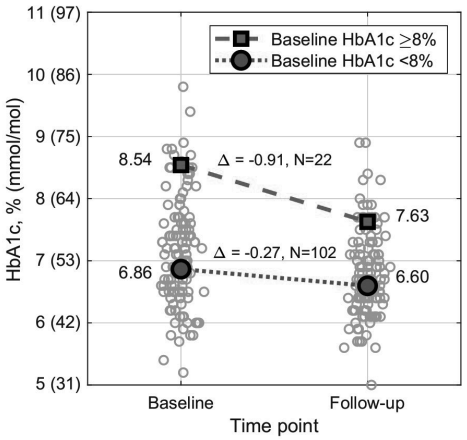
1. Can you easily bolus, adjust settings, and change a cartridge, infusion set, and sensor?
2. Can you hear the pump alerts or feel alert vibrations?
3. Does the pump cartridge hold 2 to 4 days of insulin?
4. Can you read the text on the screen?
5. Will your smartphone communicate with the AID and CGM?
6. Can you press the pump or screen buttons?
7. Can you upload or print data for clinic visits?
8. Can a caregiver quickly learn to operate the devices for a child or someone ill?
9. Do you like its look, feel, colors, features, and accessories (clips and cases)?
10. How good are 24-hour customer support, insurance coverage, and the warranty?

1.10 Use of Pumps & MDI Lessens Retinopathy



Between 1990 and 2009, retinopathy (in the solid line) declined significantly as the use of MDI and pumps (in the dashed line) increased among 1,604 adolescents and young adults with Type 1 diabetes.[15]

1.11 AID Systems Lower High A1cs



These 2021 A1c values are for 124 adults, 14–70 years old, before and three months after starting on an Omnipod 5. The bottom line shows how the A1c changed for a starting A1c below 8.0%. The upper line shows the change for those with a starting A1c above 8.0%.[19]

1.12 Differences in the Three Major Types of Diabetes			
	Type 1	**Type 2 with antibody or loss of insulin production**	**Type 2**
Avg. age at start	12	46	61, now falling with the increase in teen onset
Typical age at start	3 - 40*	15-70*	35-80*
% of all diabetes	5% (20%**)	15%	80%
Insulin problem	absence	deficiency	resistance
Time to insulin start	days	months or years	years, decades, or never
Antibodies	IA-2A, GAD65, IAA, ZnT8Ab, ICA***	mostly GAD65, some IA-2	none
Other helpful tests	low C-peptide	low or normal C-peptide	normal or high C-peptide, low HDL, high TGs

* May occur at any age
** With inclusion of all antibody positive cases, i.e. Type 1 and Type 2 with +antibodies
*** For free antibody testing, visit TrialNet.org/participate or AskHealth.org

1.13 Medications That May Reduce Post-Meal Spiking						
Type	**Brand Names**	**Dose Timing**	**FDA Approval**	**Action**	**Effect on Insulin**	**Cautions**
GLP-1 Agonist & Incretins	Ozempic Trulicity Mounjaro	Weekly injection	For Type 2 (and Type 1)	Lower weight, delay food absorption, decrease appetite, and lower glucagon levels, less CVD and renal disease	Lowers insulin doses	Nausea, diarrhea, vomiting, headaches, dizziness, sweating, indigestion, constipation
Amylin	Symlin	Injected before meals	For Type 1 and Type 2	Delays gastric emptying, decreases glucagon secretion, decreases appetite	Lowers insulin doses	Use glucose for lows, nausea, vomiting, poor appetite, stomach pain, headache
SGLT-2 Inhibitors	Farxiga Invokana Jardiance Steglatro	Pill	For Type 2,	Blocks reabsorption of glucose in kidney	Lowers insulin doses	Urinary tract and kidney infections, fungal infections, DKA (dehydration, coma)
DPP-4s	Januvia Nesina Onglyza Tradjenta	Pill	For Type 2	Raises GLP-1 by blocking dipeptidyl peptidase-4 enzyme	Lowers insulin doses	Nausea, diarrhea, stomach pain, headache, runny nose, painful skin rash

2.1 Who Controls the Settings?					
AID System	**Basal Rate**	**CarbF**	**CorrF**	**DIA**	**BG Targets**
Beta Bionics*	AID	AID	AID	AID	110, 120, 130
DIY Open-source Systems	Both	User	Both	User	80 to 150
Medtronic 780G	AID	User	AID	Both	100, 110, 120
Insulet Omnipod 5	Both	User	Both	AID	110-150
Sequel medTech twiist	Both	Both	Both	User	87 to 180
Tandem t:slim and Mobi	Both	User	Both	AID	112.5-160
Both = User and AID share control	* Body weight & glucose target are the only user settings.				

2.2 AID Settings – Specific Setting Options that Lower Highs and Stop Lows		
AID System	**To Lower a High Average Glucose, Give More Insulin**	**To Reduce Excess Hypoglycemia (Lows), Give Less Insulin**
All AID Systems	Do not reduce recommended bolus unless covering activity or excess IOB. Bolus 15 to 20 min. before all meals. Select the lowest target glucose.	Do not increase recommended boluses. Don't enter fake carbs to get a larger bolus. Raise the CarbF* and target glucose.
Beta Bionics iLet ACE Pump	Set target glucose to "lower", 110 mg/dL (6.1 mmol/L). Use consistent meal sizes.	Set target glucose to "usual" 120 (6.7) or "higher" 130 mg/dL (7.2 mmol/L). Use consistent meal sizes, no fake carbs.
Insulet Omnipod 5	Lower the target glucose. Lower the CarbF or CorrF (ISF).* Turn reverse correction off. Shorten the DIA time.	Set target glucose to 130 or 140 mg/dl. Raise CarbF or CorrF (ISF).* Turn reverse correction on. Start Activity Mode (24 hrs).
Tandem Diabetes Control-IQ	Lower CarbF.* Use a CorrF* as low as 1400/TDD. Raise basal rates. Use Sleep Mode (112.5 target) all day.	Raise CarbF* or CorrF.* Lower basal rates. Turn on Activity Exercise (140 to 160 mg/dL, on/off).
Medtronic 780G SmartGuard	Lower the CarbF (IAT).* Shorten the DIA time, especially if premeal boluses are often missed. Lower target glucose. Turn on auto-correction.	Raise the CarbF (IAT).* Lengthen the DIA time. Raise target glucose. Turn off auto-correction.
* CarbF and CorrF values are lowered when more insulin is needed and raised when less insulin is needed.		

2.3 Features for Major AID Brands							
Features:	**Beta Bionics iLet ACE Pump**	**CamDiab CamAPS FX**	**Medtronic 780G SmartGuard**	**Omnipod 5 SmartAdjust**	**Sequel MedTech twiist**	**Tandem t:slim X2**	**Tandem Mobi**
AID Algorithm	Dosing Decision Soft.	CamAPS FX	SmartGuard	Automated Mode	Tidepool Loop	Control-IQ+	Control-IQ+
Size & Weight	3.58 x 2.32 x 0.59 in, 3.88 oz.	3.35 x 1.73 x 0.75-0.87 in, 2.9 oz	3.81 x 2.18 x 1.01 in, 3.74 oz.	1.53 x 2.05 x 0.57 in, 0.92 oz.	2 in. diameter, 2 oz.	3.13 x 2 x 0.6 in, 3.6 oz.	2.02 x 1.47 x 0.56 in, 1.06 oz.
Cartridge Size	180 units	160u YpsoPump, or 300u Sooil DANA-i	300 units	200 units	300 units	300 units	200 units
Algorithm	Adaptive basal & correction + meals	MPC, treat-to-target + adaptive basal Q10 min	PID + adaptive basal & model controls	MPC + adaptive basal every 5 min	DEKA Loop MPC	MPC + adaptive basal 30 min BG prediction	MPC + adaptive basal 30 min BG prediction
Approved for	6 yrs and older	1 yr +, pregnancy	7 yrs and older	2 yrs and older	6 yrs and older	2 yrs and older	2 yrs and older
CGM (wear time, warm-up)	Dexcom G7 (10 days, 30 m), Libre 3 (14 days, 1 hr)	Dexcom G7 (10 days, 30 m), Libre 3 (14 days, 1 hr)	Simplera (7 days, 2 hrs), Libre 3+ (15 days, 1 hr)	Dexcom G7 (10 days, 30 m), Libre 2+ (15 days, 1 hr)	Pending	Dexcom G7 & G6 (10 days, 30 m) & Libre 3+ (15 days, 1 hr)	Dexcom G7 (10 days, 30 m) & G6 (10 days, 2 hr)
Bolus Max/Increm	24 u / NA	0.01 u/hr	25 u / 0.025 u	30 u / 0.05 u	25 u / 0.01 u	25 u / 0.01 u	25 u / 0.01 u
Basal Max/Increm	11.5 u/hr / 0.01 u/hr	0.01 u/hr	35 u/hr / 0.025 u/hr	30 u/hr / 0.05 u/hr	30 u/hr	15 u/hr / 0.001 u/hr	15 u/hr / 0.001 u/hr
Water Tolerance	IPX8: 12 ft, 30 mins	IPX8: 3 ft, 60 mins	IPX8: 8 ft for 24 hrs	IP28: 25 ft, 60 min	IPX8: 12 ft for 1 hr	IPX7: 3 ft, 30 min	IP28: 8 ft for 2 hrs
Target Glucoses	110, 120, or 130.	104 default 80 to 198 every 30 min.	100, 110, or 120. for SmartGuard, 120 for auto-corrections	110, 120, 130, 140, or 150 for different times of day	87 to 180 mg/dL	Corrections to 110 112.5 to 160, Sleep: 112.5-120	Corrections to 110 112.5 to 160, Sleep: 112.5-120
Exercise Target	130 mg/dL	140 to 200 mg/dL	Temp Target 150 mg/dL (2-24 hrs)	150 mg/dL (2-12 hrs), lower basal	150 to 180 mg/dL	Exercise Activity 140-160 mg/dL	Exercise Activity 140-160 mg/dL
Extended boluses?	No	Yes, up to 8 hrs	No	No,	Yes, using emojis	Yes, up to 8 hrs	Yes, up to 8 hrs
DIA/IAT	AID controlled	2-6 hrs, AID control	2-6 hrs	2-6 hrs, but AID controlled	6 hrs	AID controlled, about 5 hrs	AID controlled, about 5 hrs
Phone Bolusing	Not yet.	CamAPS FX app on Android phone	Not yet.	Android and iPhone	iPhone and Apple Watch	iPhone & Android + Quick Bolus (u or g)	iPhone + Quick Bolus (u or g)
Remote viewing		Diasend, SMS alerts, Dexcom Follow	Carelink Connect app	Dexcom Follow app, Glooko	iPhone app	Tandem Source Website & Dexcom Follow	Tandem Source Website & Dexcom Follow
Cloud data	iLet Bionic Pancreas app	Diasend/Glooko	MiniMed app	Omnipod 5 app	Tidepool AGP	t:slim Mobile App, Tandem Source Website	Mobi App, Tandem Source Website

2.4 AID Algorithms Explained

Automated Insulin Delivery (AID) systems are changing diabetes management. Like the effect of self-driving cars and smart appliances on other aspects of our lives, AID systems are revolutionizing diabetes management. Two major algorithms form the base for different AID systems: **Model Predictive Control (MPC) and Proportional-Integral-Derivative (PID)**.

One way AID systems differ is in their use of predictions and/or historical data. MPC algorithms in Beta Bionics, Omnipod, and Tandem regulate glucose through 30 or 60 minute glucose predictions, while PID in Medtronic looks back at more historical data. Some algorithms combine MPC for lowering glucose with PID for preventing lows.

Algorithms work as glucose guardians. MPC is more complex, handling the trials of daily life, including meals, exercise, and stress. It uses equations to predict and maintain glucose levels within a safe range while minimizing the risk of low glucose. The PID algorithm acts as a quick responder, rapidly calculating insulin dose adjustments based on the difference between your target and current glucose levels. Both MPC and PID consider uncertainties in glucose dynamics through **controls**.

Unlike the straightforward math and coding in MPC and PID algorithms, **machine learning and neural network controls behave differently, making them harder to explain**. These controls learn from historical glucose and insulin dosing data to improve glucose control and enhance algorithm operation. They identify patterns, relationships, and trends in the data that may not be apparent to human observers. Controllers provide increasingly accurate and individualized insulin dose recommendations by adapting to the user's changing needs and circumstances. Systems combine different controls to minimize hypoglycemia and correct hyperglycemia.

Adaptive and robust controls deal with the uncertainty and imprecision in meals, exercise, insulin delivery, and many other factors. They provide adaptive and robust management for changing glucose dynamics related to prior personal preferences and habits.

Different AID systems combine various controls into their base algorithm. For example, the Tandem Control-IQ system integrates a treat-to-range MPC module with an **adaptive component** that features basal-rate modulation, automated correction boluses, and a dedicated hypoglycemia safety system.

2.5 Tips for Using an AID System or Insulin Pump

- Keep quick carbs like SweetTarts, Smarties, or Rockets handy (all contain glucose as dextrose) to treat lows.
- When low, your AID system has already reduced basal insulin and IOB, **so you need fewer carbs to treat low glucose. DON'T OVERTREAT LOWS**.
- Likewise, you will need smaller boluses when treating high glucose because your AID has already increased insulin delivery. **DON'T OVERTREAT HIGHS**.
- **Do not stop your pump to treat low glucose.** The stoppage has little or no effect until more than an hour later, with a glucose spike two or three hours later.
- Unexpected high glucose? Check your infusion set or pod.
- Avoid micro-management.
- Remember how to manage glucose if the AID fails or supplies are unavailable.
- Frequent lows? Temporarily raise your target glucose until you identify the cause.

2.6 How Many Carbs Do You Really Need for a Low Glucose?

1. Grams needed for a low glucose

On a pump, take 1 gram of a quick carb for each 10 lbs (4.5 kgs) of body weight, while half these amounts are typically needed on AID. For example, someone who weighs 160 lb (72 kg) needs 16 grams (8 grams on an AID), while someone who weighs 220 lb (100 kg) needs 22 grams for the low glucose. Use at least 6 grams for a small child.

2. Grams needed to cover excess IOB with a low glucose.

Multiply the units of IOB times your CarbF for how many extra carbs you need.

For example, if someone weighs 130 lbs (59 kg) and has a glucose of 50 mg/dL (2.7 mmol/L) with 2 units of IOB and a CarbF of 1u/11 grams:

a) 130 lbs = 13 grams for the low glucose
b) IOB x CarbF = 2 units x 11 grams/unit = 22 grams to cover the IOB
c) 13 g + 22 g = up to 35 grams to treat this low glucose.

Eat these carbs and recheck your glucose 20 to 30 min. later.

3. Bolus for any carb grams greater than #1 plus #2.

4. Recent physical activity requires additional free carbs. (See Chap. 18.)

5. AID systems lower basal delivery to prevent going low. Because this reduces IOB, fewer carbs are needed to treat lows.

3.1 Types of Soft Sets

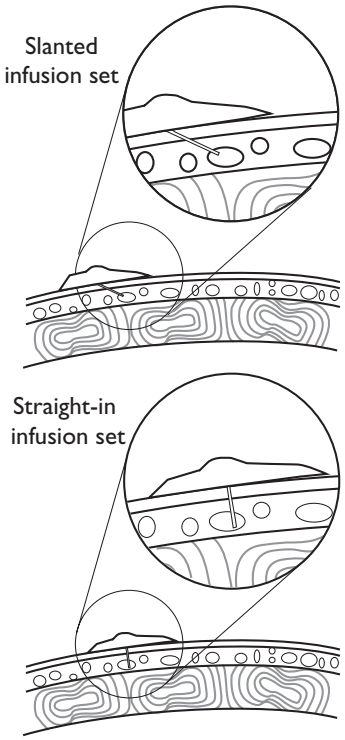
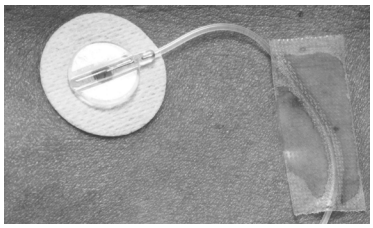
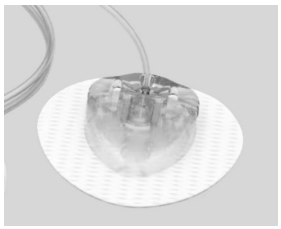
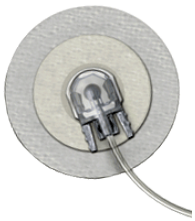


Fig. 3.3 Anchoring Helps



Anchor the infusion line with tape to significantly reduce set failures.

3.2 Wide Variety of Infusion Sets to Choose From

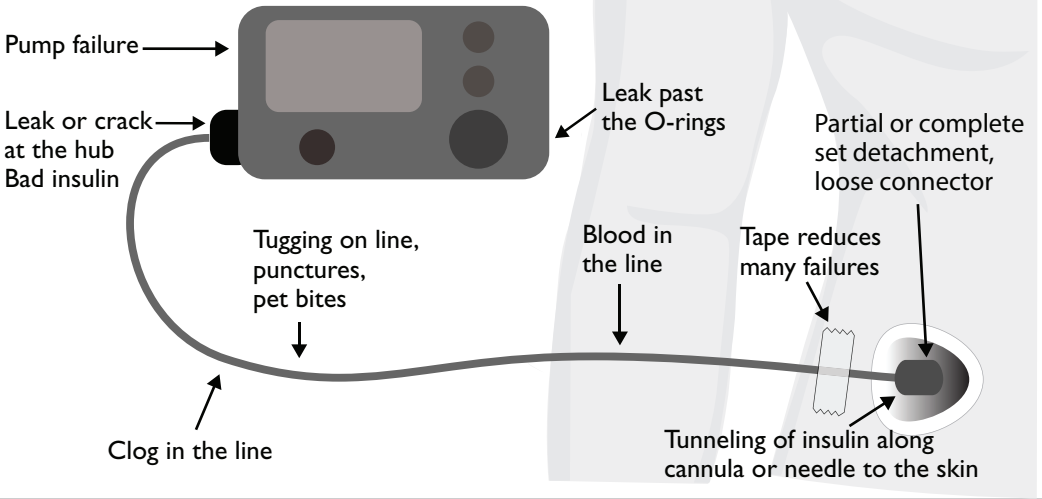
	Name	Cannula/Needle	Connection	Tubing
	Extended up to 7 days	Plastic, 90 degree, straight-in 6, 9 mm, 25 gauge cannula	Pinch & pull at site, proprietary	23, 32 inches
	TruSteel, Sure-T, Contact Detach, Rapid D	Metal, straight-in 6, 8, 10 mm 29 gauge needle	Pinch & pull 3 inches from site. Luer lock or proprietary	23, 32, 43 inches
	Ultraflex *	Plastic, straight-in 6, 8, 10 mm 25 gauge cannula	Pinch & pull at site Luer lock	24, 32, 43 inches
	AutoSoft 90, Mio 90 *	Plastic, straight-in 6, 9 mm 25 gauge cannula	Pinch & pull at site* Luer lock for Inset or proprietary for Mio	18, 23, 32, 43 inches
	Inset 30. Mio 30, and AutoSoft 30*	Plastic, slanted 30-45 degree, 13 mm 25 gauge cannula	Pinch & pull at site* Luer lock	23, 43 inches
	Varisoft, Silhouette *, Tender, * Comfort*	Plastic, 20-45 degree slanted, 13 or 17 mm cannula 25 gauge cannula	Pinch & pull at site* Luer lock or proprietary window over site	23, 32, 43 inches
	Autosoft XC	Larger grip for disconnecting	Pinch & pull at site*	5, 23, 32, or 43 inches

* Inserter Available

See also www.diabetesnet.com/diabetes-technology/infusion-sets

Figure 3.4 Where Insulin Delivery Can Fail

Successful insulin delivery brings insulin into your body through a flexible tube that ends with a small plastic cannula or metal needle inserted just under the skin. The cannula or needle is held in place on the skin by an adhesive patch.



3.5 Be Prepared for Infusion Set Failure

1. Suspect Infusion Set Failure When:

- You have symptoms of high glucoses such as thirst, frequent urination, tiredness, fruity breath or stomach ache.
- Ketones are elevated. See Box 3.8.
- Glucose stays high (above 300 mg/dL or 16.7 mmol/L) after a correction bolus and continues to rise.

2. Act Fast:

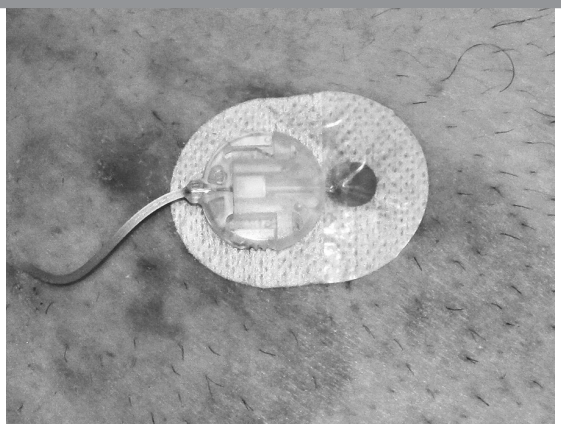
- Give insulin by pen or syringe to cover the high glucose and missing basal delivery.
- Change the infusion set and resume basal rate.
- Check glucose every 30 minutes until you are sure the infusion set is working and your glucose stays below 240 mg/dL (13.3 mmol/L).

3. Know Who to Call:

- Manufacturer's help line
- Your healthcare professional

3.6 Infusion Set Options	
Steel	**Soft**
• No kinking • Straight • Lower profile for children, sports, or carrying a child • Disconnects away from needle – anchoring only needs to be done once at insertion • Manual insertion • Few to no silent occlusions • Small 28-30 gauge needle • Biocompatibile with less back pressure37 • Straightforward insertion	• More selection • Straight or slanted • Less needle phobia with autoinserter • Disconnects at cannula – anchoring of line advised after each disconnect • Higher profile • Manual or automatic insertion • No tugs on cannula if anchored • Possible silent occlusions • A larger 25 gauge plastic cannula and 27 gauge introducer needle
• Omnipod has an angled soft cannula that reaches a depth of about 5 mm or 0.2 inch. • Tandem Mobi is a small attached pump that uses infusion sets as short as 5 inches.	

Fig. 3.7 Pump Bumps & Lipohypertrophy



Multiple pump bumps (dark spots) can be seen at infusion sites in someone not rotating sites or anchoring infusion lines with tape. Lipohypertrophy (fat enlargement) was also present.

3.8 Ketone Testing Meters

The **Freestyle Optium Neo, Abbott Precision Extra, and Nova Max Plus** meters test glucose in 5 seconds and ketones in 10 seconds using different strips. A blood ketone level below 0.6 mmol/L is normal. A level between 0.6 and 1.5 mmol/L shows early ketosis. When a ketone level is above 1.5 mmol/L, you are at a high risk of developing serious DKA.

Bayer Ketostix or Keto-Diastix strips test urine ketones without a meter. A moderate or large urine ketone test indicates ketosis or severe diabetic ketoacidosis (DKA) is underway. Urine testing takes longer to detect DKA.

Ask your clinician for a prescription.

