Basal Insulin Titration: Looking Beyond the Fasting Glucose

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Over the past decade or two, insulin treatment options have come a long way. The development of so many new insulin preparations has made it easier for providers to successfully fine-tune regimens to meet each patient's needs. Studies have shown that for those on multiple daily injections, or even basal insulin alone, use of long-acting insulin preparations (ie, glargine and detemir) has yielded better glucose control throughout the entire day with fewer doses, less weight gain, and less hypoglycemia (Mavrogiannaki & Migdalis, 2012; Monami, Marchionni, & Mannucci, 2009).

Using standardized treat-to-target algorithms, clinicians are able to effectively titrate basal doses based on the fasting plasma glucose (FPG). If FPG values are consistently above target, then the daily basal dose is increased per protocol; if below target, the dose is decreased, and so on, until the FPG is consistently within target range. A sample treat-to-target algorithm, based on the AT.LANTUS trial (Davies, Storms, Shutler, Blanchi-Biscay, & Gomis, 2005) is provided in Figure 1.

Figure 1: Sample Treat-to-Target Basal Algorithm (provider-directed)

Treat-to-Target Algorithm for Basal Insulin Titration

Starting Dose: 10 units glargine daily at HS
FPG goal: < 100 mg/dL

Instructions: Review FPG patterns in-person or via telephone consultation. Calculate mean of last three FPG readings and adjust accordingly:

Mean FPG for previous three days	Increase daily basal dose by...
≥ 100 mg/dL and < 120 mg/dL	0 to 2 units (at provider's discretion)
≥ 120 mg/dL and < 140 mg/dL	2 units
≥ 140 mg/dL and < 180 mg/dL	4 units
≥ 180 mg/dL	6 to 8 units (at provider's discretion)

Based on the AT.LANTUS Algorithm 1 (Davies & Associates, 2005) FPG: fasting plasma glucose

Treat-to-target algorithms vary somewhat in terms of FPG target, starting dose, dose adjustment frequency, and increment (number of units). A review of the effectiveness of different treat-to-target algorithms (Strange, 2007) determined that starting dose of basal insulin, typically between 10 and 20 units, did not usually impact end results in terms of glycemic control. Most of the algorithms reviewed stipulated FPG targets from 80 to 120 mg/dL. More aggressive FPG targets (less than 100 mg/dL) did not result in significantly lower A1C and yet did result in significant increase in incidence of hypoglycemia. Therefore, a more conservative FPG target seems to be the more logical option.

The review by Strange (2007) also looked at studies that compared clinician-directed titration to patient-directed titration algorithms. Surprisingly, those groups of patients using self-directed titration protocols achieved glycemic control as good (sometimes better) as those who were randomized to the clinician-directed titration groups. This may be in part due to the fact that when patients follow the step-by-step algorithm, they are able to titrate more frequently (as often as every day with some algorithms) compared to patients who must wait for the next scheduled health care provider visits to have doses adjusted.

It is worth noting that all the algorithms reviewed included patient education and regular oversight provided by knowledgeable clinic staff. Education and guidance formats and frequency varied. No significant differences were found between patients who received group versus individual initial instructions. Also surprising was the fact that the amount of phone or in-person contact (from weekly to every 6 weeks) did not seem to affect the end result in terms of glycemic control or incidence of hypoglycemia. The important point is that patient-directed algorithms are not meant to be implemented without initial and continued involvement from the health care team.

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In light of these and other more recent findings, many of today's providers and diabetes educators feel comfortable encouraging this patient-empowered approach to diabetes management of giving patients the training and guidance to self-titrate basal insulin. As discussed, the rule of thumb for this "formula" usually considers a pattern of FPG values (see Figure 1). Obviously this approach may not be appropriate for all patients, such as those with low literacy or numeracy levels, for example. In addition, some cautions should be made clear, such as not to exceed a certain max dose, not to use the titration algorithm as a "blank check" to eat inappropriately, and so on. Notwithstanding these stipulations, however, a patient-directed treat-to-target algorithm can be an effective tool for diabetes management. In addition, it allows patients to feel more in control of their diabetes and reduces the frequency of follow-up "titration" visits needed for those patients (imagine having to see every patient on basal insulin every week for minor basal titrations!).

As with many good "formulas," however, a basal titration algorithm can become problematic when patients, providers, and educators adopt a tunnel-vision mentality—focusing only on specific numbers and ignoring other factors. As good educators and providers, it is part of our duty to consider the whole picture as well as help our patients recognize other elements that come into play. Consider the following hypothetical examples.

