

**Initiation, Titration And Maintenance Of Basal Insulin In Type 1 Versus Type 2 Diabetes:  
An Important Foundation To Successful Insulin Management**

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Past President,  
The First Clinic

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**Comparing and Contrasting  
Type 1 and Type 2 Diabetes...  
Sometimes It's Like Comparing  
Apples to Oranges**



**....and Sometimes It's Like Comparing  
Apples to Apples**



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**Type 1 and Type 2 Diabetes Are  
Very Different**

- ▶ Misperceptions and Physical Appearance
- ▶ Incidence and Prevalence
- ▶ Hereditary Influence
- ▶ Etiology and "Natural History"
- ▶ Characteristics and Associated Conditions
- ▶ Treatment Strategies
- ▶ Approaches to basal insulin management strategies

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### Incidence and Prevalence of Type 1 vs Type 2 Diabetes

	Type 1	Type 2
Number in the US	1,250,000	31,000,000
Diagnosed Every Day in the US	110	6,000

Edelman SV. Taking control of your diabetes: a patient oriented book on diabetes. Fifth Edition Professional Communications Inc., Greenwich, CT. 544 pages, 2017.

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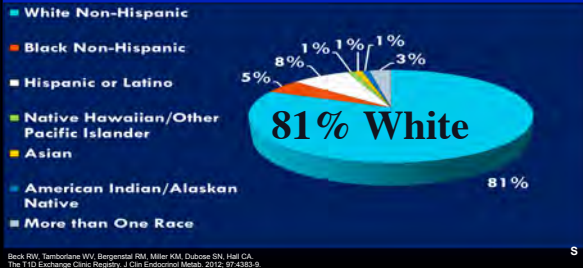
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### Type 1 Race/Ethnicity



Beck RW, Tamborlane WV, Bergstralh RM, Miller KM, Dubose SN, Hall CA. The T1D Exchange Clinic Registry. J Clin Endocrinol Metab 2012; 97:438-9.

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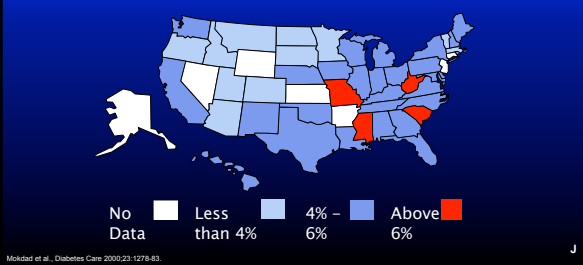
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### Trends Among Adults With Type 2 Diabetes in the U.S. 1990



Mokdad et al., Diabetes Care 2000;23:1278-83.

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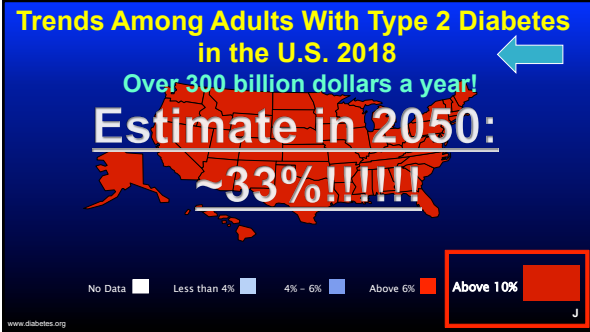
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### Risk of Developing Type 1 vs Type 2

General Population	0.3%	8-11%
If you have a sibling with T1D	4%	~30%
If your mother has T1D	2 - 3%	~30%
If your father has T1D	6 - 8%	~30%
If you have an identical twin with T1D	~50%	100%

Edelman SV. Taking control of your diabetes: a patient oriented book on diabetes. Pitt. Edition Professional Communications Inc. Greenwich, CT. 244 pages. 2017.