4.1 Handy AID and Pump Gear

- Fast-acting carbs
- CGM and sensors
- Rapid-acting insulin pen
- Long-acting insulin for basal backup
- Spare infusion sets and cartridges
- 70% alcohol pads
- Glucagon kit for a severe low
- Blood ketone meter or urine ketone test strips for severe highs
- Diabetes identification
- Emergency phone numbers

4.2 Diabetes Websites, Forums, and Blogs

- American Diabetes Assoc.: www.diabetes.org
- National Institute of Diabetes & Digestive and Kidney Diseases: www.niddk.nih.gov/health-information/diabetes
- American Assoc. of Clinical Endocrinologists: www.aace.com
- Association of Diabetes Care & Education Specialists: diabeteseducator.org
- Breakthrough T1D: https://www.breakthrought1d.org/
- A Sweet Life: asweetlife.org
- Beyond Type 1: beyondtype1.org
- Children with Diabetes: childrenwithdiabetes.com
- Diabetes Mine: diabetesmine.com
- Diabetes Services: diabetesnet.com
- Diabetes Strong: diabetesstrong.com
- DiaTribe: diatribe.org
- Integrated Diabetes Services: integrateddiabetes.com
- Six Until Me: sixuntilme.com/
- TCOYD: tcoyd.org
- T1D Exchange Glu: myglu.org
- Type One Nation: jdrf.org/community/typeonenation

4.3 Where to Wear a Pump

There is a wide range of clothing, cases and carriers, backpacks for kids, sleep and sports clothing with specially designed pockets, and pouches that attach to a bra or garter belt. This head-to-foot list comes from Barb Chafe of Insulin Pumpers Canada and other pumpers!

- Inside clothing so only the pump clip shows
- Clipped on a bathrobe
- In bicycle/tennis shorts worn under clothing
- In a regular or sports bra in the front middle
- In a baby sock pinned inside clothing
- Clipped onto the back of a bra
- Clipped onto a bra under the arm
- In a shelf bra sewn into the top of a camisole
- In a garter or garter belt
- Inside pump cases like the Waist-It, Thigh Thing, Clip-N-Go, Leg Thing, or Sports Pak
- In a vest with pockets for electronic gadgets
- Slipped under a pillow at night
- Pinned or clipped to bedsheets
- In pockets sewn on the outside of clothing with the tubing threaded through the back of the pocket.
- In Tubi-Grip, a stretchy wrap from home health stores that can be put around an arm or leg
- In a pocket sewn inside a bathing suit, favorite jammies or on clothing
- Carried in a fanny pack
- On a backpack strap
- Strapped on the arm
- Velcroed or safety-pinned in homemade products
- In body slimmers under other clothing
- In your boot
- Strapped to a thigh or calf with elastobandage
- In a Frio pump wallet for extreme cold or heat
- Clipped to your belt/waistband - front or back
- Slipped into the top of your sock with the tubing running down the leg
- In a smartphone case or change purse
- In a leather gun holster
- In a money belt
- Hanging in a pouch attached to a strap around the neck (useful when trying on clothes at a store)
- Hanging with a carabiner (mountain-climbing clip) or with a key ring and case
- Strapped to the headboard of the bed

4.4 Know What To Do If Your AID System or Pump Stops Working

Should your AID system cease to function or you find yourself without supplies, transitioning back to injections is a straightforward process. Keep an insulin pen or syringes and a bottle of rapid-acting insulin at hand, along with an insulin pen containing 24-hour glargine or Lantus to replace basal insulin delivery. It's important to note that longer-acting Treshiba and Toujeo can complicate transitions and are not recommended.

Insulin syringes, as well as Regular and NPH insulins, are readily available without prescription, letting you manage your insulin needs. With its shorter action time, NPH requires two equal injections daily to replace basal insulin. Walmart ReliOn Regular (R) and NPH (N) insulins are accessible and competitively priced options. In case of an insulin shortage, your regular pharmacist can often provide a bottle without a prescription.

Replace Your Basal and Bolus Delivery with Injections:

1. For basal delivery (about half your daily insulin), take the same number of units of long-acting insulin when you go off the pump to replace your basal insulin. If you know only your average TDD, take half of this amount as long-acting insulin.
2. If you don't have long-acting insulin on hand, replace basal insulin with injections of rapid insulin taken every 4 hours at a dose equal to 4 times your hourly basal rate. For instance, if your basal rate is 1.0 unit an hour, you would take four units by injection every 4 hours to replace this basal.
3. Use your CarbF and CorrF to calculate the bolus doses you need. Determine bolus doses with the bolus calculator in your pump or phone app if this still works.
4. For simple tracking of IOB after an injection, calculate that 20% of the bolus will be used each hour for 5 hours.
5. It's crucial to check your CGM or perform fingersticks frequently to ensure the new injection doses are effective.
6. When you go back on your pump, use a temp basal reduction to offset any residual long-acting insulin left from the last injection.

Know your current basal rates, TDD, CarbF, and CorrF in case of a pump failure.

4.5 Going Off Your Pump

Situations like water skiing, river rafting, or pump failure may necessitate going off a pump for a while, or you may want a pump vacation. These suggestions help you when you go off a pump for different lengths of time. Discuss these options with your physician.

When the time off is:	Try this:
Less than 1 hour	Give no insulin if glucose is in range. Give a bolus before detaching if your glucose is above target or you plan to eat carbs soon.
1 to 4 hours	Before disconnecting, bolus 80% of the basal you'll miss while off the pump. Reconnect and bolus for any unplanned carbs you eat or inject rapid insulin.
More than 4 hours or overnight	Bolus before disconnecting or inject rapid-acting insulin to cover carbs plus the next 4 hours of basal insulin. Inject to replace the basal insulin every 4 hours and to cover carbs. For overnight, inject rapid-acting insulin equal to 4 times your basal rate every 4 hours, or inject long-acting insulin equal to the next 12 hours of basal insulin.
More than a day	Find the average basal insulin units you use daily in your pump history. Inject the same number of units of long-acting insulin once a day to replace your basal insulin for each day you are off your pump. Then, cover carb and correction doses with rapid-acting insulin using your usual CarbF and CorrF.

5.1 How Many Carbs a Day Do You Need?

1. **Circle your personal 50% carb diet factor for your sex and typical activity level:**

	Male	Female
• **Very sedentary** – slow walking, mostly sitting	1.62	1.44
• **Sedentary** – walking, bowling, fishing or similar activities	1.75	1.56
• **Moderately active** – dancing, 18 hole golf, pleasure swimming, etc	1.88	1.69
• **Active –** 20+ min. of jogging, swimming, etc. 3+ times a week	2.00	1.81
• **Super active** – one hour or more of vigorous activity 4 or more days a week, such as football, weight training, full court basketball	2.12	1.94

2. **Multiply your desired weight by your carb diet factor to find the daily grams of carbs you need for a 50% carb diet: :**

_____ lbs X _____ = _____ grams of carb/day
weight carb diet factor carb grams in 50% carb diet

USDA Dietary Guidelines recommend that in a healthy diet 45% to 65% of calories come from mostly complex carbs. Scan for BMI and daily calorie intake recommendations to maintain current weight at www.nal.usda.gov/human-nutrition-and-food-safety/dri-calculator

5.2 Bolus Doses for Meal Sizes with a betterTDD				
betterTDD Units	**Carb Bolus Units/Day**	**Small Meal**	**Medium Meal**	**Large Meal**
20 u	9.0 u	1.5 u	3.0 u	4.5 u
22 u	9.9 u	1.6 u	3.3 u	4.9 u
24 u	10.8 u	1.8 u	3.6 u	5.4 u
26 u	11.7 u	1.9 u	4 u	5.8 u
28 u	12.6 u	2.1 u	4.2 u	6.3 u
30 u	13.5 u	2.2 u	4.5 u	6.7 u
32 u	14.4 u	2.4 u	4.8 u	7.2 u
34 u	15.3 u	2.5 u	5.1 u	7.6 u
36 u	16.2 u	2.7 u	5.4 u	8.1 u
38 u	17.1 u	2.8 u	5.7 u	8.5 u
40 u	18.0 u	3.0 u	6.0 u	9.0 u
42 u	18.9 u	3.1 u	6.3 u	9.4 u
44 u	19.8 u	3.3 u	6.6 u	9.9 u
46 u	20.7 u	3.4 u	6.9 u	10.3 u
48 u	21.6 u	3.6 u	7.2 u	10.8 u
50 u	22.5 u	3.7 u	7.5 u	11.2 u
52 u	23.4 u	4 u	7.8 u	11.7 u
54 u	24.3 u	4.0 u	8.1 u	12.1 u
56 u	25.2 u	4.2 u	8.4 u	12.6 u
58 u	26.1 u	4.3 u	8.7 u	13.0 u
60 u	27.0 u	4.5 u	9.0 u	13.5 u
62 u	27.9 u	4.6 u	9.3 u	14 u
64 u	28.8 u	4.8 u	9.6 u	14.4 u
66 u	29.7 u	4.9 u	9.9 u	14.8 u
68 u	30.6 u	5.1 u	10.2 u	15.3 u
70 u	31.5 u	5.2 u	10.5 u	15.7 u
72 u	32.4 u	5.4 u	10.8 u	16.2 u
76 u	34.2 u	5.7 u	11.4 u	17.1 u
78 u	35.1 u	5.8 u	11.7 u	17.5 u
80 u	36.0 u	6.0 u	12.0 u	18.0 u
82 u	36.9 u	6.1 u	12.3 u	18.4 u
84 u	37.8 u	6.3 u	12.6 u	18.9 u
86 u	38.7 u	6.4 u	12.9 u	19.3 u
88 u	39.6 u	6.6 u	13.2 u	19.8 u
90 u	40.5 u	6.7 u	13.5 u	20.2 u
92 u	41.4 u	6.9 u	13.8 u	20.7 u
94 u	42.3 u	7.0 u	14.1 u	21.1 u
96 u	43.2 u	7.2 u	14.4 u	21.6 u
98 u	44.1 u	7.3 u	14.7 u	22.0 u
100 u	45.0 u	7.5 u	15.0 u	22.5 u

5.3 Metric Conversions

Imperial units		Metric units
1/2 oz	=	14 grams
1 oz	=	28.4 grams
2 oz	=	57 grams
3 1/2 oz	=	100 grams
1 fl. oz	=	30 ml
1 cup (8 fl oz)	=	240 ml
33 fl. oz	=	1 liter

By design, 30 ml of water fits in one cubic centimeter of space and equals 30 grams.

5.4 Use Food Labels to Count Carbs

Let's say you want to eat 2 cups of yogurt as part of your meal.

1. Look at the Nutrition Facts label from a yogurt container shown here. The label shows a serving size as 1 cup.
2. A one-cup serving has 18 grams of carbs. Multiply 18 grams by 2 servings to get the total grams of carb you will eat:

18 grams per cup x 2 cups = 36 grams

Nutrition Facts

8 Servings Per Container

Serving Size 1 cup (8 oz)

Amount Per Serving

Calories 130

	% Daily Value
Total Fat 0 g	0%
Saturated Fat 0 g	0%
Cholesterol 0 mg	0%
Sodium 0 mg	0%
Total Carbohydrates 18 g	6%
Dietary Fiber 0 g	0%
Sugars 3 g	
Protein 4 g	

5.5 Use a Gram Scale to Count the Carbs in Cooked Spaghetti

With a standard gram scale and the carb percentage from Appendix A:

Appendix A lists a variety of carb foods with the typical percentage of their weight from carbs. Simply weigh that food on a gram scale and multiply its weight by its carb percentage to determine how many grams of carb you will eat.

1. Place a plate on a scale and press the tare or on/off button to zero out the plate's weight. Then, place the amount of cooked spaghetti you want to eat onto the plate.
2. Appendix A shows that cooked plain spaghetti is 26 percent carbs compared to 74% carbs for dry spaghetti. If your cooked spaghetti portion weighs 200 grams on the scale, multiply this weight by 26% or 0.26.

Example

200 g	x	0.26	=	52 g
weight of spaghetti		carb %		total carbs in portion

3. To cover 200 grams of cooked spaghetti with a bolus, enter 52 grams of carb into your bolus calculator to obtain the bolus you need for these carbs.

With a computer gram scale:

Computerized gram scales contain the nutritional breakdowns for various foods. Just enter the code for that food or scroll to find it in the scale's database. Then, weigh it to find your portion's carbs, calories, fat, and protein.

1. Computerized gram scales contain information about the nutrition content of spaghetti and many other foods.
2. Tare (zero out) your plate on the scale.
3. Enter the food code for spaghetti into the scale.
4. Place the amount of spaghetti you want to eat onto your plate.
5. Press the carb key on the scale to determine how many grams of carbohydrates are in the spaghetti.

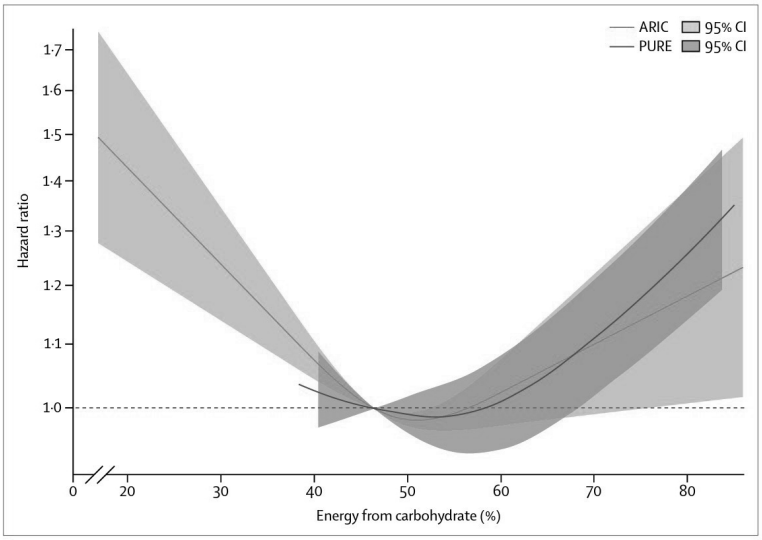
Gram scales are available online and at most kitchen supply stores.

5.6 Sample Values for Combination Foods

Below are estimated carbs per portion size for various home cooked and combination foods.

Food	Cals	Fat	Carbs
Beef Stroganoff, 5 oz	195	13	7
Beef Stroganoff with 4 oz noodles	350	14	36
Chicken Lasagna, 1 piece	300	11	32
Chicken Chop Suey with 4 oz rice	245	4	37
Deep Dish Burrito, 7 oz	265	13	20
Ground Beef Casser., 2 scoop, 6 oz	245	13	17
Ital. Meat Sauce (5 oz) for Spaghetti	150	9	9
with 5 oz Spaghetti	350	10	49
Lasagna, 1 piece	275	11	25
Meatloaf, 3 oz	205	13	4
Ranch Beans, 2 scoops, 6 oz	350	11	45
Red Beans & Rice, 7 oz	280	9	37
Scalloped Pot./Ham, 2 scoop, 6 oz	160	6	20
Stuffed Shells in Sauce (1)	105	3	17
Swedish Meatballs (3)	205	12	9
Sweet & Sour Pork/Rice, 9 oz	240	3	40
Swiss Steak, Mushroom Gravy, 5 oz	280	11	4
Tator Tot Casserole, 2 scoops, 6 oz	260	15	20
Tenderloin Tips Gravy, 5 oz	210	13	3
w 5 oz noodles	395	15	38
Tuna Noodle Casser., 2 scoop, 6 oz	180	6	17
Turkey Tetrazzini, 2 scoop, 6 oz	195	7	17
Vegetable Lasagna, 1 piece	250	13	21

5.7 Low Carb Diets Increase Mortality



This U-shaped graph shows the association between all-cause mortality for people without diabetes on the left and the percentage of energy from carbohydrates on the bottom. The initial survey among 15,428 adults aged 45-64 years living in four U.S. communities in light grey was conducted between 1987 and 1989 for the Atherosclerosis Risk in Communities (ARIC) cohort.[57] Mortality was determined 25 years later. The dark grey area shows similar results from a study conducted in Japan.58

The mortality risk is compared to people getting 50% of their energy from carbohydrates. Results are adjusted for age, sex, race, test center, total calories, diabetes, smoking, physical activity, income, and education. Lowest mortality occurs with a diet containing 50 to 55% of calories coming from carbs. Low-carb diets have a significant association with higher mortality.

5.8 Glycemic Index

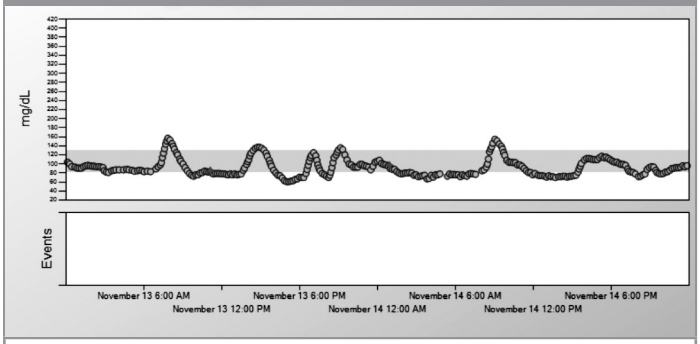
Foods are compared to glucose, which ranks 100. Higher numbers indicate faster absorption and a faster rise in the glucose, while lower numbers indicate a slower rise.

Cereals		Snacks		Fruit	
All Bran™	51	chocolate bar	49	apple	38
Bran Buds +psyll	45	corn chips	72	apricots	57
Bran Flakes™	74	croissant	67	banana	56
Cheerios™	74	doughnut	76	cantaloupe	65
Corn Chex™	83	Graham crackers	74	cherries	22
Cornflakes™	83	jelly beans	80	dates	103
Cream of Wheat	66	Life Savers™	70	grapefruit	25
Frosted Flakes™	55	oatmeal cookie	57	grapes	46
Grapenuts™	67	pizza, cheese & tom.	60	kiwi	52
Life™	66	Pizza Hut™, supreme	33	mango	55
muesli, natural	54	popcorn, light micro	55	orange	43
Nutri-grain™	66	potato chips	56	papaya	58
oatmeal, old fash	48	pound cake	54	peach	42
Puffed Wheat™	67	Power Bars™	58	pear	58
Raisin Bran™	73	pretzels	83	pineapple	66
Rice Chex™	89	rice cakes	82	plums	39
Rice Krispies™	82	saltine crackers	74	prunes	15
Shredded Wheat™	67	shortbread cookies	64	raisins	64
Special K™	54	Snickers™ bar	41	watermelon	72
Total™	76	strawberry jam	51	**Pasta**	
Root Crops		vanilla wafers	77	cheese tortellini	50
french fries	75	**Crackers**		fettucini	32
potato, new, boiled	59	Graham	74	linguini	50
potato, red, baked	93	rice cakes	80	macaroni	46
potato, sweet	52	rye	68	spaghetti, 5m boil	33
potato, wht, boiled	63	soda	72	spaghetti, 15m boil	44
potato, wht, mash	70	water	78	spaghetti, prot enriched	28
yam	54	Wheat Thins™	67	vermicelli	35

5.8 Glycemic Index - continued

Breads		Beans		Soups/Vegetables	
bagel, plain	72	baked	44	beets, canned	64
banana bread	47	black beans, boil	30	black bean soup	64
baguette, French	95	butter, boiled	33	carrots, fresh, boiled	49
croissant	67	cannellini beans	31	corn, sweet	56
dark rye	76	garbanzo, boiled	34	green pea soup	66
hamburger bun	61	kidney, boiled	29	green pea, frozen	47
muffins		kidney, canned	52	lentil soup	44
apple, cinnamon	44	lentils, gr or br	30	parsnips, boiled	97
blueberry	59	lima, boiled or frozen	32	peas, fresh, boiled	48
oat & raisin	54	navy	38	split pea and ham	66
pita	57	pinto, boiled	39	tomato soup	38
pizza, cheese	60	red lentils, boiled	27	**Cereal Grains**	
pumpernickel	49	soy, boiled	16	barley	25
sourdough	54	**Milk Products**		basmati white rice	58
rye	64	chocolate milk	35	bulgar	48
white	70	custard	43	couscous	65
wheat	68	ice cream, vanilla	60	cornmeal	68
Drinks		ice milk, vanilla	50	millet	71
apple juice	40	skim milk	32	**Sugars**	
colas	65	soy milk	31	fructose	22
Gatorade™	78	tofu frozen dessert	115	honey	62
grapefruit juice	48	whole milk	30	maltose	105
orange juice	46	yogurt, fruit	36	sucrose	61
pineapple juice	46	yogurt, plain	14	table sugar	64

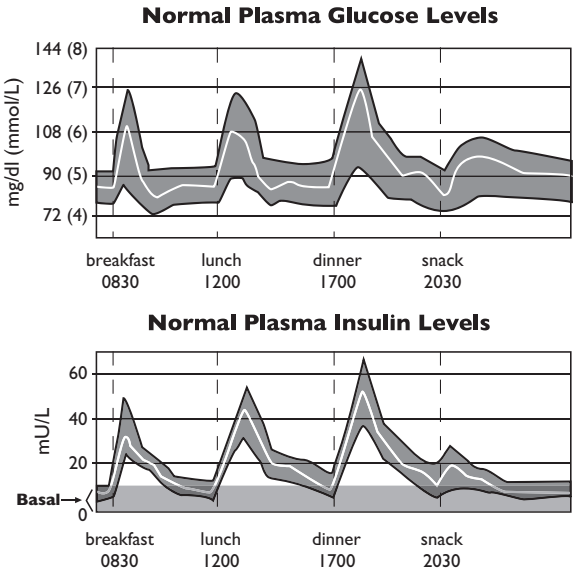
6.1 Glucose Levels in a Person without Diabetes



This graphic shows glucose levels without diabetes. The grey area shows glucose between 85 and 130 mg/dL.

6.2 Insulin Matches Glucose Intake

Post-meal glucose levels in the top graph are controlled by rapid releases of insulin, shown in the bottom graph. The grey area in the bottom graph represents basal insulin.



Adapted from BR J Diabetes Vasc Dis 4(1): 39-42, 2004

6.3 Glucose Values and Goals for Adults with Type 1 Diabetes

	Normal Glucose	ADA Goals[1]	AACE Goals[2]	Pregnancy Goals[3, 4]
Avg Meter BG:	<126 mg/dL <7 mmol/L	<154 mg/dL <8.6 mmol/L	<140 mg/dL <7.8 mmol/L	<140 mg/dL <7.8 mmol/L
A1c:	<5.7%	<7.0% without significant hypoglycemia	<6.5% for healthy individuals	<6.5%
Fasting BG	<100 mg/dL <5.6 mmol/L	70–130 mg/dL 4-7.2 mmol/L	<110 mg/dL <6.1 mmol/L	60-99 mg/dL 3.3-5.5 mmol/L
Before Meal BG	<110 mg/dL <6.1 mmol/L	70–130 mg/dL (4-7.2 mmol/L)	<110 mg/dL <6.1 mmol/L	<100 mg/dL <5.6 mmol/L
2 hr After Meal BG	70–140 mg/dL 4-7.8 mmol/L	180 mg/dL peak 10 mmol/l peak	<140 mg/dL <7.8 mmol/L	<120 mg/dL <6.7 mmol/L
Bedtime BG	<110 mg/dL <6.1 mmol/L	90-150 mg/dL 5-8.3 mmol/L	–	<100 mg/dL <5.6 mmol/L

1 Glycemic Goals and Hypoglycemia: Standards of Care in Diabetes-2024. Diabetes Care. 2024 Jan 1;47(Suppl 1):S111-S125. doi: 10.2337/dc24-S006. 2 AACE/ACE Diabetes Guidelines, Endocrine Pract. 2015; 21 (Suppl 1)
3 Normal glucose levels in pregnancy range from 63 to 120 mg/dL. 4 Blum, A. K. Insulin use in pregnancy: an update. Diabetes Spectrum, 2016, 29(2), 92-97.

6.4 Steps to Better Glucose Readings

- **Set clear goals**, such as getting 5% more glucose readings inside your target range within 30 days.
- **Look at your CGM glucose reading 8 or more times a day.**
- **Use your bolus calculator** for all carb and manual correction boluses. Check the 3- and 6-hour windows later to see how each bolus worked.
- **Bolus early** for every meal and snack unless there's a good reason not to.
- **Match bolus doses** to a meal's carb count or size, current glucose, and IOB.
- **Wait to eat more than 15 grams of carbs** until below 140 mg/dL (7.8 mmol/L).
- **Don't overtreat** lows with carbs nor highs with insulin.

