

PRACTICAL INSULIN ADJUSTMENT Via BLOOD SUGAR PATTERNS

5/14/2019

TYPE 1 VS TYPE 2 DIABETES



ADA 2019 Glycemic Targets

A reasonable A1C goal for many nonpregnant adults is <7% . **A**

- mean plasma glucose 154
- Preprandial capillary glucose 80-130
- Postprandial peak capillary glucose <180

ADA 2019 Glycemic Targets

Providers might reasonably suggest more stringent A1C goals (such as <6.5%) for selected individual patients if this can be achieved without significant hypoglycemia or other adverse effects of treatment (i.e., polypharmacy). Appropriate patients might include those with short duration of diabetes, type 2 diabetes treated with lifestyle or metformin only, long life expectancy, or no significant cardiovascular disease. **C**

- Mean plasma glucose 126
- Long life expectancy
- No significant CVD/vascular complications
- Rx with lifestyle or metformin only

ADA 2019 Glycemic Targets

Less stringent A1C goals (such as <8%) may be appropriate for patients with a history of severe hypoglycemia, limited life expectancy, advanced microvascular or macrovascular complications, extensive comorbid conditions, or long-standing diabetes in whom the goal is difficult to achieve despite diabetes self-management education, appropriate glucose monitoring, and effective doses of multiple glucose-lowering agents including insulin. **B**

ADA Recommendations

- Safety is now recognized as an important consideration in establishing glucose targets.
- Re-evaluate glycemic goals for each individual patient each time you evaluate their blood glucose control.



GLYCEMIC TARGETS

- Treat blood glucose not A1C
- Blood glucose targets and must be individualized
- Not everyone benefits from aggressive glucose management (Accord Study ~2011)
- Decisions about an individual patient's glycemic targets must be made in conjunction with the patient
- **More than one way to get to targets**

Pattern Management

- Define individual target blood sugars
- In insulin requiring patients, the patient must get blood sugar data to safely and effectively control the blood sugar
- Looks for patterns
- Define and implement "next steps"
- Blood glucose can be affected by medication, food, stress, physical activity and probably more than we know

Insulin Basics

- Mechanism of action:
 - Stimulates carbohydrate metabolism,
 - transfers glucose to muscles,
 - converts glucose to glycogen.
- Side effects:
 - Weight gain – is this true???
 - hypoglycemia

Basal Insulin

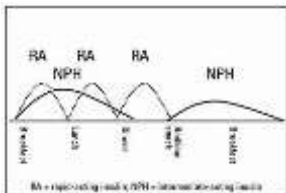
- **Purpose:** suppress glucose and ketone production
 - **Required in ALL patients with type 1 diabetes (Usually Glargine insulin)**
- Basal Insulins:**
1. Long acting- intermediate insulin such as **NPH** insulin (peaks 4-9 hrs) OR
 2. Long acting insulin analogs (**Glargine, Detemir**) – little or no peak
 3. Continuous Subcutaneous Insulin Infusion (**insulin pumps**) which use short acting analogs

Basal Insulin - NPH

- Dosed once to twice a day, am and **bed** (why hs?)
- Works 14-20 hrs.
- **Can mix with short acting insulin**
- **Starts working in 1-3 hrs.**
- **Can avoid a lunch shot**
- The patient should have a regular schedule - **need to eat lunch about 5 hours after injecting**



"Classic" NPH & Regular Regimen



Basal Insulin – glargine (Lantus)

- Dosed usually 1 time daily, sometimes twice daily
- No peak, so don't need a particular schedule
- **Unable to mix with short acting insulin**
- If need prandial insulin, will need lunch shot



A Case for Basal Insulin

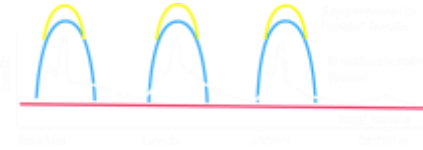
Breakfast	Lunch	Dinner	Bedtime
156	185	203	265
200		194	
164	196		188

NPH vs Lantus

- Type 1 vs Type 2 dm
- Nocturnal hypoglycemia on NPH?
- Is insulin needed for post prandial glucose rise?
- How many shots is patient willing to take a day?
- What are the patients blood sugar patterns?
- Cost – Costco cash prices for 1 vial May 4, 2019
 - Lantus \$321.37
 - NPH \$154.12
- Once a day Lantus idea is very seductive.....