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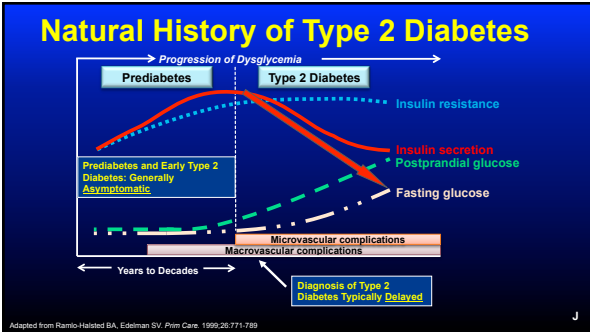
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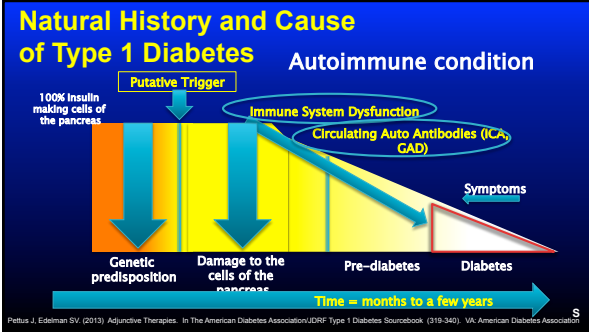
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### Type 1

**Jeremy Pettus**  
Diagnosed Age 15

- Mary Tyler Moore
- Chris Dudley
- Charlie Kimball
- Jay Cutler
- Nick Jonas
- Sharon Stone
- Gary Hall Jr.
- Phil Southerland

- ▶ Usually average weight
- ▶ Dx usually before age 25
- ▶ Beta cell destruction
- ▶ Autoimmune condition
- ▶ High rate of hypothyroidism and celiac disease
- ▶ 5-10% of all PWD

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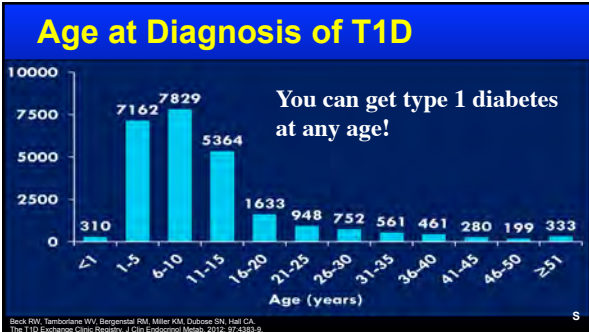
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## Latent Autoimmune Diabetes in Adults (LADA)

The most missed diagnosis in diabetes

› Type 1 diabetes can occur at any age

Slower beta-cell destruction (may respond briefly to oral agents)

› Typically does not have features of the Metabolic Syndrome

Blood test positive for type 1 diabetes (GAD auto antibodies)



**Gary Hall Jr.**  
Olympic Gold Medalist  
World Record Holder

Selman SL. Taking control of your diabetes: a patient oriented book on diabetes. 9th Edition Professional Communications Inc., Greenwich, CT 644 pages, 2017.

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## Generic and Trade Names: Insulin

	Generic Name	Trade Name
<b>Fast-Acting Insulin</b>	Regular U-500 Regular Aspart Faster Acting Aspart Glulisine Lispro (U-100 and U-200) Follow on biologic lispro Inhaled Insulin	Humulin R, Novolin R Humulin R U-500 NovoLog Fiasp Apidra Humalog Admelog Afrezza
<b>Basal Insulin</b> 	Intermediate-Acting: NPH  Long-Acting: Detemir Glargine (U-100) Glargine (U-300)* Degludec (U-100/200)* Follow on biologic glargine (U-100)	Humulin N Novolin NPH  Levemir Lantus Toujeo* Tresiba*  Basaglar

Information taken from the PDR Guide and Package Inserts

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## Shortcomings of Basal Insulins Include:

- › Hypoglycemia resulting in:
  - Insulin under-dosing
  - Insufficient glycemic control
- › Weight gain
- › Inconsistent insulin action...leading to inconsistent blood glucose levels
- › Not enough flexibility with timing of injections
- › Insufficient duration of action...therefore, requiring a minimum of 1 and, sometimes, 2 injections/day
- › Large volume injections required for some patients

Expert Opin. Biol. Ther. (2014) 14(6):7509-88

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## Two New Basal Insulins Recently Added to Our List of Options

Both approved by the FDA and now available for patients

1. U-300 glargine a long-acting basal insulin
2. U-100 and U- 200 degludec a long-acting basal insulin

Toujeo prescribing information, Bridgewater, NJ: sanofi, US, 2015 <http://products.sanofi.us/toujeo/toujeo.pdf>  
Tresiba prescribing information 2015, <http://www.novo-pi.com/tresiba.pdf>