6.5 Estimated Average Glucose from A1c

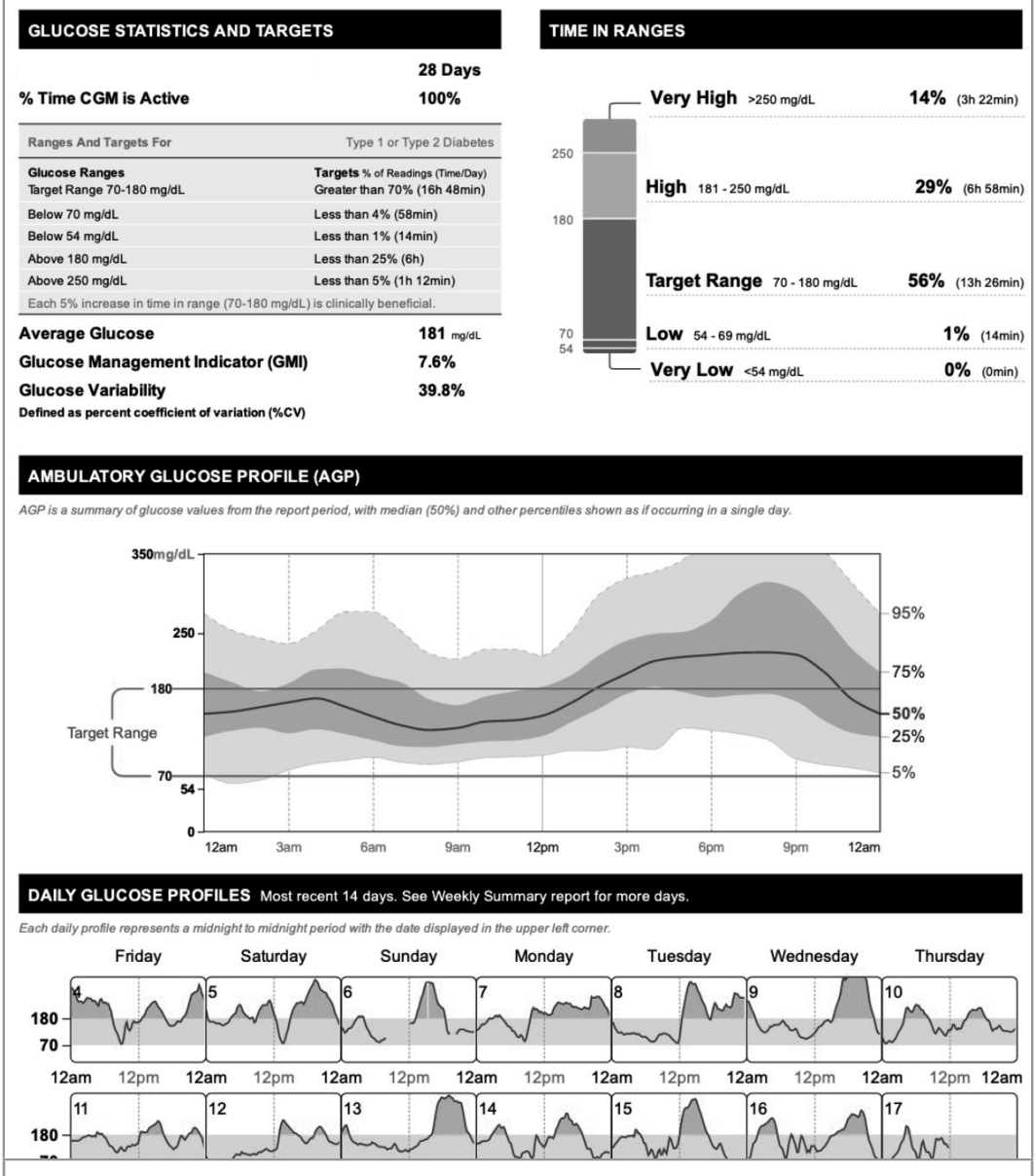
A1c	Est. Avg. Glucose mg/dL (95% range)	Est. Avg. Glucose mmol/L (95% range)
5.0%	97 (76–120)	5.4 (4.2–6.7)
5.5%	112 (88–136)	6.2 (4.9–7.6)
6.0%	126 (100–152)	7.0 (5.5–8.5)
6.5%	140 (112-168)	7.8 (6.2-9.4)
7.0%	154 (123–185)	8.6 (6.8–10.3)
7.5%	169 (135-201)	169 (7.5-11.2)
8.0%	183 (147–217)	10.2 (8.1–12.1)
8.5%	197 (159-233)	11-0 (8.8-13.0)
9.0%	212 (170–249)	11.8 (9.4–13.9)
10.0%	240 (193–282)	13.4 (10.7–15.7)
11.0%	269 (217–314)	14.9 (12.0–17.5)
12.0%	298 (240–347)	16.5 (13.3–19.3)

Based on ADAG data of 2,700 glucose measurements over 3 months per A1c measurement in 507 adults with type 1, type 2, or no diabetes. Adapted from Nathan et al. Diabetes 2014;63:282–290. Scan for conversion tool.

6.6 What the Sample AGP in Fig. 6.7 Shows

In the daily graphs visible at the bottom of Fig. 6.7, this individual's glucose often rises after lunch and stays high until after dinner. The glucose levels after lunch and dinner vary significantly from day to day. This suggests boluses were not adequately adjusted for meal size, boluses were missed or given late, or a weak (high) CarbF gave inadequate boluses. The mismatch between boluses and carbs creates a high glucose variability of 39.8%, shown by the wide light grey area that contains 90% of the glucose values.

6.7 Sample Ambulatory Glucose Profile Report



GLUCOSE STATISTICS AND TARGETS

	28 Days
% Time CGM is Active	100%

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges Target Range 70-180 mg/dL	**Targets** % of Readings (Time/Day) Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)
Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.	

Average Glucose	181 mg/dL
Glucose Management Indicator (GMI)	7.6%
Glucose Variability	39.8%
Defined as percent coefficient of variation (%CV)	

TIME IN RANGES

250 / 180 / 70 / 54

Very High	>250 mg/dL	14% (3h 22min)
High	181 - 250 mg/dL	29% (6h 58min)
Target Range	70 - 180 mg/dL	56% (13h 26min)
Low	54 - 69 mg/dL	1% (14min)
Very Low	<54 mg/dL	0% (0min)

AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.

350mg/dL / 250 / 180 / Target Range / 70 / 54 / 0

95% / 75% / 50% / 25% / 5%

12am 3am 6am 9am 12pm 3pm 6pm 9pm 12am

DAILY GLUCOSE PROFILES Most recent 14 days. See Weekly Summary report for more days.

Each daily profile represents a midnight to midnight period with the date displayed in the upper left corner.

Friday Saturday Sunday Monday Tuesday Wednesday Thursday

4 5 6 7 8 9 10

180 / 70

12am 12pm 12am 12pm 12am 12pm 12am 12pm 12am 12pm 12am 12pm 12am 12pm 12am

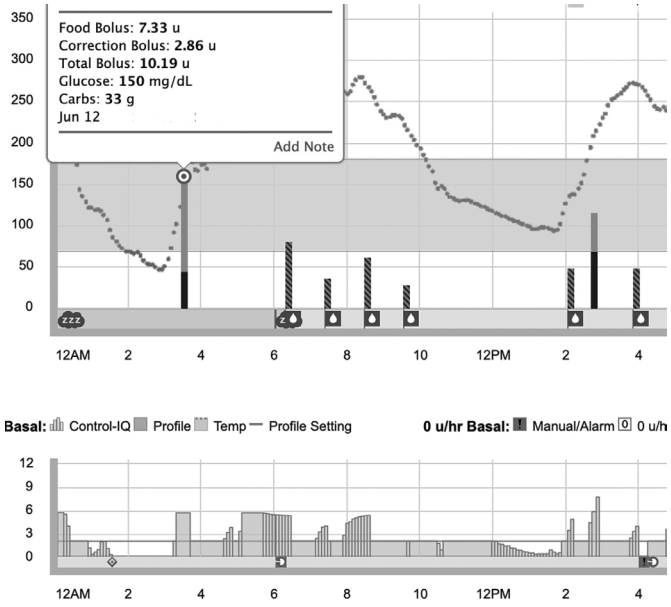
11 12 13 14 15 16 17

180

This AGP report summarizes glucose data over the last 14 days in four parts:

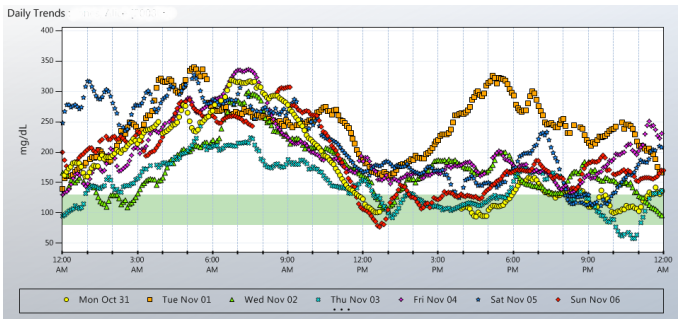
Top Left: shows the average glucose, GV, and GMI (estimated A1c). **Top Right:** time in different glucose ranges. **Middle:** AGP report with the average glucose (line), the middle 50% (darker grey) of glucose readings, and the middle 90% (lighter grey) of glucose readings. **Bottom:** daily glucose trend lines for the last 14 days.

6.8 Avoid Excess Basal Chatter on AID

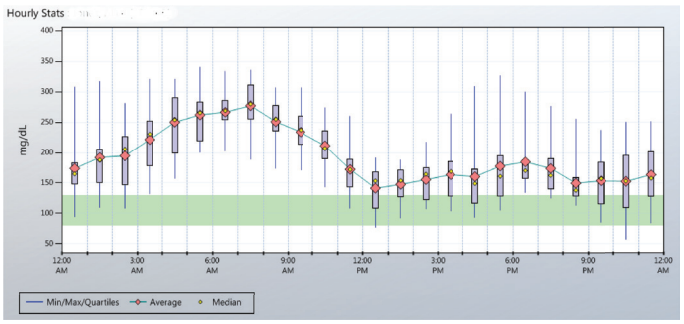


This example graph from midnight to 4 pm shows excessive "basal chatter" at the bottom with basal rates varying between 0 in the blank white areas to 6 units an hour when they spike. Although the average daily glucose is 150 mg/dL, glucose spiking occurs from late and missed boluses. Changes in basal and bolus settings and habit are required.

6.9 Daily and Hourly Trend Graphs



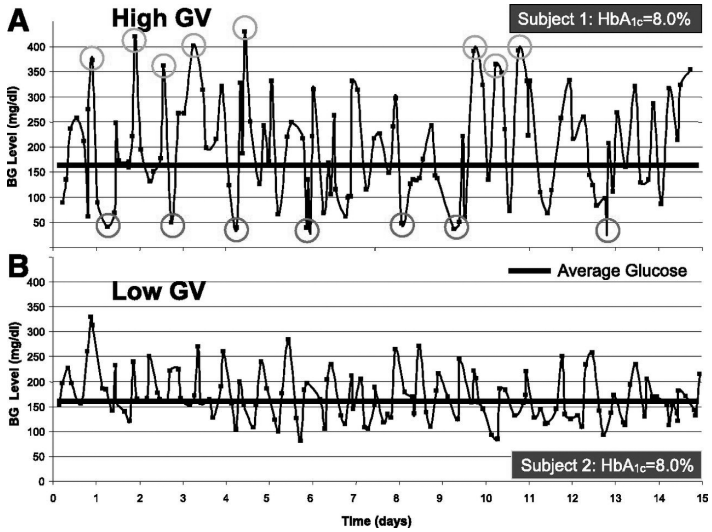
This **Daily Trend Graph** shows glucose readings with each 24-hour day as one of the lines across the graph. The consistent pattern in these high readings makes them relatively easier to correct.



Hourly Trend Graphs summarize the same data. The boxes show where 50% of the glucose readings land and the whiskers show 90% of readings. This person's glucose rises overnight after a 10 pm dinner. A higher basal between 7 pm and 7 am and a lower (stronger) dinner CarbF will help.

6.10 The Less Glucose Variability, the Better

These fifteen-day glucose tracks show two different people with an identical HbA1c of 8.0% but different degrees of GV.[74]



The same A1c or average CGM glucose can be deceptive. Over 15 days, person A has numerous lows below 50 mg/dL and highs above 350 mg/dL, marked by the circles. Their high GV comes from overtreating lows, skipping or delaying meal boluses when their glucose is lower, and then giving excessive boluses for the highs.

Person B has the same A1c, far less GV, no hypoglycemia, and can lower their A1c of 8.0% with a slight increase in their basal rates and a small reduction in their CarbF number.

Steady glucose readings make it easier to lower an average glucose with less risk of hypoglycemia.

6.11 Check These When You Want to Reduce Highs and Lows

Answer these questions and rank their importance on a 1 to 5 (low to high) scale regarding how much they are affecting your glucose variability:.

Are you:	Yes	No	Importance
• Missing meal boluses?	❑	❑	_____
• Bolusing just before or after eating?	❑	❑	_____
• Unclear about carb counts or meal sizes?	❑	❑	_____
• Having frequent or severe low glucoses?	❑	❑	_____
• Preferring lows because you fear complications?	❑	❑	_____
• Preferring to stay high to avoid lows?	❑	❑	_____
• Significantly differing bolus or basal doses day to day?	❑	❑	_____
• Having infusion set or pod failures?	❑	❑	_____
• Exercising at different times, intensities, or durations?	❑	❑	_____
• Sleeping irregularly or insufficiently?	❑	❑	_____
• Under stress, depressed, or lacking motivation?	❑	❑	_____
• In pain?	❑	❑	_____

6.12 Drinking and Diabetes

Take care when mixing alcohol and insulin. Hypoglycemia and intoxication symptoms are strikingly similar. If you go low after drinking, a police officer may not recognize the real problem when they smell alcohol. You may be placed in a drunk tank rather than receive the carbs you need. Excess alcohol impairs judgment and reduces attention and the accuracy of carb counts and bolus doses. Don't drink on an empty stomach or to excess!

Four standard drinks cut glucose production in the liver in half, making it a major cause of nighttime hypoglycemia. Excess alcohol blocks the liver from making glucose, and excess insulin stops it from releasing the glucose you need, making it difficult to raise it.

Make the best decisions about drinking:

- Know the laws in your state.
- Remember, you can say "No!"
- If you plan to drink, eat carbs first, and don't skip meals or snacks.
- Limit your intake: slowly drink one or two drinks or alternate with nonalcoholic drinks.
- Wine, beer, and straight alcohol like gin or tequila may not need a bolus. Mixed drinks, liqueurs, and marguerites with sugar usually do.
- Don't drink before you drive. Don't drive after drinking.
- Wear a diabetes medical ID.
- Let friends know: you have diabetes, hypoglycemia can make you look drunk, you can pass out from a low, and to encourage carb intake if you respond inappropriately.
- Check your glucose before going to sleep, and consider a larger bedtime snack.

7.1 Find Your Average TDD on Multiple Injections

If you are switching from MDI to a pump or AID, your average TDD on multiple injections is your best guide to finding an accurate basal rate, CarbF, and CorrF. Get your average TDD by recording all long-acting and rapid-acting insulin doses you inject for seven days. Use paper or a phone app. Then, add these doses, and divide the total units by the number of days you've recorded.

Total units in 7 days = _____ units / 7 days = _____ units per day
Current avg. TDD

For example, for 280 total units in 7 days, 280 u ÷ 7 = 40 u/day as the current average TDD.

If your average glucose is below 160 mg/dL without frequent lows, your recent average TDD on injections can be used in Table 9.7 to find your starting settings. Otherwise, you want to find a better TDD (betterTDD) below to correct a low or high average glucose.

7.2 When to Stop Injected Long-Acting Insulin Before Starting an AID System

Follow your clinician's instructions to discontinue your long-acting insulin before starting an AID system. The glucose-lowering activity of Lantus usually disappears 28 hours after the last injection. Long-acting insulin analogs like Toujeo (U-300 long-acting glargine) and Tresiba (degludec) take 36 to 42 hours to stop lowering your glucose. Test your basal rates and bolus doses once the last dose of long-acting insulin is no longer active.

If you inject Lantus in the morning, you'll likely take this dose the morning of the day before your start, but not on your start day. If you inject at bedtime, your clinician may advise you to cut your bedtime dose of Lantus in half the night before you start. Inject rapid-acting insulin to cover high glucose that night and breakfast the following morning. With Toujeo and Tresiba insulins, use a temp basal until all the residual insulin is gone.

After starting, you or your clinician can offset any residual insulin activity from long-acting insulin with a temporary basal rate reduction. Temp basal rates automatically return to normal rates when they time out.

Usual Time for LA Dose		LA Dose Day Before Start		LA Doses on Start Day	
AM	**PM**	**AM**	**PM**	**AM**	**PM**
✓		✓		X*	
	✓		half dose*		X
✓	✓	✓	half dose*	X*	X

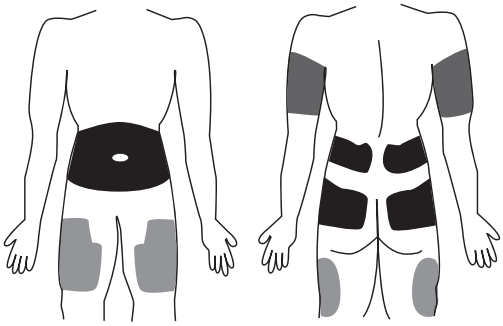
✓ = take dose
X = skip dose

* Use rapid-acting insulin until your pump start to cover basal need, carbs, and to correct any high reading. To offset any remaining long-acting IOB on start day, use a temp basal reduction.

7.3 What to Bring to Your Pump or AID Training

- Comfortable 2-piece clothing and your list of questions.
- A data download from your devices or a written glucose and insulin dose record.
- CGM sensors and glucose meter supplies – meter, strips, lancets, lancing device.
- Fast-acting carbs to treat low glucose.
- 3 pump cartridges and 3 infusion sets, or 3 pods for a patch pump.
- A bottle of rapid insulin.
- 70% alcohol pads.
- A roll of 1" tape (3M Durapore, Transpore, Blenderm, Micropore, or Smith and Nephew Hypafix).
- If requested, an additional adhesive dressing like IV 3000, Tegaderm HP,
- Polyskin II, DuoDerm, or Opsite Flexifix .

7.4 Skin Sites and Considerations



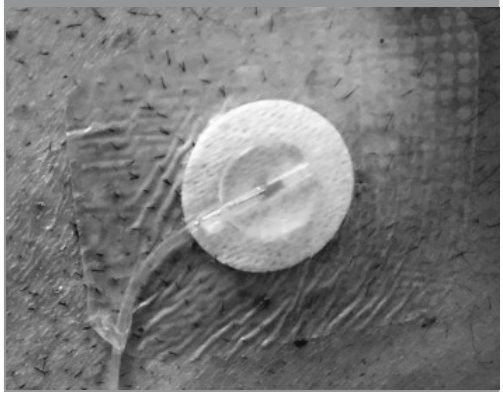
- Which body sites have enough fat padding?
- Which type and size of infusion set works best for your preferred body locations?
- Can you easily disconnect the infusion set for bathing or swimming?
- Do you want to use an insertion device?
- Does work, sports, or childcare limit specific sites?

7.5 Cannula Fill Amounts

Cannula	Fill Amount
Steel	0.0 u
6 mm plastic	0.3 u
8 mm plastic	0.4 u
9 mm plastic	0.5 u
10 mm plastic	0.6 u
13 mm plastic	0.7 u
17 mm plastic	0.7 u

Steel needles have no cannula fill. They are fully primed once insulin is visible at the needle tip. Omnipod is self-filling.

7.6 Steel Set with Overbandage



7.7 Reduce Insertion Pain

Although rarely needed, Numby Stuff and LMX 4 cream can be used to reduce insertion discomfort. EMLA, a prescription numbing cream, can also be applied to the skin about an hour before inserting an infusion set or sensor. Another handy solution is to place an ice cube or cold spoon on the site before insertion to trick the nerve endings into feeling cold instead of pain. The touch of an auto-insertion device distracts the nervous system to avoid pain. Many parents of toddlers and young children prefer the smaller needle in steel sets.

7.8 Insulin Storage Tips

- Keep insulin out of direct sunlight.
- Before entering a hot tub or sauna, disconnect and remove your pump to keep it at room temperature. Replace an Omnipod to avoid high glucose.
- The insulin bottle you use to refill your pump may be kept at room temperature for 30 days. Refrigerate insulin bottles at 36 to 45° F (2 to 8° C).
- A Frio pack keeps insulin bottles and pens cool for transport in hot weather. The insulin in your pump does not need any cooling if kept in clothing and out of direct sunlight.
- Don't leave insulin in a car.

7.9 Some Days May Go Bad

7.10 Take Extra Care with Concentrated Insulins

With U-100 insulins, each cc or ml contains 100 units, while U-200 insulins contain 200 units, and U-500 insulins contain 500 units or five times the concentration. A 200-unit cartridge covers about 3 days for those needing 60 or 65 units daily, and a 300-unit cartridge covers 3 days for those using up to 90 or 95 units daily. For those requiring larger doses, U-200 Humalog/lispro insulin pens or U-500 Regular vials can fill a pump cartridge with 2 or 5 times as much insulin.

Insulin pumps are designed for U-100 insulin. When using a more concentrated insulin, your pump settings must change. For U-200 insulin, basal rates are reduced by half and the CarbF and CorrF are doubled. For U-500 insulin, basal rates are reduced to one-fifth and the CarbF and CorrF are multiplied by five.

For example, a basal rate of 3.0 u/hr on U-100 insulin becomes 1.5 u/hr on U-200 insulin or 0.6 u/hr on U-500 insulin. In addition, a CarbF of 1u/3.0 grams of carb becomes 1u/6 grams on U-200 insulin and 1u/15 grams on U-500 insulin. Discuss these changes carefully with your healthcare professional.

With U-200 insulin, a basal rate of 1.0 u/hr now delivers 2 units each hour. Likewise, a "one unit" bolus for 10 grams now delivers 2 units for 10 grams or 1 unit for 5 grams. In data downloads, an average TDD of "120 units" for U-200 insulin is actually 240 units.

Be careful not to run out of U-200 or U-500 insulin. Once settings are changed, NEVER load the cartridge with U-100 insulin unless you change your profile or settings. You will get only half or one-fifth of your previous doses! If you need to change your insulin concentration, always change your profile or pump settings.

8.1 Which Pump Setting Do You Raise or Lower?

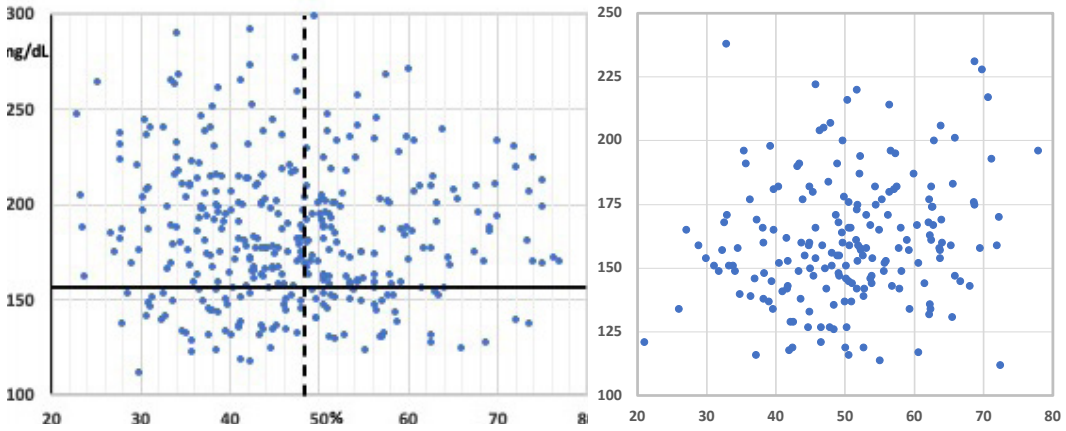
If you are having:	Change this setting in this direction:		
	Basal Rate	Carb Factor	Corr Factor
Frequent lows	↓	↑	↑
Frequent highs	↑	↓	↓

Smaller CarbF or CorrF numbers give larger boluses. Always adjust CarbFs and CorrFs in the direction opposite the glucose problem. For example, if you have high readings before lunch, lower your CarbF number at breakfast to make breakfast boluses larger.