Bolus Insulin: short acting insulin

Regular or Humalog (one or the other)
used for **correction** and **meal coverage**



Bolus Insulin: Correction Insulin

- Formerly known as "sliding scale"
- **Used to correct high blood sugar**, expressed as a ratio
example - 1 unit for 50 points
- **Is not associated with meals- GIVE EVEN IF NOT EATING!**
- Used with **short acting insulin** (regular or Humalog)
- Rule of 1500, 1800 to determine ratio

Bolus insulin: Nutritional/Prandial Insulin Regular OR Humalog

- Given to patients who are eating meals
- Purpose: cover ingested carbohydrates
- Must be matched to the patient's nutrition pattern as set dose or carb counting
- **Regular insulin: give 30 min before meal**
- **Humalog: give within 15 minutes of meal**
- Carbohydrate counting given as a ratio –example 1 unit for 15 grams of carbohydrate (CHO)

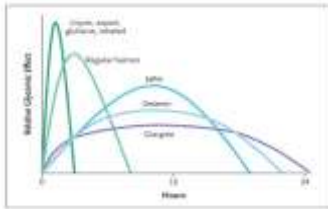
Prandial + Correction Case

Pt with blood sugar of 250 before breakfast.
AM insulin doses are 20N/10r + correction. He is eating.

Correction is 1 unit for 30 points:
150-180 = 1 unit
181-210 = 2 units
211- 240 = 3 units
240-271 = 4 units

How many total units of regular insulin does he get?

Insulin Actions



Insulin Actions and Adjustments

TYPE	TIME INJECTED	PEAK	TIME OF EFFECT
NPH	breakfast	4-10hrs	dinner
NPH	dinner/bedtime		night/breakfast
REGULAR	breakfast	2-4hrs	lunch
	lunch		dinner
	dinner		bed
LANTUS	bedtime	flat	breakfast
LISPRO	breakfast	1-2 hrs	between breakfast and lunch
	lunch		between lunch and dinner
	dinner		between dinner and bedtime

Blood Sugar Pattern for Prandial Insulin

52 y/o female on NPH insulin 20 units am and 10 units at Bed.
 metformin 1000mg bid and glipizide 10mg bid with an a1c 8.3

Breakfast	Lunch	Dinner	Bedtime
124	136	170	200
150		145	199
135	114	164	240

Quick Think

A patient is going to have a colonoscopy and is on 15 units of lantus at night, 4 regular in the morning.

Her correction scale is 1 unit for 50 points:

150-200 1 unit of insulin

201-250 2 units of insulin

He is not to eat the morning of the test.

His blood sugar is 249

How much regular insulin does he take?



Total Daily Dose (TDD)

Each column is a 4 hour time period.



Case Study # 1

- 64 y/o female on metformin 1000mg bid and glipizide 10mg bid.
- Hx of heart disease on lasix 20mg a day and lisinopril 40mg a day.
- A1c 10.5
- GFR 50
- Weight is 100 kg
- What do you do?

ADA Initiate Basal Insulin

- Start 10 units/day or 0.1-0.2 units/kg/day
--> 100 kg x 0.1-0.2 = 10-20 units per day
- ??? Single dose - if so, what time?
- ??? Twice a day dose – if so, how much and when?

Weight Based Calculation for Insulin

Total Daily Dose of Insulin = weight in kg x 0.4-1.0

Example : 100 kg x 0.4-1.0 = 40-100 total units/day

Type 2 pts -> 2/3 am (26) and 1/3 pm (13)

(2/3 N, 1/3 R)

(½ N, ½ R)

16N/8r

7r dinner, 6N bed

Lantus insulin ½ basal and ½ bolus-> 20 lantus and 7 Humalog before each meal

Calculating Total Daily Dose (TDD) of Insulin

Weight-based examples for initiation of insulin therapy as per the ADA 2019 guidelines

TYPE 2 DIABETES

- Type 2 diabetes the initial basal starting dose is 10 units/day or 0.1-0.2 units/kg/day
- Total Daily Dose of Insulin = 0.4-1.0 units/kg divided into a basal/bolus regimen
- For mealtime bolus insulin the initial recommended dose is 4 units, 0.1 units/kg or 10% of the basal dose.
- The basal insulin (NPH or Glargine) is 50-75% of the total daily dose and the prandial insulin (regular or Humalog insulin) is 25-50% of the total daily dose divided before meals

TYPE 1 DIABETES

- The typical TDD for type 1 diabetes is 0.5 units/kg.