Example 1: Basal Adjustment Based on Only Fasting Morning Values

According to his self-monitoring records, Mr. Jones has a clear pattern of elevated fasting morning blood glucose (see Table 1). If following the provider-directed titration algorithm (Figure 1), we would average the last 3 days of FPG readings, which would give a mean FPG of 229 mg/dL. According to the algorithm, we would then increase the patient's bedtime basal insulin dose by 6 to 8 units, resulting in a glargine dose of 30 to 32 units QHS. A follow-up visit would be scheduled for 1 to 2 weeks to evaluate this change and readjust in needed.

Table 1: Glucose Log for Mr. Jones (morning readings only)

Current Insulin Dose: 7 units aspart before each meal; 24 units glargine before bed				
	Pre-Breakfast	**Pre-Lunch**	**Pre-Dinner**	**Bedtime**
Monday	221			
Tuesday	187			
Wednesday	240			
Thursday	216			
Friday	199			
Saturday	282			
Sunday	206			

Let us assume that Mr. Jones has been instructed on how to use a self-directed titration algorithm. From time to time you review the algorithm with your patient and advise him on how to proceed. As with the provider-directed algorithm, our sample patient-directed algorithm (Figure 2) dictates that the basal insulin needs to be increased, although using a much more conservative increment. With a current dose of 24 units of glargine every night at bedtime, the next step would be an increase to 26 units; advise him to continue to monitor glucose every morning. If the pattern holds, he should increase again, and so on until his morning glucose values are consistently within target. This seems straightforward enough and in many cases may be an effective means of helping the patient achieve his glycemic target. Let's look at this scenario with additional information, however.

Figure 2: Sample Basal Self-titration Algorithm (for patients)

Instructions for Adjusting Your Basal Insulin

Name: _____ Date: _____

Starting Dose: _____ at _____(time)

Morning Glucose Target: _____

1. Check your blood glucose every morning before eating.
2. If your glucose is above the target for three mornings in a row, increase your dose of basal insulin by 2 units. This is your new bedtime dose.
3. If your glucose is less than the target for more than one consecutive day, decrease your dose of basal insulin by 2 units. This is your new bedtime dose.
4. Continue this process each day until your fasting morning glucose is consistently within your target.
5. Do not exceed _____ units without first speaking to your provider.
6. If you have a very unusual day (sick, much more active than usual, lots more food than normal such as on a holiday), do not count that day towards making adjustment in your insulin.

If you have any trouble or concerns, contact your certified diabetes educator at the following phone #/email address: _____

Example 2: More Blood Glucose Data

Now we not only have Mr. Jones's fasting morning glucose values, but also his bedtime values (see Table 2). Notice that although his morning glucose is indeed elevated, his bedtime values are even higher. In fact, if you do a little math, you will see that the average drop in glucose overnight is greater than 80 mg/dL! So we must ask ourselves, is the problem here that he is not receiving enough basal insulin? Likely not. His glucose is way too high after dinner, hence, either his dinner meal plan or his dinner insulin should be addressed first (likely both). Imagine a scenario if Mr. Jones were to actually go to bed with blood glucose of 130 mg/dL . . . with an 80 mg/dL drop, his current dose would put him somewhere in the 50s by morning! So in fact, not only may his evening meal insulin need an increase, but you may want to consider reducing the bedtime basal at the same time to prevent nocturnal hypoglycemia.

Now let's look at some scenarios in which the blood glucose data do not paint a complete picture.

Example 3: Missed Basal Doses

Ms. Garcia's pattern reveals that on a few mornings her glucose is within target (see Table 3). In addition, there is little difference between these specific mornings' readings and her bedtime values the nights before. However, on many other mornings, her glucose is significantly elevated. Because the "elevated" mornings outnumber those in which she was within her target range, you may be tempted to simply advise an increase of the bedtime basal dose. But now let's examine the numbers more carefully. You may also notice that several of these incidents of fasting hyperglycemia seem to occur after nights for which she has no bedtime readings. Because you have developed a good, trusting rapport with Ms. Garcia, you question her about this. She admits to you that she frequently falls asleep during the Jay Leno show and on those nights misses her bedtime glucose test as well as her basal insulin dose. With this new information, we now see that increasing the bedtime dose is pointless and, more importantly, potentially dangerous! A good strategy would be to discuss with Ms. Garcia some ways in which she might be more successful taking her bedtime blood glucose and basal insulin. Perhaps she could take it earlier in the evening, set an alarm, put her meter and insulin pen next to her toothbrush, or even use Jay's opening monologue as a trigger to monitor and take her insulin.