8.2 Settings to Know

- Not a setting, the average TDD controls the average glucose and guides you to correct BC settings
- Basal rates and daily basal total
- Carb factor (CarbF or I:CR)
- Correction factor (CorrF)
- Correction target (or range)
- Duration of insulin action (DIA)

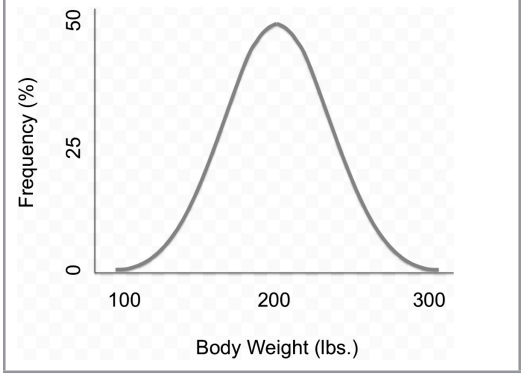
8.3 Improvement in Basal Settings 2007 to 2024



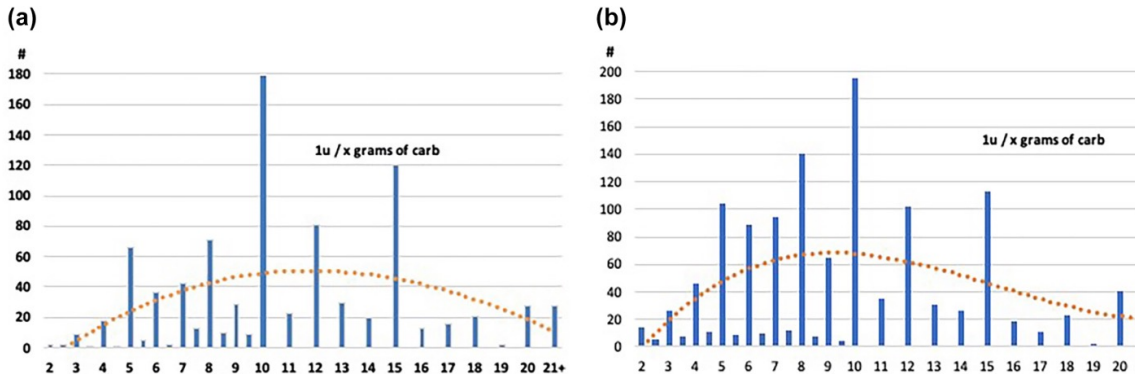
These graphs shows the average glucose on the left against basal percentage of the TDD at the bottom. The graph on the left shows 996 consecutive U.S. insulin pumps downloaded for a 2007 software upgrade. The graph on the right shows 193 AID devices analyzed in 2024. The horizontal line is at 154 mg/dL (A1c of ~7.0%) and the vertical dashed line shows a basal at 48% of the TDD.

Nearly 75% of the 2007 pumps had an average glucose higher than 154 mg/dL. The 2024 AID devices show marked improvement with 50% of the AID system results below 154 mg/dL. Note the centering of basal percentages and reduction in glucose levels in the 2024 data.

8.4 Gaussian Weight Distribution



8.5 CarbFs from Consecutive Pump Downloads in 2007 and 2018



The graph on the left shows CarbFs (ICRs) downloaded from 907 insulin pumps in 2007. The graph on the right shows the same for 1,301 non-AID insulin pumps downloaded in 2018. The X-axis on the left shows whole number CarbFs ±0.05 g (for example, 8.95 to 9.05 g/U) and fractional CarbF values between the whole number values. The Y-axis shows the number of pumps having these CarbFs.

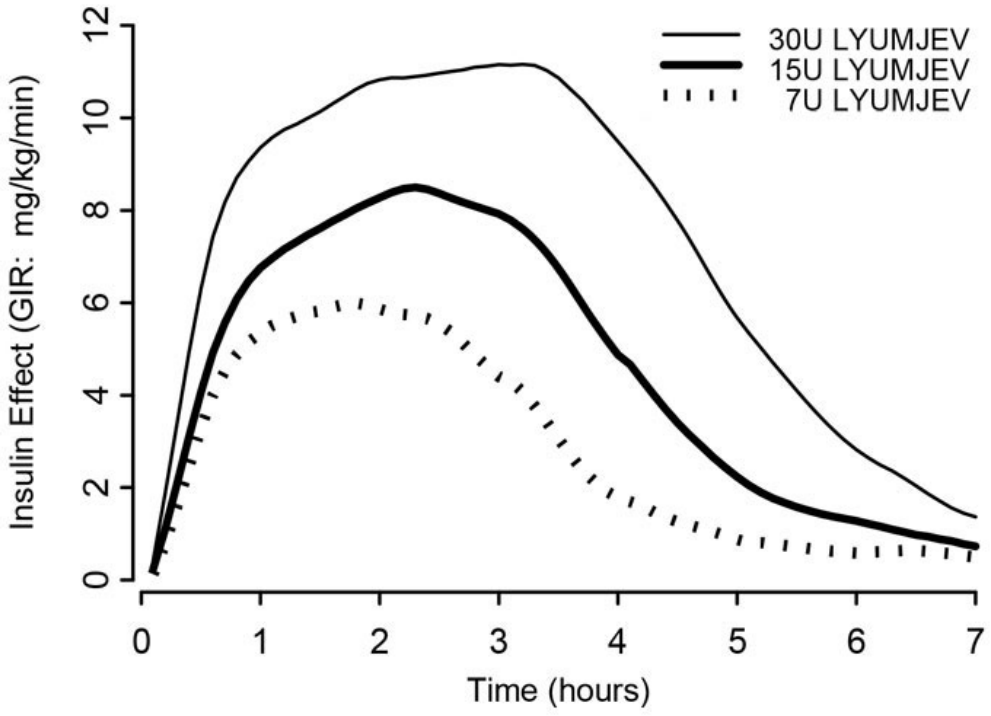
These CarbFs do not follow an expected bell-shaped curve, indicating that numerous pumps contained inaccurate or inappropriate CarbFs..

8.6 Estimated IOB 3 hours after a 10-Unit Bolus Using Different DIAs

	BC's Estimate of Bolus Insulin on Board			
For this DIA setting =	3 hr	4.5 hr	5.0 hr	5.5 hr
Estimated Remaining IOB =	0 u	2.5 u	3.4 u	4.0 u

When using the DIA time in the upper row, the IOB that a BC calculates to remain three hours after a 10 unit bolus is shown in the lower row. For a DIA of 3 hours, the estimated residual insulin activity is zero, while for a more realistic DIA of 5.0 hours, the remaining glucose-lowering activity at 3 hours is 3.4 units.

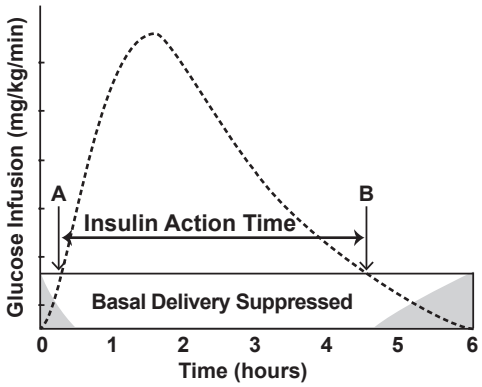
8.7 Lyumjev's Insulin Action Times



These lines show the glucose infusion needed to offset 7, 15, and 30 U of Lyumjev insulin in people without diabetes. Lumjev starts faster but works as long as other rapid insulins.

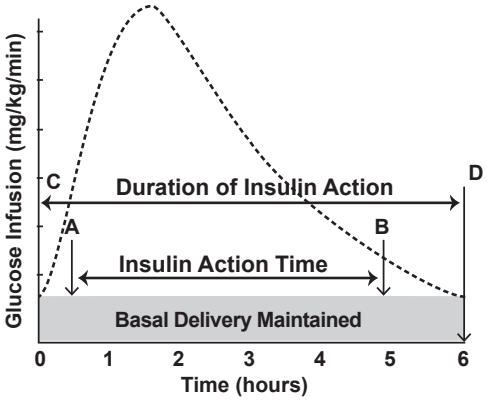
8.8 How Insulin Action Time Differs From Duration of Insulin Action

Fig. 1 Insulin Action Time



IAT is measured between points A and B, with suppression of basal delivery.

Fig. 2 Duration of Insulin Action



DIA is measured between points C and D while basal delivery is maintained.

Insulin product handouts give insulin action times (IAT) as "3 to 5 hours" for rapid insulins. In IAT studies, glucose is infused from an IV bag into a healthy person's arm to keep their glucose flat at 90 mg/dL after injections of different insulin doses. IAT, measured from A to B in Figure 1, starts late when the injection begins suppressing insulin release from the pancreas, and ends early when the pancreas starts to produce insulin.

Duration of insulin action (DIA) in Figure 2 starts as soon as insulin is injected or bolused (C) and ends when its glucose-lowering activity stops (D), while basal insulin delivery continues. The steady basal insulin delivery on a pump reduces the variability observed between small and large doses in IAT studies. Optimal DIA times for measuring IOB with today's rapid-acting insulins are 4.5 to 6 hours.[91-95].

9.1 To Reach Glucose Goals, Start Where You Are:				
Data:		**Date:** ___/___/____	**Recommended Goal:**	**Where You Are:**
14-day CGM Average Glucose: (guide to finding your better TDD):			<154 mg/dL	_____ mg/dl(mmol/l)A
*** Average Glucose Goal: (where you want to go)**			Select from Table 9.2*	_____ mg/dl(mmol/l)
Glucose Elevation: (14-day avg. glucose – avg. glucose goal):			none	_____ mg/dl(mmol/l)C
Glucose Variability: (glucose stability, aka coeff. of variation)			<30%	_____ %A
14-day Average TDD: (controls your avg. glucose, guide to BC settings):			The optimal number of units	_____ u/dayB
Insulin Use as Percent of TDD	**Daily Basal Rates**		Close to half	_____ %B
	Carb/Meal Boluses		Close to half	_____ %B
	Manual Corrections		About 3%	_____ %B
	AID Auto-Corrections		About 3%	_____ %B
	Basal/Bolus Balance		About 46% each	Basal _____ % B Bolus _____ % B
Time in Range: (TIR)	**** <54 mg/dL (3 mmol/L):**		<1%**	_____ %A
	**** <70 mg/dL (3.9 mmol/l):**		<4%**	_____ %A
	***** 70-180 mg/dL (3.9-10 mmol/L):**		>70%	_____ %A
	>180 mg/dL (10 mmol/L):		<20%	_____ %A
	>250 mg/dL (14 mmol/L):		<5%	_____ %A

* Most people start with a glucose goal between 140 and 155 mg/dL (7.8 and 8.6 mmol/L, equivalent to an A1c of 6.5% to 7.0%). For pregnancy, the goal is 70% TIR between 63 and 140 mg/dL.

** If higher than these recommendations, start at Section B on pg. 88. *** Glucose goal range.

A) data from an AGP or CGM report B) data from pump history or AGP report.

9.2 Estimated Average Glucose from A1c

A1c	Approx. Avg. Glucose mg/dl	Approx. Avg. Glucose mmol/l
5.4%	108	6.0
5.6%	114	6.3
5.8%	120	6.6
6.0%	126	7.0
6.2%	131	7.3
6.4%	137	7.6
6.6%	143	7.9
6.8%	148	8.2
7.0%	154	8.6
7.2%	116	8.9

9.3 Hypo Symptoms Versus True Hypoglycemia

If your average glucose has been above 200 mg/dL for months and you feel low with a CGM reading of 100 or 120 mg/dL, this is not hypoglycemia. A long history of high readings can make a person feel low when the glucose is normal.

Here, multiply your average TDD by 1.06 (+ 6%) and select new settings from this larger TDD. Do this every 4 weeks to lower your average glucose by 20 to 30 mg/dL each time. Repeating this brings your average glucose down over a few weeks without feeling low when your glucose is normal.

9.4 For Frequent Lows, Reduce Your TDD

Reduce your TDD by 5% or 10% for frequent lows that are mild or more severe, respectively. Find your current average TDD in the left column and go across for a lower TDD from which to get new pump settings in Table 9.7. Multiply your current average TDD by 0.95 for a 5% reduction or by 0.90 for a 10% reduction, as shown in the table below.

$$\frac{\text{\_\_\_\_\_ u/day}}{\text{Current Avg TDD}} \times \frac{\text{0.95 (or 0.90)}}{\text{New Lower Avg TDD}} = \text{\_\_\_\_\_ u/day}$$

Current Avg. TDD	5% Lower TDD	10% Lower TDD	Current Avg. TDD	5% Lower TDD	10% Lower TDD
20.0 u	19.0 u	18.0 u	55.0 u	52.4u	50.5 u
25.0 u	23.8 u	22.5 u	60.0 u	57.1 u	54.0 u
30.0 u	28.5 u	27.0 u	65.0 u	61.9 u	58.5 u
35.0 u	33.3 u	31.5 u	70.0 u	66.7 u	63.5 u
40.0 u	38.1 u	36.0 u	80.0 u	76.2 u	72.0 u
45.0 u	42.9 u	40.5 u	90.0 u	85.7 u	81.0 u
50.0 u	47.6 u	45.0 u	100.0 u	95.0 u	90.0 u

My new betterTDD = _____ units/day.

Keep lowering your TDD every four to seven days until the lows largely disappear. Each time you lower your TDD, use the betterTDD to find more appropriate BC settings in Table 9.7.

9.5 Steps to Stop Frequent Lows

1. Lower your average TDD.
2. Consider when most lows happen: are your basal rates, carb boluses, or correction boluses causing them?
3. Check your basal/carb bolus balance. The larger one is usually the one to reduce.

9.6 Get a betterTDD to Lower an Elevated Average Glucose

Best use of this table: bolus BEFORE meals and DON'T have frequent lows and AREN'T over 3% TIR below 70 mg/dL. Late boluses falsely increase your average glucose and your TDD.

1. Determine your glucose elevation:

_____ mg/dL – _____ mg/dL = _____ mg/dL

14-day avg glucose — avg glucose goal = glucose elevation

A. Glucose Elevation	B. Multiply Avg TDD by	A. Glucose Elevation	B Multiply Avg TDD by
+5 mg/dL	**1.01**	**+50 mg/dL**	**1.08**
+10 mg/dL	**1.01**	**+55 mg/dL**	**1.09**
+15 mg/dL	**1.02**	**+60 mg/dL**	**1.10**
+20 mg/dL (1.1 mmol/L)	**1.03**	**+65 mg/dL**	**1.11**
+25 mg/dL	**1.04**	**+70 mg/dL**	**1.12**
+30 mg/dL	**1.05**	**+75 mg/dL**	**1.13**
+35 mg/dL	**1.05**	**+80 mg/dL**	**1.14**
+40 mg/dL	**1.06**	**+85 mg/dL**	**1.15**
+45 mg/dL	**1.07**	**+90 mg/dL**	**1.16**

2. Find a better TDD (betterTDD) by multiplying your current 14-day average TDD by the factor in column B next to your glucose elevation:

_____ u/day	x	_____ (B)	=	_____ u/day
Current avg TDD		**B Factor**		**Your better TDD**

Example: for a 14-day average CGM glucose of 200 mg/dL (11.1 mmol/L) and an average glucose goal of 145 mg/dL (8.0 mmol/L), the glucose elevation is 55 mg/dL (3.1 mmol/L). For a current average TDD of 40 units/day, 40 units would be multiplied by 1.09 to the right of +55 mg/dL. 40 units times 1.09 = 43.6 units as the betterTDD.

3. Then find appropriate basal and bolus settings from the betterTDD in Table 9.7 or 9.8.

For a glucose elevation greater than 30 mg/dL (1.7 mmol/L), you may want to multiply the current TDD by 1.06 to gradually lower your TDD. Then redo the calculation above in 2 to 4 weeks.

9.7 Appropriate Basal Rate, CarbF, & CorrF for an Insulin Pump and CGM or AID Start:												
betterTDD u/day	**Basal u/hr**	**CorrF[2] (mg/dL)/u (mmol/dL)/u**	**Carb Factor[3] in grams/u for these body weights:**									
			100 lbs 45.4 kg	110 lbs 49.9 kg	120 lbs 54.4 kg	130 lbs 59.0 kg	140 lbs 63.5 kg	150 lbs 68.0 kg	160 lbs 72.6 kg	170 lbs 77.1 kg	180 lbs 81.6 kg	190 lbs 86.1 kg	200 lbs 90.7 kg
16u	0.333	113 (6.3)	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
20u	0.416	90 (5.0)	12.0	13.2	14.4	15.6	16.8	18.0	19.2	20.4	21.6	22.8	24.0
24u	0.499	75 (4.2)	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
28u	0.582	64 (3.6)	8.6	9.4	10.3	11.1	12.0	12.9	13.7	14.6	15.4	16.3	17.1
32u	0.666	56 (3.1)	7.5	8.3	9.0	9.8	10.5	11.3	12.0	12.8	13.5	14.3	15.0
36u	0.749	50 (2.8)	6.7	7.3	8.0	8.7	9.3	10.0	10.7	11.3	12.0	12.7	13.3
40u	0.832	45 (2.5)	6.0	6.6	7.2	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0
45u	0.936	40 (2.2)	5.3	5.9	6.4	6.9	7.5	8.0	8.5	9.1	9.6	10.1	10.7
50u	1.040	36 (2.0)	4.8	5.3	5.8	6.2	6.7	7.2	7.7	8.2	8.6	9.1	9.6
55u	1.144	33 (1.8)	4.4	4.8	5.2	5.7	6.1	6.5	7.0	7.4	7.9	8.3	8.7
60u	1.248	30 (1.7)	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0
65u	1.352	28 (1.6)	3.7	4.1	4.4	4.8	5.2	5.5	5.9	6.3	6.6	7.0	7.4
70u	1.456	26 (1.4)	3.4	3.8	4.1	4.5	4.8	5.1	5.5	5.8	6.2	6.5	6.9
80u	1.664	23 (1.3)	3.0	3.3	3.6	3.9	4.2	4.5	4.8	5.1	5.4	5.7	6.0
90u	1.872	20 (1.1)	2.7	2.9	3.2	3.5	3.7	4.0	4.3	4.5	4.8	5.1	5.3
100u	2.080	18 (1.0)	2.4	2.6	2.9	3.1	3.4	3.6	3.8	4.1	4.3	4.6	4.8

[1] Basal Rate = betterTDD x 0.0208 u per hr 2Corr Factor = 1800 mg/dL / betterTDD 3Carb Factor = 2.4 x Wt (lbs) / betterTDD or 5.16 x Wt (kgs) / betterTDD

For exact calculations, use the Pump Setting Tool at diabetesnet.com/aid-system-settings/

9.8 Appropriate Basal Rate, CarbF, & CorrF for an AID System:

betterTDD u/day	Basal u/hr	CorrF[2] (mg/dL)/u (mmol/dL)/u	Carb Factor[3] in grams/u for these body weights:										
			100 lbs 45.4 kg	110 lbs 49.9 kg	120 lbs 54.4 kg	130 lbs 59.0 kg	140 lbs 63.5 kg	150 lbs 68.0 kg	160 lbs 72.6 kg	170 lbs 77.1 kg	180 lbs 81.6 kg	190 lbs 86.1 kg	200 lbs 90.7 kg
16u	0.352	107 (5.9)	13.9	15.3	16.7	18.1	19.5	20.9	22.3	23.7	25.1	26.5	27.9
20u	0.440	86 (4.8)	11.2	12.3	13.4	14.5	15.6	16.7	17.8	19.0	20.1	21.2	22.3
24u	0.528	71 (3.9)	9.3	10.2	11.2	12.1	13.0	13.9	14.9	15.8	16.7	17.7	18.6
28u	0.616	61 (3.4)	8.0	8.8	9.6	10.4	11.2	11.9	12.7	13.5	14.3	15.1	15.9
32u	0.704	53 (2.9)	7.0	7.7	8.4	9.1	9.8	10.5	11.2	11.8	12.5	13.2	13.9
36u	0.792	48 (2.7)	6.2	6.8	7.4	8.1	8.7	9.3	9.9	10.5	11.2	11.8	12.4
40u	0.880	43 (2.4)	5.6	6.1	6.7	7.2	7.8	8.4	8.9	9.5	10.0	10.6	11.2
45u	0.990	38 (2.1)	5.0	5.5	5.9	6.4	6.9	7.4	7.9	8.4	8.9	9.4	9.9
50u	1.100	34 (1.9)	4.5	4.9	5.4	5.8	6.2	6.7	7.1	7.6	8.0	8.5	8.9
55u	1.210	31 (1.7)	4.1	4.5	4.9	5.3	5.7	6.1	6.5	6.9	7.3	7.7	8.1
60u	1.320	29 (1.6)	3.7	4.1	4.5	4.8	5.2	5.6	5.9	6.3	6.7	7.1	7.4
65u	1.430	26 (1.4)	3.4	3.8	4.1	4.5	4.8	5.1	5.5	5.8	6.2	6.5	6.9
70u	1.540	24 (1.3)	3.2	3.5	3.8	4.1	4.5	4.8	5.1	5.4	5.7	6.1	6.4
80u	1.760	21 (1.2)	2.8	3.1	3.3	3.6	3.9	4.2	4.5	4.7	5.0	5.3	5.6
90u	1.980	19 (1.1)	2.5	2.7	3.0	3.2	3.5	3.7	4.0	4.2	4.5	4.7	5.0
100u	2.200	17 (0.9)	2.2	2.5	2.7	2.9	3.1	3.3	3.6	3.8	4.0	4.2	4.5

[1] Basal Rate = betterTDD x 0.022 u per hr [2]Corr Factor = 1710 mg/dL / betterTDD [3]Carb Factor = 2.23 x Wt (lbs) / betterTDD or 4.92 x Wt (kgs) / betterTDD

For exact calculations, use the Pump Setting Tool at diabetesnet.com/aid-system-settings/

9.9 The One for Five Rule for a betterTDD

To quickly lower an elevated average glucose (with infrequent lows and no significant retinopathy), increase your current average TDD with the **One for Five Rule:**

Raise your TDD by 1% for every 5 mg/dL (0.3 mmol/L) of glucose elevation.

Example: for an average CGM glucose of 200 mg/dL (11.1 mmol/L) and an average glucose goal of 150 mg/dL (8.3 mmol/L), a 10% increase in the TDD to correct the 50 mg/dL elevation, or TDD times 1.08, will lower the average glucose by about 40 mg/dL (2.2 mmol/L), much closer to the average glucose goal. For someone with a TDD of 50 units, their new TDD would be 50 times 1.08 or 54 units,

9.10 Other Paths to a betterTDD

On an AID system, insulin delivery is continually increased to lower high readings and decreased to prevent lows. These actions rapidly produce a better 14-day average TDD if you bolus before and between meals with the CorrF from page 94. Use your AID system for one week, and then use this betterTDD to select appropriate BC settings in Table 9.8.

If not yet on an AID system with an elevated average glucose and no excess hypoglycemia, look at your CGM glucose five or six times daily and correct any elevation with the bolus your BC recommends, using the CorrF from page 94. After one week, the extra correction boluses provide a betterTDD and lower average glucose. Use this betterTDD in Table 9.7 to get a more appropriate basal rate, CarbF, and CorrF. Repeat if needed.