Bolus (regular/humalog) Calculations

Rule of 1500 – correction calculation (1800 if humalog)

- 1500 / total daily dose of insulin
- Example: 1500 / 44 units = 34 --> round up to 40
- 1 unit will lower the blood glucose 40 points
- Start at target (ie 120) – correction would start at 160

Rule of 450 for carbohydrate calculation (500 if humalog)

- 450/total daily dose of insulin
- Example: 450/44 = 10.22
- 1 unit will cover 10 grams of carbohydrate

Options for Case # 1

- **Weight based for NPH and regular**
100kg x 0.4-1.0 = 40-100 units/day

25 units am and 15 units pm
20N/5r am and 5r dinner and 10N bed

- **Weight based for Lantus and regular**
Lantus 20 units bed Regular/humalog 7 units before meals

Case Study # 1 2 weeks later

20N/5r am and 5r dinner and 10N bed

Breakfast	Lunch	Dinner	Bedtime
167	200	158	187
	187	120	
175			200
	154		

82y/o male with ckd here for diabetic foot wound. On 12N/16r am and 8r dinner

Medication	Breakfast	Lunch	Dinner	Bedtime
Humalog	7u	7u	7u	7u
Regular	12u	16u	8u	16u
NPH				20u

69y/o with type 2 dm on 15N am and 5N hs with low correction scale.

Point of Care Tests					
Date/Time	05/07/18	05/07/18	05/07/18	05/07/18	05/07/18
Site	LAD	RTD	ADA	RTD	LAD
Plasma Glucose (mg/dL)	126	146	136	130	126
Glucose (mg/dL)	126	146	136	130	126
Ref Range (mg/dL)	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL
Function	OK	OK	OK	OK	OK
Comments	05/07/18 08:00	05/07/18 12:00	05/07/18 05:00	05/07/18 08:00	05/07/18 08:00
Plasma	126	146	136	130	126
Plasma Glucose (mg/dL)	126	146	136	130	126
Ref Range (mg/dL)	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL
Function	OK	OK	OK	OK	OK

Impact of Low GFR on Glucose Pattern

- Pts with GFR <60 are more prone to hypoglycemia- decreased insulin clearance
- Have a typical pattern of rising glucose during the day with bed to morning drop
- If GFR <40 they generally need for little or no basal insulin during the night
- So what would be the best basal insulin to use?

Typical Glucose Pattern with GFR <40

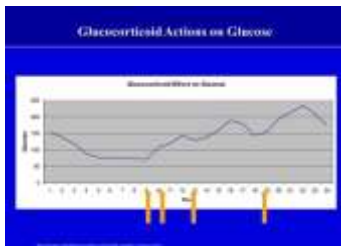
Breakfast	Lunch	Dinner	Bedtime
101		203	286
86	210		
120		277	230
97	196	194	

DM 2 on 20N am and 20N hs. GFR 45.

Point of Care Tests	05/06/18	05/07/18	05/08/18	05/09/18	05/10/18
Test Panel	COX	COX	COX	COX	COX
Blood Glucose (Adapted)	10.8	10.4	10.4	10.4	10.4
Glucose (Adapted)	10.8	10.4	10.4	10.4	10.4
Self-Monitoring Glucose	10.8	10.4	10.4	10.4	10.4
Reference	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL
Glucose (Adapted)	10.8	10.4	10.4	10.4	10.4
Reference	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL	70-100 mg/dL

Impact of steroids on Glucose

- Steroids increase insulin resistance – especially I response to CHO's
- Most steroids given outpatient are given in the morning such as once a day prednisone
- Typical AM steroid pattern is rising glucose during the day with bed to morning drop
- What would be the best basal insulin to use?
- All patients who are on steroids that do not have diabetes should have their blood glucose checked initially to evaluate for hyperglycemia --> **What would be the best time of day to test?**
- Insulin needs to be adjusted as steroid doses change