Table 2: Glucose Log for Mr. Jones (more readings)

Current Insulin Dose: 7 units aspart before each meal; 24 units glargine before bed				
	Pre-Breakfast	**Pre-Lunch**	**Pre-Dinner**	**Bedtime**
Monday	221	177		270
Tuesday	187		180	309
Wednesday	240	149		278
Thursday	216		207	300
Friday	199	162		274
Saturday	182		212	291
Sunday	206	134		267

Table 3: Glucose Log for Ms. Garcia

Current Insulin Dose: 15 units (+correction) lispro before each meal; 48 units detemir before bed				
	Pre-Breakfast	**Pre-Lunch**	**Pre-Dinner**	**Bedtime**
Monday	259	190		144
Tuesday	112		136	
Wednesday	176	181		
Thursday	201		170	130
Friday	121	124		
Saturday	168		158	
Sunday	212	201		

Example 4: Snacking Before Bedtime

Now consider Mrs. Smith (see Table 4). She comes in with her logbook showing a pattern of glucose that increases overnight to a level above her target range. She states unequivocally that she never misses her bedtime insulin dose. Your first thought might be to increase the basal insulin, which may in fact be appropriate. But here again is where patient–provider/educator communication is so important. You see, in this hypothetical scenario, Mrs. Smith is very worried about having a hypoglycemic event while sleeping, and therefore, every night after checking her blood glucose, eats a bowl of ice cream. If you didn't know this, you'd likely suggest increasing the basal dose. If Mrs. Smith doesn't challenge the dose increase during the visit (which some patients do not like to do), what do you think her home actions will be? She may ignore the advice and take a lower dose—or no dose at all. Likely, she will eat a *bigger* bowl of ice cream at bedtime as the "fear factor" just increased due to a larger dose of bedtime insulin!

How might a provider or educator work with Mrs. Smith to help improve her control? Address her fear. Acknowledge that hypoglycemia, especially while sleeping, is a scary possibility. Rather than increasing the basal insulin, discuss a realistic bedtime goal. For example, highlight how the pattern reveals that her nightly snack increases her blood sugar an average of 60 to 70 mg/dL and that her bedtime sugar is already well above the worry zone. Ask her to name the lowest BG value at which she would feel safe going to bed. Negotiate with her. For example, "Mrs. Smith, what do you say to having just a half-size bowl of ice cream and only if your glucose is between 100 and 180 mg/dL at bedtime? If you are 180 or above, then do not eat anything; if your glucose is less than 100 mg/dL, then have a regular-sized bowl. If you are worried, you can set your alarm for 3 AM and check your glucose." Make a deal that if these steps are successful over the next 2 weeks, then the 2 of you can take a next step, moving slowly toward a more appropriate target range, but only as she feels comfortable. This approach not only makes good clinical sense, but is likely to result in much greater patient adherence, which benefits everyone involved.

Table 4: Glucose Log for Mrs. Smith

Current Insulin Dose: 16 units detemir before bed (plus BID metformin and glyburide)				
	Pre-Breakfast	**Pre-Lunch**	**Pre-Dinner**	**Bedtime**
Monday	219		110	166
Tuesday	238			172
Wednesday	240	159		209
Thursday	274		206	199
Friday	266	113		158
Saturday	234		120	144
Sunday	207	98		180

Example 5: When More Insulin Is Not the Only (or Even the Best) Answer

Finally, remember to look beyond just the insulin dose! Remember the other factors that affect glucose—namely, food and activity! If you notice a trend of increasing weight (above desirable BMI) along with increasing insulin, little alarm bells should go off. Address the food intake, including snacking (e.g., after dinner). Many patients are actually over-basaled to compensate for overeating. In addition to contributing to unwanted weight gain, this can increase a patient's risk for hypoglycemia should he or she suddenly eat a lesser amount. With a higher dose of basal insulin than is actually required for basal needs, the patient is then in a situation where he or she *must* eat, just because of the extra insulin on board.

And then there is exercise. Lots of patients, believe it or not, may welcome a "natural" way to decrease their blood glucose without adding more medication to their regimens. A good substantial brisk walk before bed can have a positive glycemic effect, lasting throughout the night, resulting in much better FPG values. Of course the added bonus of this approach is that a good brisk evening walk is also likely to aid digestion, improve quality of rest, lower blood pressure and cholesterol, improve weight, and result in a greater sense of well-being.

Give your patients tools and support they need to self-adjust when appropriate. But make sure to consider all aspects of a patient's situation!

So what is the take-home message? Embrace the potential of the excellent basal insulin options. Consider the use of evidence-based treat-to-target algorithms. Give your patients tools and support they need to self-adjust when appropriate. But make sure to consider all aspects of a patient's situation! Develop a good rapport and work with your patients to identify the actual causes of problems and thereby the best possible solutions. ■

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