9.11 Reminders and Alerts (vary from pump to pump)		
Reminder or Alert	**What It Does**	**Range for Values**
Low Battery	Warns when battery needs changing.	24 hrs
Low Cartridge*	Alerts when a selected # of units are left in reservoir.	5 – 50u
Special Features	Alerts when an alternate bolus, temporary basal, or auto-off are active.	24 hrs
Delivery Limit	Warns when a maximum number of units of insulin are given per day or per meal.	1 – 150u
Glucose Reminder*	Reminder to test glucose at time selected after a bolus.	1 – 4 hr in 15 min increments
Low Glucose	Reminder to test glucose at selected time after a low glucose reading.	Time: 5 min – 1 hr BG: 50 – 100 mg/dl
High Glucose	Reminder to retest glucose at selected time following a high glucose reading.	Time: 30 min–2 hrs BG: 150–300 mg/dl
Automatic Off*	Turns pump off if no pump button is pushed during a selected time.	8 – 24 hrs
Site Reminder	Reminder to change infusion set.	Alerts at a certain time after 2–4 days.
Missed Meal Bolus	Alerts when a meal bolus was not given at a certain time of day.	Time range, such as 11:30 am to noon
* Alerts and reminders often have a default of "OFF" and must be set to "ON" with a personal value.		

10.1 Find Your Average Hourly Basal Rate

With a calculator, divide your betterTDD by 48 to get an hourly basal rate = half of your TDD:

Hourly basal rate = your betterTDD ÷ 48

For example, 48 u TDD ÷ 48 = 1.0 u/hour

10.2 Basal Percentages of TDD

43% or less	Those: • Sensitive to insulin, • Physically fit, • On a high carb or Asian diet • Producing residual insulin
44-58%	Most people
59% or more	Those: • On a low-carb diet • Who miss, delay, or give inadequate carb boluses.

10.3 Find Hourly Basal Rate as Percentage of Average TDD

To get a basal percentage of:	Multiply average TDD by:
40%	0.0167
45%	0.0188
50%	0.0208
55%	0.0229
60%	0.0250

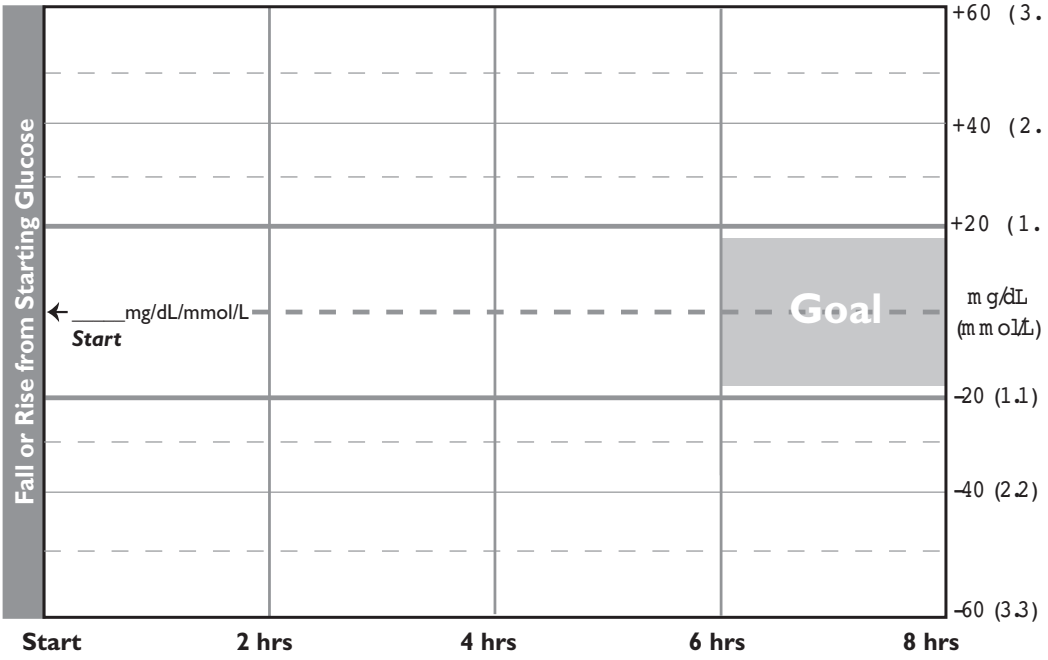
Example: if avg. TDD = 40u a day and you want 50% as basal, 40u x 0.0208 = 0.832 u/hr

10.4 Check Your Basal Rates

Basals Tested: ____u/hr@____ am/pm ____u/hr@____ am/pm ____u/hr@____ am/pm

Date: ____/____/_____ ____u/hr@____ am/pm ____u/hr@____ am/pm

	Start	**+ 2 hrs**	**+ 4hrs**	**+ 6 hrs**	**+ 8 hrs**
Time:	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm
BG:	_____ mg/dL	_____ mg/dL/mmol/L	_____ mg/dL/mmol/L	_____ mg/dL/mmol/L	_____ mg/dL
Change in BG:		_____ mg/dL/mmol/L	_____ mg/dL/mmol/L	_____ mg/dL/mmol/L	_____ mg/dL



Goal: A basal rate that keeps your glucose within 20 mg/dL (1.1 mmol/L) of the starting glucose.

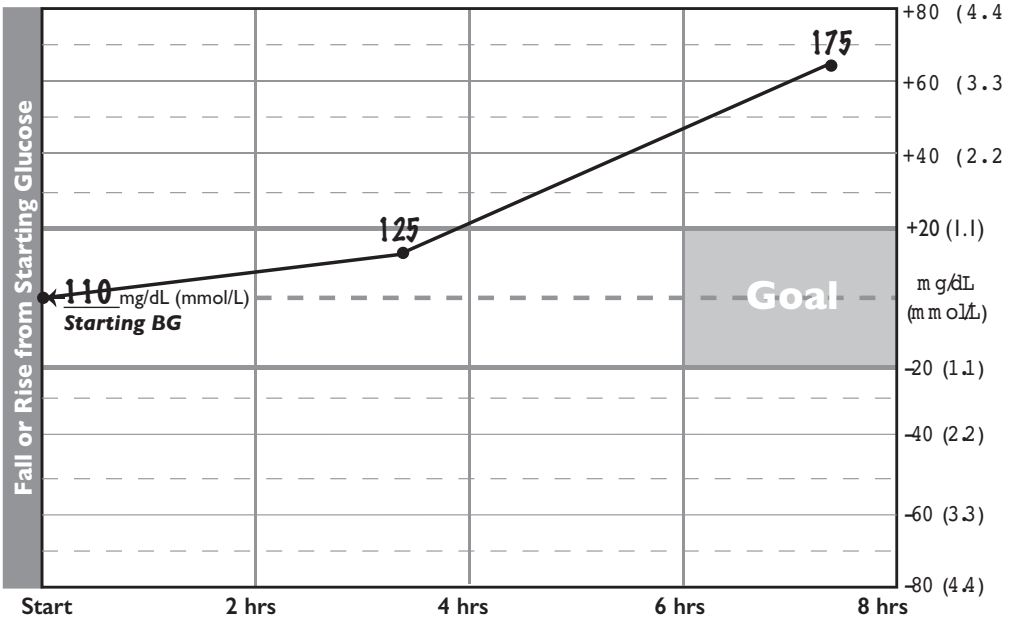
1. Start a basal check any time your glucose is between 90 and 120 mg/dL (5.0 - 6.7 mmol/L), you have not eaten in the last 3 hours, and have not taken a bolus in the last 5 hours. Check an AID by the degree of basal chatter or by temporarily suspending it.
2. Eat no carbs. Small amounts of protein (a few nuts, cheese, boiled egg, etc.) are OK.
3. Record and plot your CGM glucose every 1-2 hours on the graph.
4. If your glucose goes below 70 mg/dL (4 mmol/L), stop and have carbs.
5. if your glucose rises or falls over 20 mg/dL (1.1 mmol/L), use Table 10.7 to adjust your basal rates by matching how many mg/dL or mmol/L your glucose rises or falls with the same change in the first row of Table 10.4.
6. Repeat until your glucose stays relatively flat on two consecutive tests.

10.5 Example: Chris Checks his Overnight Basal

Basals Tested: 1.1 u/hr@ 12 am/pm ____u/hr@____ am/pm ____u/hr@____ am/pm

Date: 3 / 22 / 24 ____u/hr@____ am/pm ____u/hr@____ am/pm

	Start	+ 2 hrs	+ 4hrs	+ 6 hrs	+ 8 hrs
Time:	11:00 am/pm	_____ am/pm	2:50 am/pm	_____ am/pm	7:20 am/pm
BG:	110 mg/dL	_____ mg/dL/mmol/L	125 mg/dL/mmol/L	_____ mg/dL/mmol/L	175 mg/dL/mmol/L
Change in BG:	_____ mg/dL/mmol/L		+15 mg/dL/mmol/L	_____ mg/dL/mmol/L	+65 mg/dL/mmol/L



With an average TDD of 60 units a day, Chris started on his pump with a single basal rate of 1.1 u/hr (44% basal or 26.4 u/day). On this basal, his bedtime reading of 110 mg/dL (6.1 mmol/L) rose to 125 mg/dL (6.9 mmol/L) at 2 a.m. and 175 mg/dL (9.7 mmol/L) before breakfast. From Table 10.9, with a TDD of 60 units and a glucose rise of 65 mg/dL (3.3 mmol/L), Chris determined he needed about 1.6 more units in his overnight basal.

From the results, his physician suggested raising his basal from 1.1 u/hr to 1.2 u/hr from 9 pm to 2 am, then to 1.3 u/hr between 2 am and 6 am, an increase of 1.4 units overnight. A followup basal check showed that his glucose still rose by 25 mg/dL (1.4 mmol/L) overnight. His glucose finally remained flat overnight when he raised his 9 pm basal rate from 1.2 to 1.25 u/hr and his 2 am basal from 1.30 to 1.35 u/hr, flattening his overnight glucose.

10.6 Total Units for Changes in Basal Rate

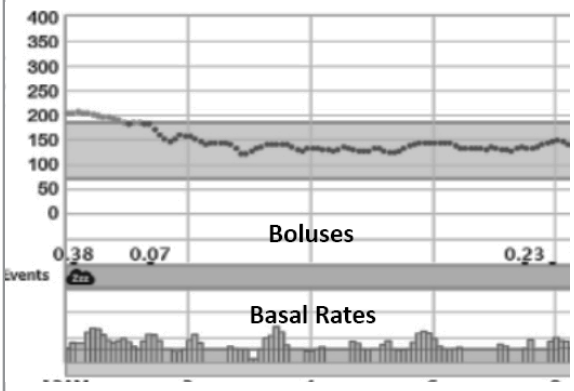
When you change a basal rate, it helps to know how many total units the change brings.

Change in Basal Rate	Total units over 8 hrs	Total units over 24 hrs
+/- 0.010 u/hr	0.08 u	0.24 u
+/- 0.025 u/hr	0.20 u	0.60 u
+/- 0.050 u/hr	0.40 u	1.20 u
+/- 0.100 u/hr	0.80 u	2.40 u

Basal adjustments of 0.025 and 0.1 u/hr equal 0.6 and 2.4 units over the entire day. For a glucose that falls or rises slightly during a basal test, a basal change of 0.01 to 0.025 u/hr may fix this.

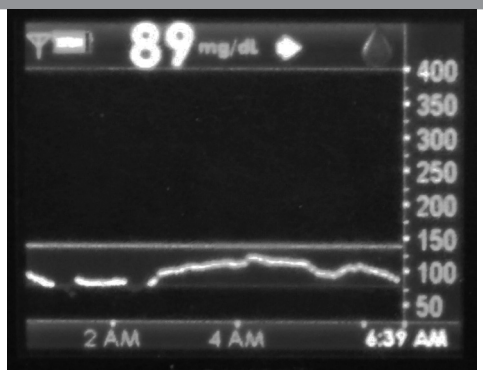
To find out how much a change in basal rate affects your glucose, **multiply the total change in basal units by your CorrF**. For example, with a CorrF of 40 mg/dL per unit, lowering or raising your basal rate by 0.05 u/hr over 8 hours reduces insulin by 0.4 units X 40 mg/dL/unit = 16 mg/dL, lowering glucose by about 16 mg/dL or raising it by about 16 mg/dL.

10.7 Real-time CGM Basal Check



When testing basals, look at whether the AID is increasing or decreasing the programmed rate. Here the AID is increasing the programmed basal rate throughout the night. A higher basal rate would help.

10.8 Real-time CGM Basal Check



On this 6-hour night basal check, the person had 15 grams of carb at 2:30 am to treat a low glucose. The glucose rose temporarily and then dropped again. Lowering the overnight basal from 0.775 u/hr to 0.725 u/hr flattened the glucose overnight.

10.9 How to Adjust Your Basal Rate

1. With a glucose FALL or RISE of:	20 mg/dL 1.1 mmol/L	30 mg/dL 1.7 mmol/L	40 mg/dL 2.2 mmol/L	50 mg/dL 2.8 mmol/L	60 mg/dL 3.3 mmol/L	70 mg/dL 3.9 mmol/L	80 mg/dL 4.4 mmol/L
2. And this TDD:	**3. LOWER or RAISE the basal rate for 8 hours by:**						
20 u	0.025 u/hr	0.025 u/hr	0.025 u/hr	0.025 u/hr	0.075 u/hr	0.075 u/hr	0.075 u/hr
30 u	0.05 u/hr	0.05 u/hr	0.05 u/hr	0.05 u/hr	0.125 u/hr	0.125 u/hr	0.125 u/hr
40 u	0.075 u/hr	0.075 u/hr	0.075 u/hr	0.075 u/hr	0.15 u/hr	0.15 u/hr	0.15 u/hr
50 u	0.1 u/hr	0.1 u/hr	0.1 u/hr	0.1 u/hr	0.225 u/hr	0.225 u/hr	0.225 u/hr
60 u	0.125 u/hr	0.125 u/hr	0.125 u/hr	0.125 u/hr	0.25 u/hr	0.25 u/hr	0.25 u/hr
80 u	0.15 u/hr	0.15 u/hr	0.15 u/hr	0.15 u/hr	0.325 u/hr	0.325 u/hr	0.325 u/hr
100 u	0.2 u/hr	0.2 u/hr	0.2 u/hr	0.2 u/hr	0.4 u/hr	0.4 u/hr	0.4 u/hr

1. If your glucose rises or falls over 20 mg/dL (1.1 mmol/L) from the starting glucose in a basal check, use this table to raise or lower your current rates. Raise your basal rate if your glucose rises during the basal test and lower it if your glucose falls.
2. Adjust basal rates until they keep your glucose within 20 mg/dL over 6 to 8 hours on 2 checks.

Example: For a glucose rise of 80 mg/dL during an 8-hour test with a TDD of 30 units a day, the current basal rate would be raised by as much as 0.10 u/hr for 8 hrs.

10.10 Case Study Basal Change

Six days after her pump start, Gwenn was thrilled that her breakfast reading was in her target range at 90 mg/dL (5 mmol/L). At her clinic visit later that day, her doctor reviewed her CGM data download. Her glucose had been 180 mg/dL (10 mmol/L) at 2 a.m. and her last bolus was given at 6 pm the evening before, with no bolus after that. Even so, her glucose fell over 90 mg/dL (5 mmol/L) by breakfast! Gwenn and her physician lowered her overnight basal rate despite her "perfect" breakfast reading.

10.11 The Dawn Phenomenon

After growth spurts, a child or teen's TDD and basal rates increase, multiplying several times during growth. Teens and young adults may require a slightly higher basal rate in the pre-dawn hours to counteract a **Dawn Phenomenon**, where more growth hormone is released in the early morning hours. This causes glucose levels to rise unless offset by an even earlier rise in basal delivery.

Remember that an insufficient basal rate in the pre-dawn hours looks exactly like a Dawn Phenomenon and is often the real source for high before-breakfast glucose levels.[109, 110] High breakfast glucose levels in the teen years are often corrected by a small increase in the overnight basal rate, starting near midnight. An AID makes these adjustments automatically.

10.12 How Common Are Carb Count Errors?

Carb counting requires estimating a meal's carb content. This can be influenced by portion size, food composition, preparation method, and more. In an analysis of carb counts in 448 meals by people with Type 1 diabetes, nutritionists found that 63% of the counts were underestimated. Underestimating carbs impairs glucose management even on an AID. A 2011 study published in Diabetes Technology & Therapeutics found that among 64 participants with Type 1 diabetes who used a bolus calculator, 47% made errors in carbohydrate counting, 29% made errors in insulin dosing, and 20% made errors in both.

11.1 Calculate Your Insulin Pump Carb Factor

To find a starting CarbF, multiply your weight(lb) by 2.4 grams per pound and divide this number by your 14-day average betterTDD or current average TDD in a calculator:

$$\text{Pump CarbF} = \left(\frac{2.4 \times \text{Wt(lb)}}{\text{betterTDD}}\right) \text{ or } \left(\frac{5.3 \times \text{Wt(kg)}}{\text{betterTDD}}\right) \quad \text{AID CarbF} = \left(\frac{2.23 \times \text{Wt(lb)}}{\text{betterTDD}}\right) \text{ or } \left(\frac{4.9 \times \text{Wt(kg)}}{\text{betterTDD}}\right)$$

For example, if a person's weight is 160 lbs and their 14 day average betterTDD is 45 units a day, their CarbF would be 2.4 g/lb x 160 lbs / 45 u = 8.5 grams of carb per unit. From experience, if 8 units covers 70 grams of breakfast carbs, your CarbF for breakfast will be 70 g / 8.0 units or 8.8 grams per unit.

11.2 How High Should Your Glucose Go After a Meal?

The American Diabetes Assoc. recommended in 2001 that post-meal readings not go above 180 mg/dL (10 mmol/L) at two hours.[113] The European Diabetes Policy Group recommended post-meal readings go no higher than 165 mg/dL (8.9 mmol/L) in Type 2 diabetes to prevent diabetes complications, and no higher than 135 mg/dL (7.5 mmol/L) to prevent heart attacks and strokes in those at risk.[114] In 2011, the Inter. Diabetes Federation recommended that postprandial glucose levels stay below 160 mg/dL (9.0 mmol/L) 1 to 2 hours after meals for both Type 1 and 2 as long as hypoglycemia is avoided.[115] Post-meal targets in pregnancy are even tighter with a goal of staying below 130 mg/dL (7.2 mmol/L) after meals.[116]

11.3 Math for Carb Boluses

Grams of Carb/CarbF = Carb Bolus

So, for 44 grams of carb and a CarbF of 11 grams/u:

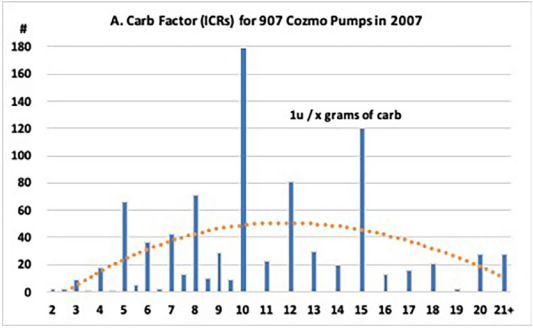
44 grams/(11 grams/u) = 4.0 u for a carb bolus

11.4 What to Ask When You Bolus

- What is my glucose?
- What is the direction of my trend line?
- What is my IOB?
- What should I do?

11.5 CarbFs – Often Inaccurate

This graphic shows the CarbFs found in 907 pumps turned in for a software upgrade.86 20% of these pumpsused 10 grams for their CarbF, while only 4% used 9 grams and 2.5% used 11 grams. Only 41% of the CarbFs matched an expected distribution, shown by the curved line in the figure.



People & health-care professionals prefer easy-to-use CarbFs like 5, 10, 15, and 20, rather than accurate ones. A difference of 1 gram or less in the CarbF dramatically changes glucose readings after multiple daily meals and snacks.

Always start CarbF checking with a CarbF from Table 9.7 or using Box 11.1.

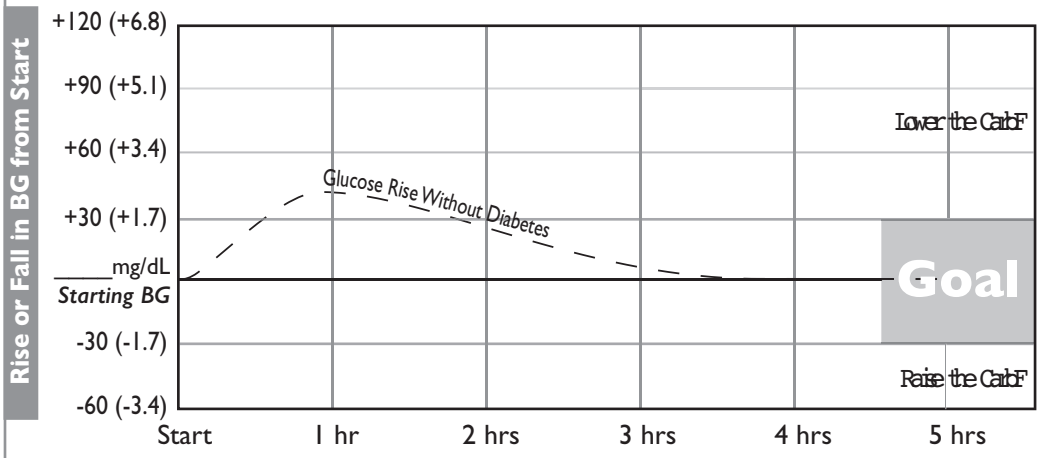
11.6 Real-time CarbF Test

The 24-hr window on the right shows mildly elevated glucose spikes in the post meal-readings. The CarbF appears OK since readings come down in about 4 hours. Giving carb boluses earlier before meals or adding low GI foods would reduce the post-meal rises.

11.7 Assess Your Carb Factor

Date: ____ /____/_____ **CarbF: 1u /** ____ **gram** **Carbs:** ____ **gr** **Bolus:** ____ **u**

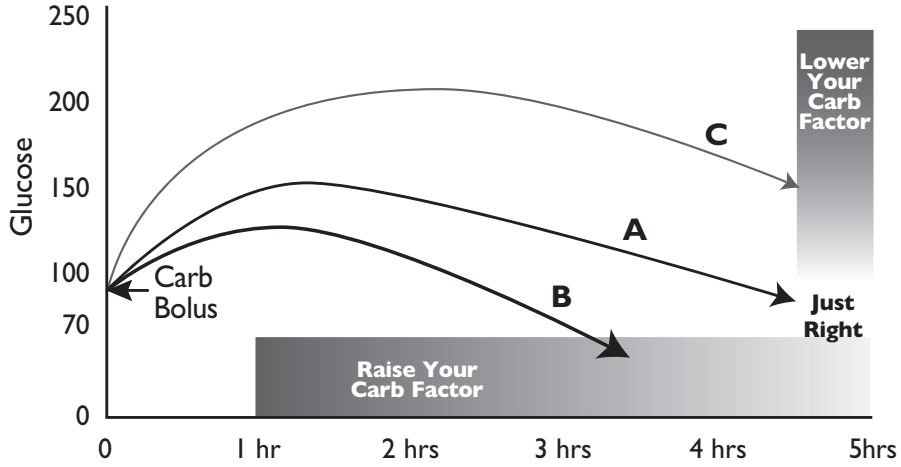
	Start	**~ 1 hr later**	**~ 2hrs later**	**~ 3 hrs later**	**~ 4 hrs later**	**~ 5 hrs later**
	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm
BG:	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl
Change in BG =	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl	_____ mg/dl



Goal: Test and adjust your CarbF until it brings your glucose within 20 mg/dL (1.1 mmol/L) of your start 5 hours later. Wait at least 5 hours after your last bolus and 3 hours after last carbs.