Pearls: Glucose Patterns in Renal Patients and Patients on Steroids

- Consider decreasing or stopping bedtime NPH and avoid using Glargine as these patients usually need little or no insulin at night!
- Usual insulin for these patients is am NPH and regular insulin before breakfast and before and dinner

75y/o with ckd and IgA vasculitis on glipizide 10mg bid and metformin 500mg bid at home. Gfr is 31. A1c 7.4

Time of Entry (hr)	12:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00
Mean Glucose (mmol/L)	10.8	10.8	10.8	10.8	10.8
Mean Glucose (mg/dL)	194	194	194	194	194
Standard Deviation (mmol/L)	1.2	1.2	1.2	1.2	1.2
Standard Deviation (mg/dL)	21.6	21.6	21.6	21.6	21.6
Minimum (mmol/L)	5.0	5.0	5.0	5.0	5.0
Minimum (mg/dL)	90	90	90	90	90
Maximum (mmol/L)	16.0	16.0	16.0	16.0	16.0
Maximum (mg/dL)	288	288	288	288	288

58y/o female with renal tx on prednisone 5mg am 8N/3 Humalog am, 3 Humalog lunch and 3 Humalog dinner-(started 7/5). GFR 31

Why bed to am rise on 7/6???---- hard one!

Time of Entry (hr)	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00
Mean Glucose (mmol/L)	11.8	11.8	11.8	11.8	11.8
Mean Glucose (mg/dL)	212	212	212	212	212
Standard Deviation (mmol/L)	1.5	1.5	1.5	1.5	1.5
Standard Deviation (mg/dL)	27.0	27.0	27.0	27.0	27.0
Minimum (mmol/L)	5.0	5.0	5.0	5.0	5.0
Minimum (mg/dL)	90	90	90	90	90
Maximum (mmol/L)	16.0	16.0	16.0	16.0	16.0
Maximum (mg/dL)	288	288	288	288	288

45 y/o pt on 35N/14r and 8r dinner and 20N hs

Breakfast	Lunch	Dinner	Bedtime
145	67	199	262
	87	156	
126	56		245
167			180

Pearls

- Look at HBA1C and see what the target is
- Look at GFR and age
- If A1c above goal on basal insulin and trends of post prandial highs, consider starting prandial insulin
- Consider continuing Metformin/Actos with insulin if possible
- Stop glipizide when adding mealtime insulin.

56y/o, A1c 8.8, GFR 72 on 30N/6r am, 6r dinner, 10N hs

Week	Overweight	Early Morning	Late Morning	Early Afternoon	Late Afternoon	Early Evening	Late Evening	Midnight
1/15/2017	100							
1/22/2017	100	115						
1/29/2017	100	120						
2/5/2017	100	125						
2/12/2017	100	130						
2/19/2017	100	135						
2/26/2017	100	140						
3/5/2017	100	145						
3/12/2017	100	150						
3/19/2017	100	155						
3/26/2017	100	160						
4/2/2017	100	165						
4/9/2017	100	170						
4/16/2017	100	175						
4/23/2017	100	180						
4/30/2017	100	185						
5/7/2017	100	190						
5/14/2017	100	195						
5/21/2017	100	200						
5/28/2017	100	205						
6/4/2017	100	210						
6/11/2017	100	215						
6/18/2017	100	220						
6/25/2017	100	225						
7/2/2017	100	230						
7/9/2017	100	235						
7/16/2017	100	240						
7/23/2017	100	245						
7/30/2017	100	250						
8/6/2017	100	255						
8/13/2017	100	260						
8/20/2017	100	265						
8/27/2017	100	270						
9/3/2017	100	275						
9/10/2017	100	280						
9/17/2017	100	285						
9/24/2017	100	290						
10/1/2017	100	295						
10/8/2017	100	300						
10/15/2017	100	305						
10/22/2017	100	310						
10/29/2017	100	315						
11/5/2017	100	320						
11/12/2017	100	325						
11/19/2017	100	330						
11/26/2017	100	335						
12/3/2017	100	340						
12/10/2017	100	345						
12/17/2017	100	350						
12/24/2017	100	355						
12/31/2017	100	360						