1. Start checking your glucose when it is between 90 to 140 mg/dL (5.0 to 7.8 mmol/L).
2. Eat enough carbs to challenge your CarbF, such as grams equal to half your weight in lbs (or equal to your weight in kgs). For example, if you weigh 140 lbs, have 70 grams of carbs. Select foods low in fat and protein.
3. Enter the carb count into your pump without a glucose reading and deliver the recommended carb bolus 20 minutes before you eat.
4. Check your glucose each hour with your CGM or test with a meter for the next 5 hours. Stop and eat carbs if your glucose goes below 70 mg/dL (3.9 mmol/L).
5. Plot readings from the 6 hour real-time screen on your CGM (or meter) on the graph.

11.8 How to Adjust Your Carb Factor



Adjust your CarbF from the Glucose Path:

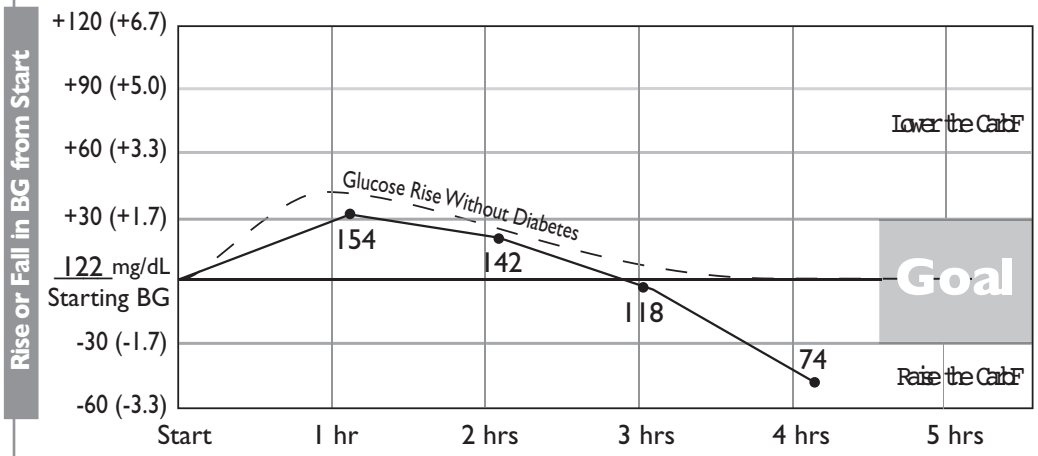
1. The CarbF is appropriate (Arrow A) when your glucose ends up within 20 mg/dL (1.1 mmol/L) above or below your starting glucose after 5 hours. Recheck to verify.
2. If your glucose goes low (B), increase your CarbF number to get smaller carb boluses.
3. If your glucose typically stays more than 20 mg/dL (1.1 mmol/L) above your starting glucose at 5 hours (C), decrease your CarbF to get larger boluses.
4. Use this table to see how much to change your CarbF:

If current CarbF is:	Adjust up or down by:
Less than 5.0 grams per unit	0.2 to 0.3 grams per unit
5-10 grams per unit	0.3 to 0.5 grams per unit
10-15 grams per unit	1 gram per unit
16-24 grams per unit	1 to 2 grams per unit
Larger or smaller CarbF changes may be needed.	

11.9 Elaine Checks and Adjusts Her Carb Factor

Date: 9 / 22 / 17 **CarbF: 1u /** 10 **gram Carbs:** 80 **gr Bolus:** 8.0 **u**

	Start	~ 1 hr later	~ 2hrs later	~ 3 hrs later	~ 4 hrs later	~ 5 hrs later
Time:	12:00 am/(pm)	1:10 am/(pm)	2:05 am/(pm)	3:00 am/(pm)	4:07 am/(pm)	_____ am/pm
BG:	122 mg/dl	154 mg/dl	142 mg/dl	118 mg/dl	74 mg/dl	_____ mg/dl
Change in BG:	+32 mg/dl	+20 mg/dl	-4 mg/dl	-48 mg/dl	_____ mg/dl	



On a new diet, Elaine began to have mild lows in the late afternoon. Basal testing showed her basal rates kept her glucose flat when she was not eating. At noon, 5 hours after her breakfast bolus, she decided to confirm her CarbF by having lunch at a local Italian diner. She took the 7 units her pump recommended for 70 grams of linguine (CarbF = 1u/10 grams).

Her glucose started at 122 mg/dL (6.1 mmol/L), rose to 154 mg/dL an hour later, then fell to 76 mg/dL (4.2 mmol/L) only 4 hours later, 48 mg/dL below her start. Elaine emailed her test results to her clinician who suggested she raise her CarbF from 1u/10 grams to 1u/11 grams. This reduction in her lunch boluses eliminated many of her afternoon lows.

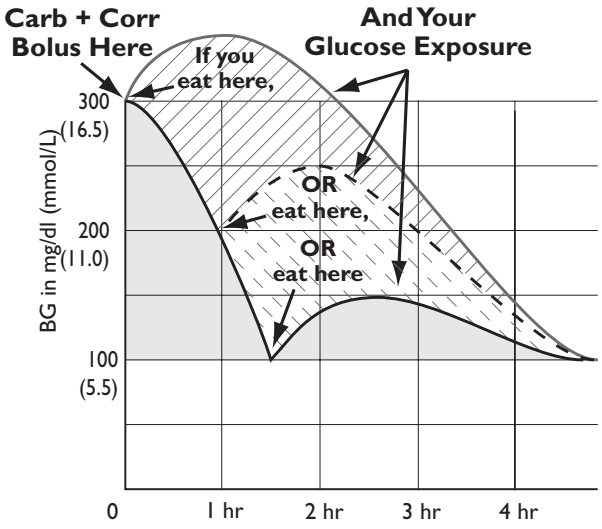
11.10 A Quick Way to Verify Carb Counts

To approximate your daily calorie intake, multiply the 14-day average carb count in your pump history by 10. For example, if your pump shows 80 grams of carb per day, this is equivalent to approximately 800 total calories a day. If you weigh less than 70 lbs. (32 kgs.), this calorie intake may be appropriate. But if you're an adult, you may be on a low carb diet, missing meal boluses, or under-counting carbs.

If your average carb count seems low or post-meal readings vary a lot, a visit to your dietitian is a quick way to reduce this. Bring along a three-day food diary of the foods, snacks, and caloric beverages you eat at each meal and your estimated carb count for your dietitian to review with you.

11.11 Reduce Glucose Exposure by Waiting to Eat When Above Target Range

If a glucose is above 140 mg/dL (7.8 mmol/L) before a meal, reduce glucose exposure by waiting to eat, as shown in the figure on the left. The higher your glucose, the longer you might delay eating after you bolus. Enter your glucose and carb grams and take the recommended bolus. When able, wait to eat until your glucose is below 140 mg/dL. Don't delay too long and don't try this if you might forget to eat or you have hypo unawareness. Set an alarm for the times in the table. Please be careful.

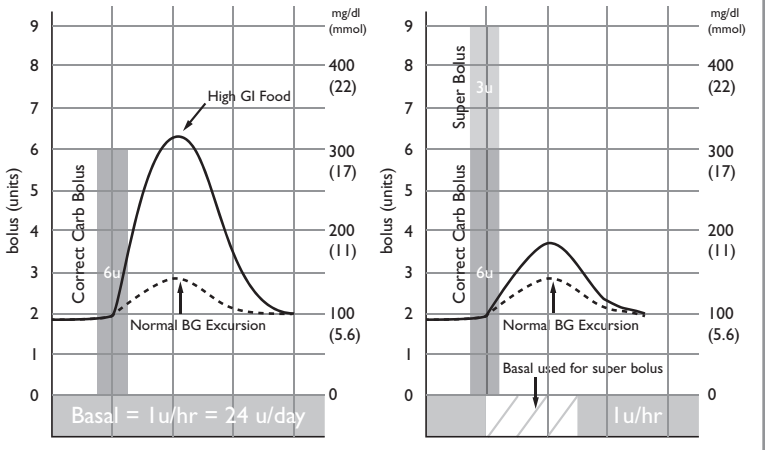


How Long to Wait before You Eat

A high glucose rarely falls faster than 3 mg/dL (0.17 mmol/L) a minute. The estimates below give reasonably safe times to wait to eat after giving a carb plus correction bolus. Watch your CGM!

Pre-meal BG	Approx. Wait Time
90-120 mg/dL	10-20 min
150 mg/dL	30 min
180 mg/dL	40 min
210 mg/dL	50 min
240 mg/dL	60 min
270 mg/dL	70 min
300 mg/dL	80 min

11.12 How a Super Bolus Works



Instead of taking 6 units for breakfast cereal, start a temp basal rate at 20% (80% reduction) of the 1.0 u/hr basal rate over the next 3 hours. The 2.4 units from this basal reduction (1.0 u/hr x 0.8 x 3 hrs = 2.4 units) can be added to the 6.0 u meal bolus. This covers the cereal with a larger 8.4 u bolus (6.0 u + 2.4 u) with little risk of going low later.

12.1 Math for a Correction Bolus

To get your correction bolus, subtract your target glucose from your current glucose, then divide this number by your CorrF to get the units you need:

$$\frac{\textbf{Current BG - Target BG}}{\textbf{CorrF}} = \textbf{Correction Bolus}$$

If a glucose is 230 mg/dL with a target of 110 mg/dL and CorrF of 40 mg/dL:

$$\frac{\textbf{230 mg/dL – 110 mg/dL}}{\textbf{40 mg/dL per unit}} = \frac{\textbf{120 mg/dL}}{\textbf{40}} = \textbf{a 3.0 u correction bolus}$$

12.2 Calculate Your Own Correction Factor (or Use Table 9.7)

For the CorrF with an average glucose of 140 mg/dL, divide 1800 by the average betterTDD:

$$\textbf{CorrF} = \frac{\textbf{1800 mg/dl}}{\textbf{betterTDD}} \textbf{ or } \frac{\textbf{00 mmol/L}}{\textbf{betterTDD}}$$

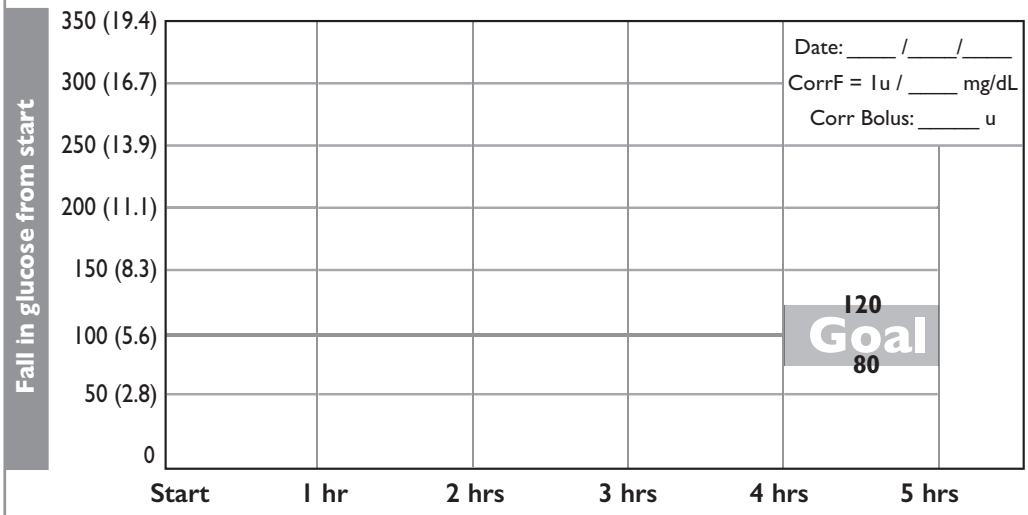
For example, if a person's 14 day average TDD is 50 units a day, their CorrF would be 1800/50 = 36 mg/dL per unit (2.0 mmol/L per unit). Note that on an AID system, a stronger (lower) CorrF often improves the average glucose without increasing hypoglycemia.

12.3 A Smaller CorrF Lowers a Higher Average Glucose

For a Recent A1c of:	Or a 14-day average glucose of:	Use this Corr Factor Scale Number (CorrF-SN) for mg/dL between	for mmol/L between
5.1% to 6.3%	100 to 135 mg/dL	= 2100 to 1900/TDD	=117 to 106/TDD
6.4% to 7.0%	136 to 155 mg/dL	= 1900 to 1800/TDD	= 106 to 100/TDD
7.1% to <8.5%	156 to 198 mg/dL	= 1800 to 1560/TDD	= 100 to 87/TDD
8.6% to 10%	199 to 241 mg/dL	= 1560 to 1325/TDD	= 87 to 74/TDD
10.1% to 12.1%	242 to 300 mg/dL	= 1325 to 1000/TDD	= 74 to 56/TDD
CorrF = CFRN / average TDD			

12.4 Test Your Correction Factor in Manual Mode

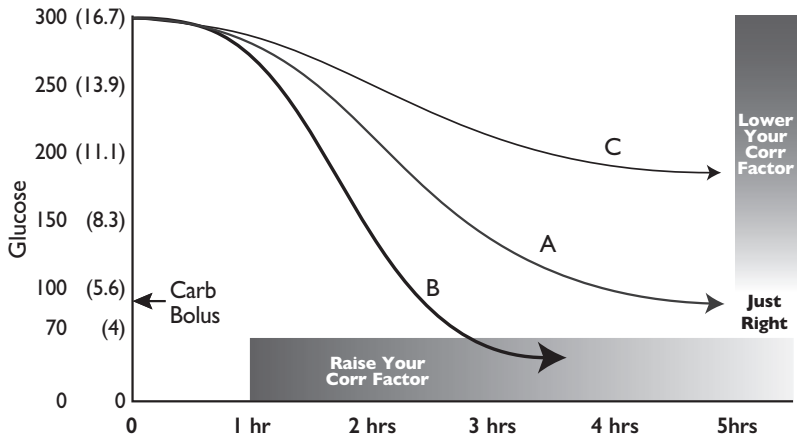
	Start	~ 1 hr later	~ 2hrs later	~ 4 hrs later	~ 5 hrs later
Time:	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm	_____ am/pm
BG:	_____ mg(mmol)	_____ mg(mmol)	_____ mg(mmol)	_____ mg(mmol)	_____mg(mmol)
Change in BG:		_____ mg(mmol)	_____ mg(mmol)	_____ mg(mmol)	_____mg(mmol)



Goal: To find a CorrF that lowers higher readings to 80 to 120 mg/dL (4.4 to 6.7 mmol/L) after 5 hours without going low. To clear out prior boluses and carbs, take no bolus in the previous 5 hours and no carbs in the previous 3 hours.

1. Test when your glucose is above target, such as above 250 mg/dL (12.9 mmol/L) and you can wait to eat for another 5 hours. Small amounts of protein (5 grams or less) from nuts, cheese, or boiled egg may be eaten while checking.
2. Take the correction bolus your pump BC recommends.
3. If your CGM glucose goes below 70 mg/dL (4 mmol/L), stop checking and eat carbs.
4. From your 6-hour CGM screen, plot your readings on the graph above.
5. Repeat until an above-target glucose falls within the goal area on 2 consecutive checks. See Change Your CorrF in 12.6 if your glucose goes below 70 mg/dL (4 mmol/L) at any time or stays above 120 mg/dL (6.7 mmol/L) at the end of the check.

12.5 Adjust Your CorrF from Your Glucose Response

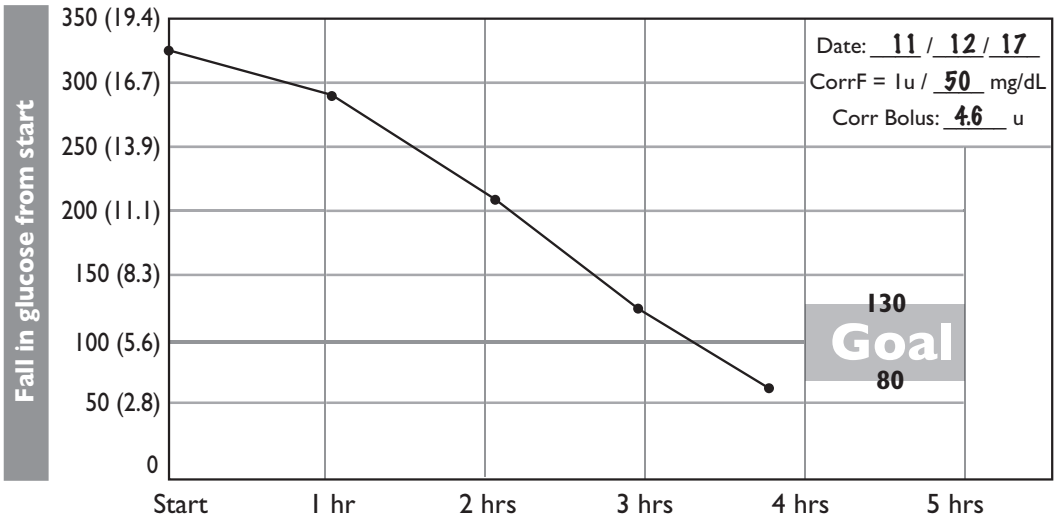


1. If your glucose ends up within 20 mg/dL (1.2 mmol/L) above or below your target glucose (Arrow A), celebrate and check the CorrF once more to verify.
2. If your glucose goes below 70 mg/dL (4 mmol/L), such as in Arrow B, treat the low and raise your CorrF number by 10% using the table below to make correction boluses smaller. For example a CorrF of 1 u:40 mg/dL (1 u:2.2 mmol/L) would be raised to 1 u:44 mg/dL (1 u:2.4 mmol/L). If your glucose goes low after only 2-3 hours, a larger increase may be needed. Then recheck.
3. If your glucose stays above 130 mg/dL (7.2 mmol/L), such as in Arrow C, lower your CorrF by 10% using the table below to make correction boluses larger. For example, a CorrF of 1 u:80 mg/dL (4.4 mmol/L) would be lowered to 1 u:72 mg/dL (4.0 mmol/L). A larger decrease may be needed if your glucose stays very high. Then recheck.
4. Change the CorrF until it brings high glucose close to your target glucose 5 hours later.

Current CorrF	CorrF to Make Corr Boluses 10% Larger	CorrF to Make Corr Boluses 10% Smaller	Current CorrF	CorrF to Make Corr Boluses 10% Larger	CorrF to Make Corr Boluses 10% Smaller
120 mg/dL	108 mg/dL	132 mg/dL	30 mg/dL	27 mg/dL	33 mg/dL
100 mg/dL	90 mg/dL	110 mg/dL	25 mg/dL	22 mg/dL	28 mg/dL
80 mg/dL	72 mg/dL	88 mg/dL	20 mg/dL	18 mg/dL	22 mg/dL
60 mg/dL	54 mg/dL	66 mg/dL	15 mg/dL	14 mg/dL	16 mg/dL
50 mg/dL	45 mg/dL	55 mg/dL	10 mg/dL	9 mg/dL	11 mg/dL
40 mg/dL	36 mg/dL	44 mg/dL	5 mg/dL	4.5 mg/dL	5.5 mg/dL

12.6 Example: Elaine Checks and Changes Her Correction Factor

	Start	~ 1 hr later	~ 2hrs later	~ 3 hrs later	~ 4 hrs later	~ 5 hrs later
Time:	5:00 am/pm	6:05 am/pm	7:12 am/pm	8:10 am/pm	8:51 am/pm	-- am/pm
BG:	328 mg/dl	298 mg/dl	209 mg/dl	123 mg/dl	58 mg/dl	-- mg/dl
Change in BG:	-30 mg/dl	-119 mg/dl	-205 mg/dl	-270 mg/dl	-- mg/dl	



Elaine underestimated the carbs in a pasta lunch. Her glucose 5 hours later was 328 mg/dL (18 mmol/L) and she also bolused then with no food since. She decided to skip dinner and check her CorrF. Her basal rate, checked before, kept her glucose flat when she was not eating.

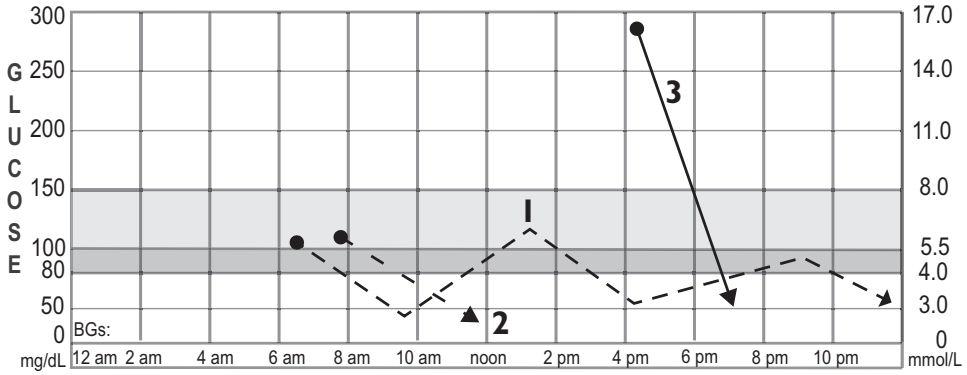
With a CorrF of 1 unit for every 50 mg/dL (2.8 mmol/L) above 100 mg/dL (5.6 mmol/L), Elaine bolused 4.6 units to lower her glucose by 228 mg/dL (12.7 mmol/L). [228/50 = 4.6 units]. Her glucose fell to 58 mg/dL (3.6 mmol/L) less than 4 hours later. After treating the low, she raised her CorrF to 1 unit for each 55 mg/dL (3.1 mmol/L). She planned to check her new CorrF at the earliest opportunity.

13.1 Glucose Stability Is Possible If You:

- Are motivated
- Are educated in diabetes management
- Have appropriate pump settings
- Receive good feedback through glucose monitoring

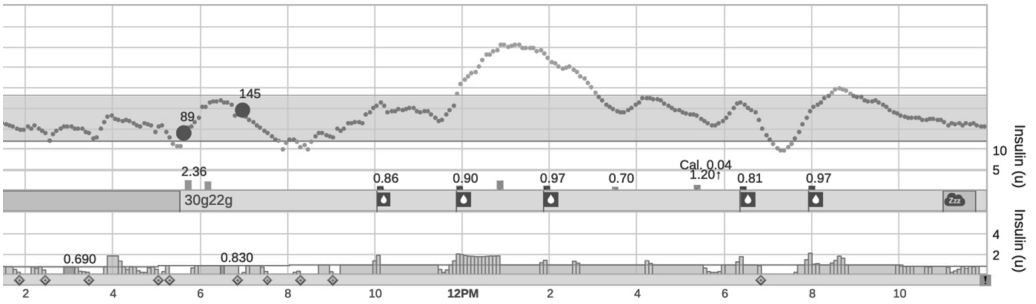
From Dr. Robert Tattersall: Workshop On Home Monitoring of Blood Glucose, Nottingham Univ., 1980.

13.2 Common Frequent Low Patterns and Solutions

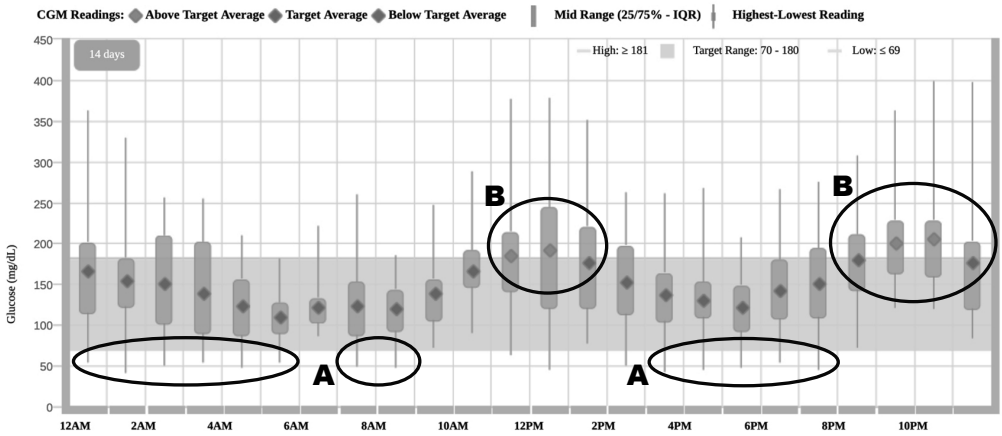


1. **frequent lows –** lower TDD by 5 to 10% and find new pump settings from the reduced TDD.
2. **frequent lows at a particular time of the day –** lower the basal rate 5 to 8 hours before the low reading typically happens or increase the CarbF for the previous meal.
3. **over-correcting highs –** raise the CorrF/ISF, do not increase recommended correction boluses unless CGM trend line suggests this is needed, set DIA to 4.5 hrs or longer. .

13.3 Frequent Lows on an AID



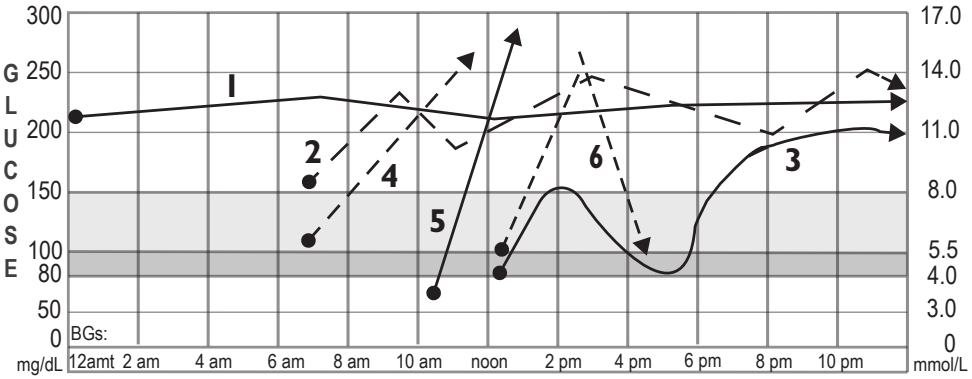
The glucose repeatedly goes low during the night and only minimal boluses are given during the day.



This 14-day graph shows frequent night and afternoon lows with readings frequently below 50 mg/dL in the lower circles marked A. Rebound highs follow at the B circles. The lows stopped once the basal rate was lowered from 0.83 to 0.60 u/hr, and the CarbF raised from 1u/11 grams to 1u/14 grams, allowing meal boluses to again be given. Settings matter, even on AID systems.

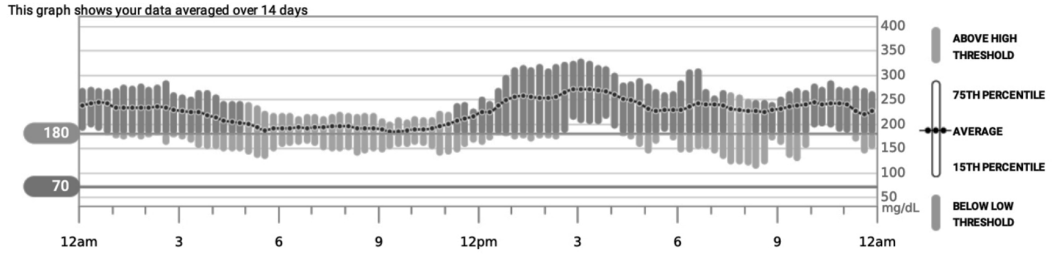
13.4 Common High Glucose Patterns and Solutions

These common unwanted patterns are displayed on a **36 hour graph** from midnight one day to noon the next day. Specific solutions below.



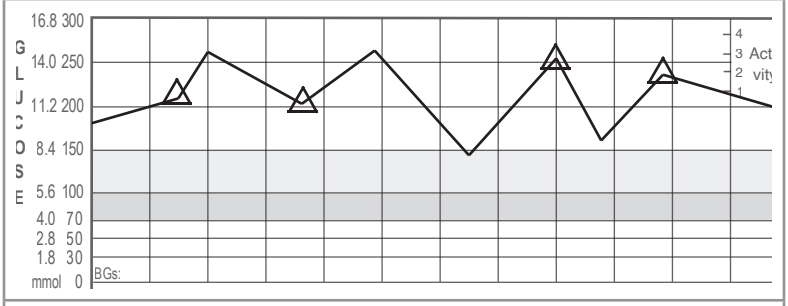
1. **frequent highs that stay relatively flat all day –** raise the basal rates,
2. **frequent highs from post-meal spiking –** raise basal rates and lower the CarbF.
3. **most common pattern (lower readings during the day, then higher after dinner and into the night) –** raise afternoon and evening basal rate, lower dinner CarbF),
4. **frequent highs at a particular time of the day –** raise the basal rate 5 to 8 hours earlier or decrease the CarbF for the previous meal,
5. **over-treating lows –** don't overtreat: Carbs = 1g/10 lbs (5kgs) + IOB x CarbF
6. **post-meal spiking –** review 3 causes and solutions in Section F,
7. Several patterns often coexist. Choose one at a time and adjust the basal rate or bolus most responsible for that pattern. Get rid of excess lows first and then the highs. .

13.5 High Glucose All Day



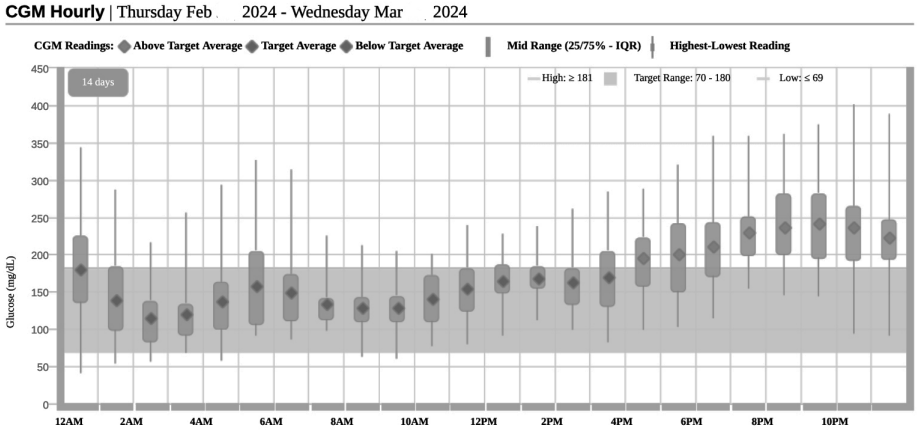
Here, the basal rate would be increased all day, with perhaps a smaller CarbF for lunch and dinner. This can happen on an AID system with incorrect settings.

13.6 Frequently High with Post-Meal Rise



This pattern is an example of #2 in Figure 13.4.

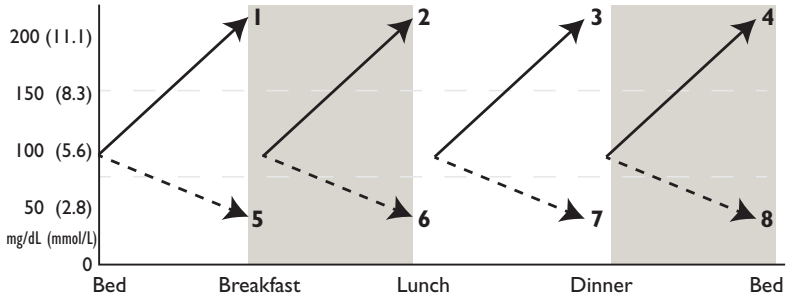
13.7 Common High Glucose Pattern



The major glucose elevation for this person on AID starts after their 3 pm dinner. Meal boluses are inadequate or missed, with some lows in the early morning after excessive corrections.

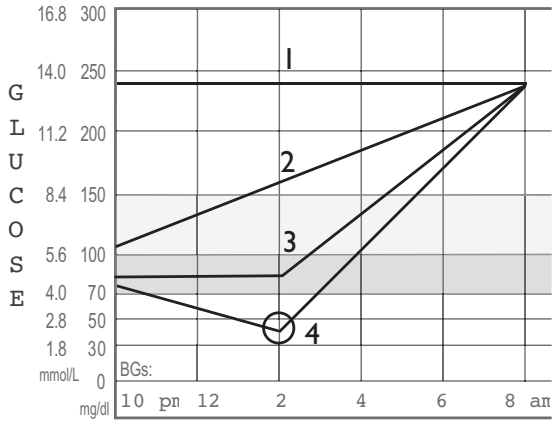
13.8 How to Stop Highs or Lows at a Particular Time of Day

Look for the time of day when your glucose typically goes low or high, and try a correction suggested for that number. Stop frequent lows first. For example, if your glucose goes low between breakfast and lunch, look at number 2 for suggestions.



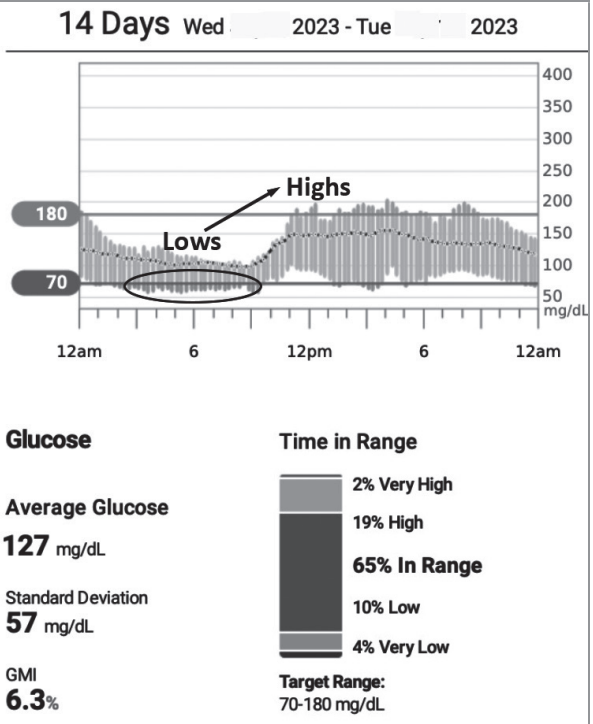
1) If the glucose usually goes up between bedtime and breakfast, raise your basal rate overnight at least 2 hours before the glucose starts to rise. (See 4 if your glucose is usually already high at bedtime.) See also Pattern E in this chapter.
2) Lower your breakfast CarbF or raise the basal rate(s) 5 to 8 hours earlier.
3) Lower your lunch CarbF or raise the basal rate(s) 5 to 8 hours earlier.
4) Lower your dinner CarbF or raise the basal rate(s) 5 to 8 hours earlier. Consider whether after-dinner snacks cause the rise
5) If your glucose usually goes low between bedtime and breakfast, lower the basal rate(s) 5 to 8 hours earlier. Check how much IOB is active at bedtime.
6) Raise your breakfast CarbF or lower the basal rate(s) 5 to 8 hours earlier.
7) Raise your lunch CarbF or lower the basal rate(s) 5 to 8 hours earlier.
8) Raise your dinner CarbF or lower the basal rate(s) 5 to 8 hours earlier. .

13.9 Highs Before Breakfast



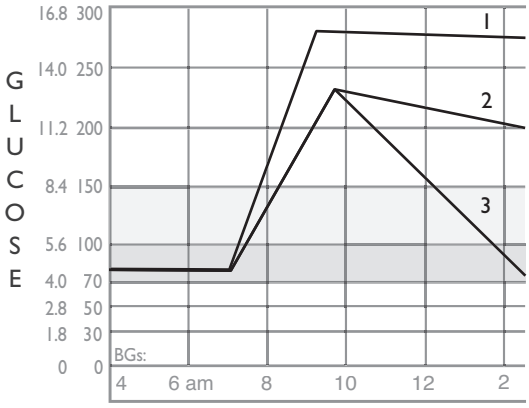
1. Already high at bedtime
2. Overnight basal too small or high fat or protein dinner
3. Dawn Phenomenon or insulin resistance
4. Overtreatment of night low

13.10 Lows to Highs



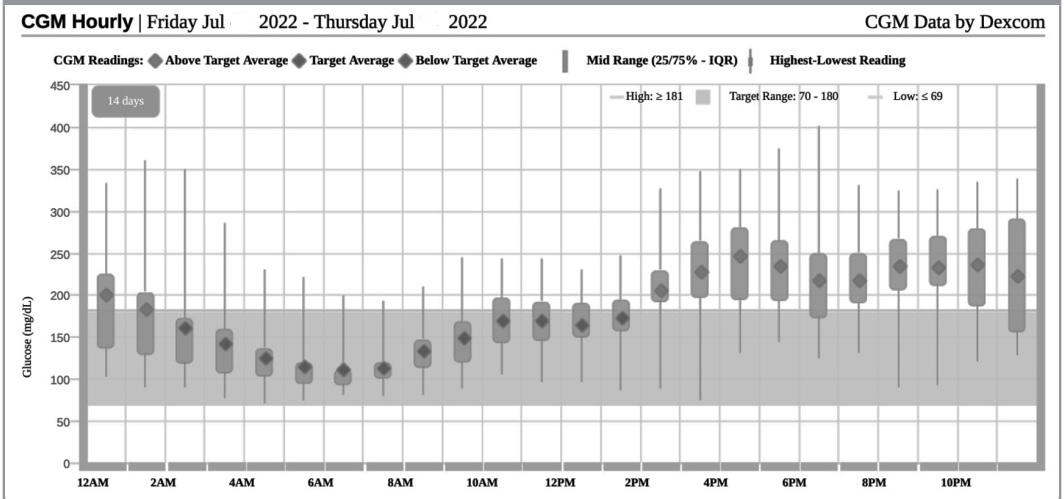
This great average glucose comes at the price of an one hour (4%) a day below 54 mg/dL, and 2.5 hrs (10%) below 70 mg/dL a day. The excess GV of 45% (57 / 127) dropped to 24% once the basal rate total was reduced from 38 u to 22 u a day. Their new average glucose was 145 mg/L, with only 2% below 70 mg/dL.

13.11 Post-Meal Spiking



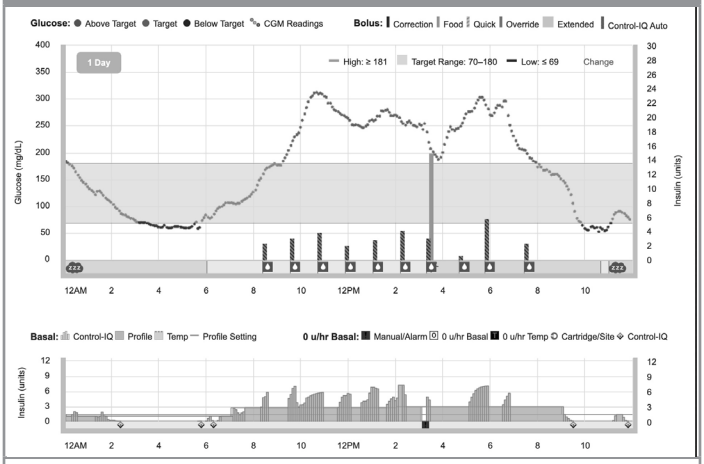
1. Missed carb bolus
2. Carb bolus too small
3. Late carb bolus or high GI food

13.12 Highs from Missed or Inadequate Meal Boluses



Here the glucose rises after breakfast, lunch, and dinner on an AID system, largely from missed meal boluses. A smaller CorrF can shorten the peaks and durations of the rise, but remembering to bolus before all meals is a better solution.

13.13 High Glucose Following a Missed Bolus



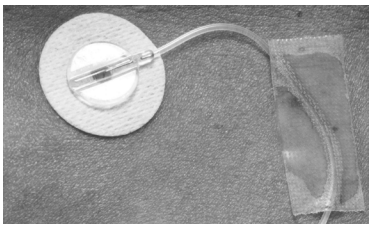
After a mild low glucose at 3-5 am, this person skipped their breakfast bolus. Their high readings were over-treated, either because the CarbF number is too small (strong) or they increased the AID's recommended boluses.

14.1 Infusion Line Occlusion		
Problem	**Causes**	**Solutions**
An occlusion alarm sounds when a cannula kinks or insulin crystallization blocks a cannula or infusion line.	A rough or defective infusion set wall, a defective connector, a kinked cannula, bad insulin, or exposure of insulin to excess heat or cold.	Remove the Teflon cannula or metal needle and give a 3 unit bolus. If insulin is not visible, the problem is a kink in the cannula or the infusion set. Refill the cartridge from a new insulin bottle, and replace the infusion set.
A Pump Alarms with Complete Blockage		

14.2 What Insulin Smells Like
Insulin has a distinctive odor from the m-creosol and phenol that help stabilize the insulin molecule and act as anti-bacterial agents. The odor is often described as smelling like creosote, railroad ties, or Band Aids. If you smell an odor like this, insulin is leaking somewhere.

14.3 Leaks and Detached Sets		
Problem	**Causes**	**Solutions**
Complete or partial detachment of the infusion set or pod.	**Set comes loose from sweat or tugs, lack of tape on infusion line, or a problem during insertion.**	**Look for loose set, dampness, or the smell of insulin. Replace the infusion set or pod. Anchor the infusion line. Switch to a different infusion set if problem continues.**
Hole in the infusion line.	Puncture from a pet or sharp object.	Give a bolus, then feel and look for damage or an insulin leak along the line. Replace the infusion set.
Infusion line connection is leaking at infusion set or cartridge hub.	Connection is not fully engaged at the site or hub, or the hub is overtightened causing a crack.	Feel and smell for insulin at hub and site. Check for a crack in the hub. If loose, retighten. Otherwise, replace cartridge and infusion set.
Seal between the O-rings and cartridge wall lets insulin leak backward.	When cartridges sit for some time, O-ring lubricant pools at the bottom of the cartridge.	Replace cartridge and move O-rings back and forth before drawing up insulin. Inserting cartridge carefully into the pump.
For these, your pump will NOT alarm.		

Fig. 14.4 Anchoring Helps



Anchor the infusion line with tape to significantly reduce set failures.

14.5 Tunneling

About	Causes	Solutions
The glucose rises higher than normal if insulin leaks from the end of a cannula or metal needle back to the skin. More common in 90 degree Teflon cannulas when no tape is used to anchor the infusion line.	Bumps or movement of the infusion set loosen contact between Teflon cannula and surrounding tissues, opening a path for insulin to escape back to the skin surface.	Use infusion sets no longer than 3 to 4 days. Always anchor infusion lines with 1" tape to the skin. Replace the infusion set and anchor it.
Will Pump Alarm? No		

14.6 Is It Bad Insulin?

Insulin going bad is rare. Suspicion should arise if you experience unexplained highs that do not correct when you change your infusion set, but do correct when a new bottle of insulin is used. Exposure to excess sunlight, heat, or cold can cause insulin to go bad. The insulin inside a pump on your body does not get hot or cold enough to damage it. Exposure to extreme temperatures is required to damage insulin. These temperatures may result during shipping or from being left in a hot car or stored inside a refrigerator below 36° F (2° C) at your pharmacy or home. A vial of insulin can be stored at room temperature for at least 30 days without any problem.

To check for bad insulin, check the insulin's expiration date. Then grasp the bottle by the neck, turn it upside down, and swirl it a few times against a light background. If you see any cloudiness or tiny particles that fall or attach themselves to the inside wall of the bottle, your insulin is likely bad. These particles are quite small and hard to see. Good insulin appears as clear as water. If you have any question about your insulin's potency, replace your cartridge and infusion set immediately and use a new bottle of insulin, preferably with a different lot number.

14.7 Tips for Skin Allergies from Infusion Set and Sensor Adhesives

Two quick things to try:

- 3M's Cavalon No-Sting Barrier Film as a first barrier, and then a hydrocolloid adhesive like CVS Advanced Healing Hydrocolloid Bandages, both under the sensor.
- 28 ml bottle of 3M™ (or Solventum) Cavilon™ No Sting Barrier Film. Apply lightly to skin and let dry for 90 seconds before applying Hydrocolloid Bandage and inserting infusion set or CGM sensor. 60 days, 6 refills. Available as a spray or with an applicator.
- CVS Health Advanced Healing Hydrocolloid Bandages. Cut a hole in the bandage for the sensor or infusion needle, apply it on top of the No Sting Barrier, and insert the sensor infusion set. Dispense 15 four-packs, 6 refills.
- Visit www.woundsource.com/product-category/skin-care/liquid-skin-protectantssealants for various skin protectors and barriers

Also check out the "Dexcom and Libre Rash" group on Facebook that offers multiple discussions and solutions.

14.8 Rapid Lowering of Glucose May Temporarily Worsen Retinopathy

Suppose your average glucose level has been high for months or years. In that case, rapid lowering of glucose can temporarily increase VEGF (vascular endothelial growth factor) levels, causing existing retinopathy to worsen.[101-103] Higher VEGF may increase proliferative retinopathy (growth of new weaker blood vessels into the clear vitreous of the eye), and macular edema (swelling in the central vision area from leaky blood vessels).104 To avoid this, your physician may advise you to gradually lower your glucose over a few weeks to minimize VEGF release.

Injection of a prescription VEGF inhibitor is highly effective in protecting vision. For broader vascular support, some over-the-counter supplements may help. High doses of vitamin E (1,600 to 2,000 units a day), two 500 mg rutin capsules, or two omega-3 capsules have been shown to significantly lower systemic VEGF levels.[105-108] Once vitamin E collects a free radical and oxidizes, vitamin C and glutathione clear vitamin E back to a protective form. When using vitamin E, take some vitamin C and 600 to 1,000 mg of N-acetyl cysteine twice a day or one bottle of a hundred 200 mcg of selenium tablets once a day to maintain healthy glutathione levels.

Bringing glucose levels to target goals for 6 to 12 months stabilizes vision. Work with your ophthalmologist and diabetes specialist to ensure that bringing a high average glucose down does not worsen existing eye damage. You may want to gradually lower a high average glucose by multiplying your current average TDD by 1.06 once a month until you are at goal. This lowers your average glucose by about 25 mg/dL a month.

15.1 Hypo Symptoms and When They Occur	
From Stress Hormone Release (at ~65 mg/dL/3.6 mmol/L)	**From Low Glucose in Brain (at ~55 mg/dL/3.1 mmol/L)**
• Sweating • Shaking • Irritability • Stubbornness • Fast heart rate • Hunger • Feeling amped up or nervous • Resisting help • Tingling of the lips or fingers • Nausea • Vomiting	• Confusion • Poor concentration • Mental slowness • Vision blurred or spotty • Sudden tiredness • Silliness • Frequent sighing • Yawning • Inability to form words • Headache • Seizure • Coma

15.2 Lows Are More Likely When You:

1. Give too much insulin.
2. Give a meal bolus but miss or delay a meal.
3. Stack boluses over a short period of time.
4. Increase correction boluses to bring a high glucose down faster.
5. Have a DIA less than 4 hours that hides IOB.
6. Are less than 48 hours from a previous low.
7. Give a bolus without checking glucose and IOB.
8. Drink alcohol.
9. Sleep without eating after increased activity.

15.3 Stop Frequent Lows!

Anytime you have frequent lows, reduce your TDD, usually by 5 or 10 percent. Use this lower TDD to calculate new basal rates and new bolus factors. You'll have fewer lows and fewer highs following these lows. See Chapter 8 and Table 8.1.

15.4 Handy Quick Carbs

Each provides 15 grams of quick carbs that raise the glucose in 10 to 20 min:

- 1 Tablespoon of honey
- 3 BD Glucose Tablets
- 3 Smartie Rolls (in cellophane)
- 4 CanAm Dex4® Glucose Tablets
- 5 Dextrosols Glucose Tablets
- 5 Wacky Wafers®
- 6 Sweet Tarts® (3 tabs/packet)
- 7 Pixy Stix
- 8 Sweet Tarts® (3/4" diam roll)
- 14 Smarties® (3/4"diam roll)

15.5 How Much 1 Gram of Carb Raises Your Glucose

If your weight is:	1 gram will raise you about:
50 lbs (23 kg)	8 mg/dL (0.44 mmol/L)
75 lbs (34 kg)	7 mg/dL (0.39 mmol/L)
90 lbs (41 kg)	6 mg/dL (0.33 mmol/L)
120 lbs (55 kg)	5 mg/dL (0.28 mmol/L)
160 lbs (73 kg)	4 mg/dL (0.22 mmol/L)
200 lbs (91 kg)	3 mg/dL (0.17 mmol/L)

15.6 Get the Right Number of Carbs for Each Low

1. Treat the Low Glucose

Take 1 gram of carb for each 10 lbs (4.5 kgs) of body weight. For example, someone who weighs 150 lb (68 kg) would consume 15 grams, while someone who weighs 220 lb (100 kg) would consume 22 grams for the low glucose. (Use at least 6 grams for a small child.)

2. Cover Excess IOB

If any IOB is present, multiply the units of IOB times your CarbF to find how many EXTRA free carbs you need to cover it.

For example, if someone weighs 130 lbs (59 kg) and has a glucose of 50 mg/dL (2.7 mmol/L) with 2 units of IOB and a CarbF of 1u/11 grams:

a) 130 lbs = 13 grams
b) IOB x CarbF = 2 units x 11 grams/unit = 22 grams
c) 13 g + 22 g = up to 35 grams are needed to treat this low glucose.

Have these carbs and recheck your glucose 20 to 30 min. later. Cover any carbs above this amount with a bolus to avoid going high later.

3. Consider Any Recent Increased Activity

Add extra free carbs to cover any recent or planned increase in activity. (See Chapter 18.)

15.7 Don't Overdo Control

A healthy A1c should never be obtained at the cost of frequent hypoglycemia, unconsciousness or grand mal seizures. Clinicians advise the overly conscientious to use less insulin and select safer targets.

Keep your glucose above 70 mg/dL (3.9 mmol/L). Follow recommended boluses unless valid reasons exist for modifying them. Pay close attention when IOB is greater than the bolus needed for your current glucose.

15.8 How to Stop Hypoglycemia Unawareness

- Check all your pump settings for accuracy and lower your TDD.
- Make sure your DIA time is set to 4 hours or more.
- Before giving a bolus, check that your IOB is less than the units you need to correct your current glucose.
- Wear a CGM and set the low glucose target at 90 or 100 mg/dL and be sure to treat with adequate carbs as soon as a low alert sounds.
- Keep all glucose readings above 80 mg/dL (4.4 mmol/L) for 6 to 18 weeks.
- Treat at the first sign of a low to maintain stress hormone levels.
- Do not increase an AID or BC's recommended dose.
- Raise your target glucose to 120 mg/dL (7.8 mmol/L) or more, and raise the CorrF to prevent lows occurring within 5 hours of treating a high glucose.
- Limit alcohol to one or two standard drinks a day.

16.1 Causes of Severe Highs and Ketoacidosis

- Onset of Type 1 diabetes
- Severe infection
- Heart attack, stroke, or serious illness
- Insulin doses that are skipped or are too low
- A loose or detached infusion set or pump failure
- Growth spurts in kids and adolescents
- Use of prednisone, other steroid, or an SGLT-2
- Severe stress

16.2 Ketone Test Tools

The ***Freestyle Optium Neo*** glucose and beta ketene monitoring system and the ***Nova Max Plus*** meter kit test glucose in 5 seconds and ketones in 10 seconds using a different strip. A blood ketone level below 0.6 is normal. A level between 0.6 and 1.5 mmol/L shows early ketosis. When a ketone level is above 1.5 mmol/L, you are at a high risk of developing serious DKA.

Bayer Ketostix® or Keto-Diastix® strips test urine ketones. A moderate or large urine ketone test indicates ketosis or severe diabetic ketoacidosis (DKA) is underway. This takes longer to detect.

Ask your clinician for a prescription.

16.3 Ketoacidosis Symptoms

Early Symptoms

- Any unexplained high glucose reading
- Nausea or abdominal pain
- Vague flu-like symptoms
- Increased thirst and dry mouth
- Excessive urination
- Increased hunger
- Excessive tiredness or weakness
- Confusion
- An acetone or fruity odor in the breath

Late Symptoms

- Vomiting
- Severe abdominal pain
- Rapid breathing
- Shortness of breath
- Unconsciousness

Call your physician or go to an emergency room immediately anytime a blood ketone level is 3.0 or higher, large amounts of ketones in urine or blood, or any late sign is present.

16.4 Steps to Treat Ketoacidosis on a Pump

Always check for ketones if you have nausea, an unexplained high glucose, or an unexplained glucose above 250 mg/dL (13.9 mmol/L). If you have moderate or large ketone levels, your pump is not delivering insulin or you have an infection or other serious illness. Follow the directions below for normal to small, or moderate ketone levels.

If blood ketones are less than 1.2 mmol/L or urine ketones are normal or small:	**If blood ketones are above 1.2 or 3.0 mmol/L or urine ketones are moderate or large:**
1. Give a correction bolus with the pump. 2. Drink 8 to 12 ounces of water or non-caloric fluid every 30-60 min. until control is regained. 3. Check your glucose at least every 2 hours when a reading is above 250 mg/dL (13.9 mmol/L). 4. In 2 hours, if your glucose has not fallen and ketones are again small, change the infusion set and site, and follow the procedure to the right. 5. If the glucose is about the same or lower, recheck in another one to two hours and enter this reading into your pump to determine if another correction bolus is needed. 6. If your reading stays high or ketones appear, call your physician and follow the procedure to the right.	***1. Stay hydrated.*** Start with 16 ounces and drink 8 to 12 ounces of non-caloric fluid every 30 min. even if you do not feel thirsty until control is regained. Use water, water with a pinch of Nu-Salt™ to restore potassium levels, or diluted Gatorade. ***2. Give insulin by injection from Table 16.7 until your glucose is below 200 mg/dL (11.1 mmol/L).*** More insulin will be needed with ketones, if basal insulin has been missed, or you have an illness or fever. ***3. Call your doctor if a glucose is over 250 mg/dL (14 mmol/L) with moderate or large ketones.*** ***4. If vomiting begins when ketones are large, immediately call your doctor or go to an ER*** for IV hydration and treatment. Medical treatment is required. Call 911 if no one is available to drive you. 5. Replace the pump insulin cartridge and entire infusion set at a new site, using a new bottle of insulin. Check your pump settings. 6. Once the glucose is less than 200 mg/dL (11.1 mmol/L), ***drink fluids with carbs***, like Gatorade, to avoid having a low glucose and to speed up the fall in ketones.

Thanks to Geri Wood, RN, BSN, CDE and John Stanchfield, MD, of Salt Lake City for their helpful suggestions.

16.5 Prevent Infusion Set Problems

A frequent cause for DKA on a pump is a leaking or detached infusion set. Once insulin delivery stops, ketosis can start in 4 to 5 hours. Always check your infusion set and pump if your glucose is unexpectedly high or above 250 mg/dL (14 mmol/L) without an obvious cause. Anchoring the infusion line with tape eliminates most infusion set problems.

16.7 Approximate Correction Insulin Requirements Based on Blood Ketone Levels (Illness or DKA)

Blood Ketone Level	What It Means	BG = 100-180 mg/dL (5.5-10.0 mmol/L)	BG = 180-250 mg/dL (10.0-14.0 mmol/L)	BG = 250-400 mg/dL (14.0-22 mmol/L)	BG > 400 mg/dL (> 22 mmol/L)
0.5 mmol/L or less	Normal ketones	Give usual correction bolus from pump.	Extra fluid. Give usual correction bolus from pump.	Extra fluid. Give usual correction bolus from pump.	Extra fluid. Give usual correction bolus from pump.
0.6 to 1.5 mmol/L	Ketones are building up. Check infusion set and pump.	Extra carbs and fluid. Give usual bolus doses if infusion set is OK. Recheck in 2-3 hours.	Extra carbs and fluid. Give extra 5% of TDD or 1 u for every 80 lbs (40 kgs). Recheck in 2-3 hours.	Extra fluid. Give extra 10% of TDD or 1 u for every 40 lbs (20 kgs). Recheck in 2-3 hours.	Extra fluid. Give extra 15% of TDD or 1 u for every 25 lbs (12 kgs). Recheck in 2-3 hours.
1.5 to 2.9 mmol/L	Ketoacidosis (DKA) is developing – contact doctor. Check pump, replace infusion set & cartridge.	Extra carbs and fluid. **Inject** extra 5% of TDD or 1 u for every 80 lbs (40 kgs). Recheck in 2-3 hours.	Extra carbs and fluid. **Inject** extra 10% of TDD or 1 u for every 40 lbs (20 kgs). Recheck in 2-3 hours.	Extra fluid. **Inject** extra 15% of TDD or 1 u for every 25 lbs (12 kgs).	Extra fluid. **Inject** extra 20% of TDD or 1 u for every 20 lbs (10 kgs).
At about 3 mmol/L	Severe DKA – call doctor or have someone take you to ER, esp. if vomiting starts. Check pump, replace infusion set & cartridge.	Extra carbs and fluid. **Inject** extra 5% of TDD or 1 u for every 80 lbs (40 kgs). Repeat every 2-3 hrs based on glucose until ketones come down.	Extra carbs and fluid. **Inject** extra 15% of TDD or 1 u for every 25 lbs (12 kgs). Repeat every 2-3 hours until ketones come down.	Extra fluid. **Inject** 20% of TDD or 1 u for every 20 lbs (10 kgs). Repeat every 2-3 hours until ketones come down.	Extra fluid. **Inject** 25% of TDD or 1 u for every 15 lbs (7 kgs). Repeat every 2-3 hours until ketones come down.

The doses above are correction bolus or injection doses only. Larger or smaller doses may be needed.
Basal or long-acting insulin must also be given! **Do not stop basal delivery even if you are not eating.**
Do not go to sleep if you are alone and ketones are 1.5 mmol/L or higher. Call someone to stay with you.
Check your glucose and ketones every 2 hours if your last glucose is above 300 mg/dL (16.7 mmol/L). Above 150 mg/dL in pregnancy.

Modified from International Society for Pediatric and Adolescent Diabetes recommendations [148]

16.6 Injections of a Long-Acting Insulin to Replace Some Basal

Anyone who has had more than one episode of ketoacidosis or who needs to ensure that DKA does not occur because of pregnancy or a heart condition may want to replace some AID basal insulin with a bedtime injection of long-acting insulin for overnight coverage. About half of the day's basal delivery can be replaced with long-acting insulin to ensure enough insulin remains active if an infusion set gets dislodged or other disruption of pump delivery occurs. This lowers the risk of DKA and works well for sports where a pump may need to be disconnected for some time. Talk with your doctor about this.

17.1 Check Your Basal/Bolus Balance

Compare these average values from 132 pumpers in the best control group in the APP study with your own average basal and bolus percentages of the TDD over the last 14 or 30 days [86]

Optimal Doses for the Best Control Group		
Insulin:	**Average % of the TDD**	**Mid 50% for better control group**
Basal	**48%**	**40% to 55%**
Carb Boluses	**43%**	**36% to 51%**
Corr Boluses	**9%**	**6% to 11%**

My average TDD = ____ U/day

My average basal = ____ U/day = ____% of TDD

My avg carb bolus = ____ U/day = ____% of TDD

My avg corr bolus = ____ U/day = ____% of TDD

A pump's history screen shows what percentage of the average TDD comes from basal rates and bolus doses. Also available on a download of your pump.

18.1 Goals to Guide How You Exercise			
Goal:	**How Often**	**How Intense**	**How Long**
Reduce Risk of Heart Disease and Illness	2-3 times a week	40% max heart rate	15–30 min
Get Physically Fit	4 times a week	70–90% max heart rate	15–30 min
Lose Weight	5 times a week	45–60% max heart rate	45–60 min
220 – your age = your maximum heart rate.			

18.2 TIR During Exercise Depends on:
• Your current IOB, glucose, and glucose trend • Timing of the exercise relative to recent meals and boluses • The duration and intensity of the activity • Your training level • Whether the exercise is aerobic or anaerobic • Stress hormone release in competitive sports

18.3 How Glucose and Insulin Levels Affect Performance		
Glucose	**Metabolic State**	**Performance Impact**
< 70 mg/dl (3.9 mmol/L)	Excess insulin without enough glucose for cells	Fatigue, poor performance
70-180 mg/dl (3.9-10 mmol/L)	**Efficient fuel flow, monitor IOB and trend line**	**Maximum performance**
> 180 mg/dl (> 10 mmol/L)	If insulin level is OK, glucose will come down	Performance may be reduced but exercise is OK.
> 250 mg/dl (13.9 mmol/L)	With no ketones, exercise should lower the glucose	Impaired performance – moderate exercise is OK
> 250 mg/dl (13.9 mmol/L)	With the presence of moderate or large ketones	Do not exercise. Address the cause for high ketones.

18.4 What Makes the Glucose Rise During and After Exercise with Diabetes	
Exercise usually lowers the glucose. These four things can make glucose rise with diabetes:	
Lack of insulin	This is the most common cause for a glucose rise during exercise. For example, if a person goes for a run before breakfast and their fasting glucose is above 140 mg/dL (7.8 mmol/L), their glucose may be more likely to rise because the liver will be releasing glucose with this relatively low insulin level. The same run on another morning with a fasting glucose below 140 mg/dL (7.8 mmol/L) may not do this.
Anaerobic exercise	With short, intense anaerobic exercises, like running the 100-yard dash or power weight-lifting, glucose is rapidly released into the blood by rising epinephrine levels. Epinephrine can raise glucose production seven or eight times higher than normal, while glucose uptake into cells increases only three to four fold.156 A normal pancreas can release extra insulin directly into the blood, but a pump cannot.
Competition	Large amounts of stress hormones are released in competitive events, like a swim meet, a 10K run, or a century bike ride. Stress hormones release large amounts of glucose in these "fight or flight" situations. The person without diabetes quickly releases insulin to balance this, but someone with diabetes may see their glucose rise rapidly.
Dehydration	Serious dehydration during hot weather or strenuous exercise can make glucose test higher than it actually is. If your urine looks like lemonade, dehydration is unlikely. If it looks like apple juice, dehydration may make the glucose test higher than it actually is. Thirst is a late sign of dehydration. Drink ample non-caloric fluids and retest your glucose 20 minutes later before you decide the correction bolus to give.

18.5 Match Carbs to Need

Not all carbs are the same, so it helps to know how quickly different foods raise glucose.

Fast carbs are ideal for raising low glucose levels before or during exercise and for exercises that consume carbs rapidly. Fast carbs include glucose tablets, Sweet Tarts, honey, corn flakes, raisin bran, athletic drinks (Gatorade™, Power Ade™), dried or ripe fruits, and regular soft drinks.

Slower carbs like PowerBars™, oatmeal, Swiss muesli, fruit, ginger snaps, pasta al dente, brown rice, and many candy bars help prevent glucose from dropping during longer periods of activity. They can be eaten before the start of some exercises, every 45 minutes during, and then afterward to replenish glycogen stores.

18.6 ExCarbs: Grams of Carb per Hour of Activity

These are the total grams of carb used in one hour of each activity at these weights. Can be eaten before, during, or after an activity, or used to guide insulin reductions or lower a high glucose.

	Weight		
Activity	**100 lbs.**	**150 lbs.**	**200 lbs.**
baseball	25	38	50
basketball			
moderate	35	48	61
vigorous	59	88	117
bicycling 6 mph	20	27	34
10 mph	35	48	61
14 mph	60	83	105
18 mph	95	130	165
20 mph	122	168	214
dancing			
moderate	17	25	33
vigorous	28	43	57
digging	45	65	83
golf (pull cart)	23	35	46
handball	59	88	117
jump rope 80/min	73	109	145
mopping	16	23	30
mountain climbing	60	90	120
outside painting	21	31	42
raking leaves	19	28	38
running 5 mph	45	68	90
8 mph	96	145	190
10 mph	126	189	152
shoveling	21	45	57
skating			
moderate	25	34	43
vigorous	67	92	117
skiing			
crosscountry 5mph	76	105	133
downhill	52	72	92
water	42	58	74
soccer	45	67	89
swimming			
slow crawl	41	56	71
fast crawl	69	95	121
tennis/volleyball			
moderate	23	34	45
vigorous	59	88	117
walking 3 mph	15	22	29
4.5 mph	30	45	59

18.7 Number of ExCarbs Needed for Exercise per 100 lbs. (45 kg) of Weight

For intensity, the number 1 represents a slight increase in activity like a casual walk. A 7 would be all-out exercise like running hard and barely able to talk between breaths.

Duration (minutes)	Exercise Intensity						
	1	2	3	4	5	6	7
15	4 g	9 g	13 g	17 g	21 g	26 g	30 g
30	9 g	17 g	26 g	34 g	43 g	51 g	60 g
45	13 g	26 g	39 g	51 g	64 g	77 g	90 g
60	17 g	34 g	51 g	69 g	86 g	103 g	120 g
75	21 g	43 g	64 g	86 g	107 g	129 g	150 g
90	26 g	51 g	77 g	103 g	129 g	154 g	180 g
105	30 g	60 g	90 g	120 g	150 g	180 g	210 g
120	34 g	69 g	103 g	137 g	171 g	206 g	240 g
150	43 g	86 g	129 g	171 g	214 g	257 g	300 g
180	51 g	103 g	154 g	206 g	257 g	309 g	340 g
210	60 g	120 g	180 g	240 g	300 g	360 g	420 g
240	69 g	137 g	206 g	274 g	343 g	411 g	480 g

A = carb intake B = carb intake + bolus reduction

C = carb intake + bolus reduction + basal reduction

18.8 Carb and Insulin Adjustments to Balance Exercise per 100 lbs. Weight

Exercise Duration	Exercise Intensity								
	Mild			Moderate			Intense		
	Carbs	Bolus	Basal	Carbs	Bolus	Basal	Carbs	Bolus	Basal
15 min	+ 0g	normal	normal	+ 0 g	normal	normal	+ 20g	- 10%	normal
30 min	+ 10g	normal	normal	+ 20g	- 10%	normal	+ 40g	- 20%	normal
45 min	+ 18g	- 10%	normal	+ 30g	- 20%	normal	+ 50g	- 30%	normal
60 min	+ 25g	- 15%	normal	+ 40g	- 30%	normal	+ 60g	- 40%	- 10%
90 min	+ 38g	- 20%	normal	+ 55g	- 45%	- 20%	+ 90g	- 50%	- 20%
120 min	+ 50g	- 30%	normal	+ 70g	- 60%	- 20%	+110g	- 70%	- 30%
240 min	+ 80g	- 50%	- 10%	+120g	- 60%	- 20%	+200g	- 70%	- 40%

These estimates must be adjusted for your weight and through testing.

18.9 Rebuild Glycogen Faster to Reduce Delayed Hypoglycemia

After prolonged or strenuous exercise, you want to rebuild muscle glycogen quickly once the exercise stops. There is a 20- to 30-minute window following exercise when muscles are primed to restore depleted glycogen. Consuming carbs and protein for muscle repair right after exercise lets muscle glycogen stores quickly rebuild. Chocolate milk provides a convenient way to provide both carbs and protein just after exercise.

Fast glycogen rebuilding means less glucose will be drawn out of the blood in the following hours, with less risk of a low glucose during the night, even on an AID system. Carb intake just after exercise reloads your glycogen and prepares you for exercise the next day. A small carb bolus may be needed to cover these carbs and improve glycogen uptake.

Higher carb intake increases muscle glycogen storage for endurance and performance. On a high-carb diet, a trained marathon runner can run for about four hours before exhaustion. Many athletes "fuel up" muscle glycogen stores to improve performance by eating a high-carb meal covered with a carb bolus the evening before major exercise events.

19.1 ADA Glucose Goals for Children and Teens

	Toddler Preschoolers (0-6 yrs)	School Age (6-12 yrs)	Adolescents/ Young Adults (13-19 yrs)
A1c (%)	≤ 7.5%	< 8%	< 7.5%*
Before meal glucose	100 - 180 mg/dl (5.5-10 mmol/L)	90-180 mg/dl (5-10 mmol/L)	90-130 mg/dl (5-7.2 mmol/L)
Bedtime/overnight glucose	110-200 mg/dl (6.1-11.1 mmol/L)	100-180 mg/dl (5.5-10 mmol/L)	90-150 mg/dl (5-8.3 mmol/L)

The International Society for Pediatric and Adolescent Diabetes (ISPAD) recommends an HbA1c of less than 7.5% for all age groups. In Sweden, the recommendation is for this group to get as close to 7.0% as possible without problematic hypoglycemia.

19.2 When Is a Child Ready for Self-Care?

Children differ greatly in the age at which they can manage the self-care required on a pump. After acquiring a skill, relapses may occur, but the desire to manage the pump on their own is often reintroduced by the desire to stay overnight at camp or a friend's house.

When is a child ready to:

count carbs:	about 9 years
test blood sugar:	about 10 years
give a bolus:	about 10 years
insert an infusion set :	about 12 years
determine a carb bolus:	about 12 years

19.3 Needles and Kids

When inserting an infusion set or pod, or giving an injection or drawing blood from young children, remember that their imagination can be vivid. Reassurance may be needed.

Let them know that an infusion needle will not affect their heart or puncture a large blood vessel or cause bleeding, and their bodies easily replenish the small amounts of blood removed for blood tests. Encourage them to ask questions to allay their fears.

19.4 Prevent Afternoon Highs

A common problem among school age children and teens is a high glucose in the late afternoon or before dinner. This is often a result of neglecting to take boluses for after-school snacks. A parent can often follow the paper trail of wrappers and containers in the trash, then compare these with the history of boluses actually delivered.

If afternoon highs are a problem, review bolus history regularly and provide guidelines for bolusing for each snack. Label each food container with how many grams it contains, matched with a bolus dose. To cover lunches or afternoon snacks when a child or teen forgets to take carb boluses raise the afternoon basal rate. A pump can also be set up with a reminder to take a bolus at a certain time with a warning if a bolus was not taken.

19.5 Grams of Carbs for Lows in Children and Teens

Age	1-6 yrs	6-10 yrs	10 yrs-Adult
Grams of Carbs	**5-10 grs**	**10-15 grs**	**15-20 grs**
Glucose Tabs 5 grams each	1 - 2 tabs	2 - 3 tabs	3 - 4 tabs
Glucose Tabs 4 grams each	1 - 2 tabs	3 - 4 tabs	4 - 5 tabs
Orage Juice 1/3 cup = 10 grams	1/4 - 1/2 cup	1/2 - 3/4 cup	3/4 - 1 cup
Apple Juice 1/3 cup = 10 grams	1/4 - 1/2 cup	1/2 - 3/4 cup	3/4 - 1 cup
Table Sugar 4 grams per tsp.	2 tsps.	3 tsps.	4-5 tsps
Regular Soda 3 grams per oz	2 - 3 ozs	4 - 5 ozs	5 - 6 ozs
Lifesavers 3 grams each	2 - 3	4 - 5	5 - 7
Milk 8 oz = 12 grams	4 - 5 ozs	6 - 7 ozs	8 - 10 ozs

Adapted from Understanding Diabetes, 10 ed., by H. Peter Chase, M.D., 2002

19.6 What to Keep in Your School or Sleep-over Kit

- Insulin
- An insulin pen and pen needles
- Spare infusion sets, reservoirs and any tape or related supplies
- Glucose and ketone testing supplies
- Fast-acting carbs for lows
- Glucagon and glucose gel for severe lows
- Crackers and cheese, granola bars, or other snacks to cover exercise and activity
- Extra batteries or a spare charger
- Emergency contact phone and information