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## U-300 Glargine

- A more concentrated (300 units/ml) form of traditional glargine insulin (100 units/ml)
- Compared to U-100 glargine, U-300 glargine has less intra-subject variability, less hypoglycemia and less weight gain.
- Flat, stable and prolonged action up to 30 hours (**needs 5 days to equilibrate...tell your patients!**)
- In the clinical trials patients on U-300 glargine with type 1 and type 2 diabetes may require a dose 12 to 18% higher than previous U-100 glargine (still with less hypo and less weight gain).
- Pen holds 450 units
- New Pen holds 900 units and can give 150U at one time

Riddle MC et al. Diabetes Care. 2014;37:2755-2762; Wu Järvinen H et al. Diabetes Care. 2014. Published ahead of print. doi: 10.2337/14.0990  
Boll GB et al. Poster presented at EASD 2014. P947; Bajaj H. Oral presentation at CDA 2014. #14; Home P et al. Abstract presented at EASD 2014. 0148  
Bajaj H et al. Poster presented at CDA 2014. P112; Mathurka M et al. Poster presented at EASD 2014. P919; Terazoni Y et al. Poster presented EASD 2014. P979

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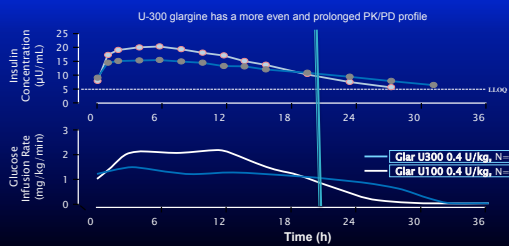
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## PK/PD Profile with Glar U-300 vs Glar U-100



Becker RH, et al. Diabetes Care. 2015;48:539-543.

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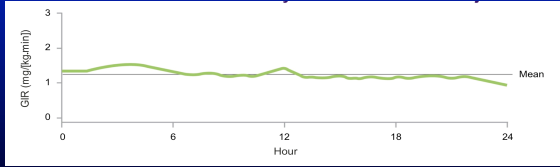
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### Glucose Infusion Rate In Subjects With Type 1 Diabetes Insulin Glargine U-300



50 T1D subjects underwent two euglycemic clamp studies after 6 days of receiving Insulin glargine U-300

Becker RHA, et al. Diabetes Obes Metab. 2015; 17(3): 201-207

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### U-100 and U-200 Insulin Degludec

- Available as either 100 units/ml (~detemir) or 200 units/ml
- Long duration of action up to 42 hours (needs 5 days to equilibrate...tell your patients!)
- Peakless
- Low intra-subject variability
- Less hypoglycemia and variability compared to U-100 glargine
- Disposable pens hold a maximum of 300 (U-100) and 600(units) 160 units can be given at one time.

Chewell et al. Diabetes Metab Res Clin. 2014;20:188-193  
 Heise T et al. Diabetes Obes Metab. 2012; 14:944-950  
 Heise T et al. Diabetes Metab. 2012; 14:951-957  
 Jovanovic L et al. Pharm Res. 2012;29:2104-2114  
 Pfizer Release. [http://www.pfizer.com/corporate/investor\\_relations/news\\_attachments/3U0+1+15+0+12+0+10+455+5677980158e](http://www.pfizer.com/corporate/investor_relations/news_attachments/3U0+1+15+0+12+0+10+455+5677980158e). Accessed December 15, 2014.

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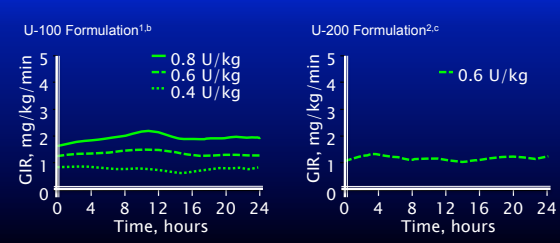
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### Pharmacodynamics of Insulin Degludec<sup>a</sup> U-100 and U-200 in Patients with T2DM: Same time course of action



Heise T, et al. Diabetes Obes Metab. 2012; 14:944-950  
 Heise T, et al. Diabetes. 2012; 61(suppl 1):A91 [Abstract 349-091]  
<sup>a</sup> Glucose clamp study in patients with T2DM (n = 49).  
<sup>b</sup> Glucose clamp study in patients with T2DM (n = 16).

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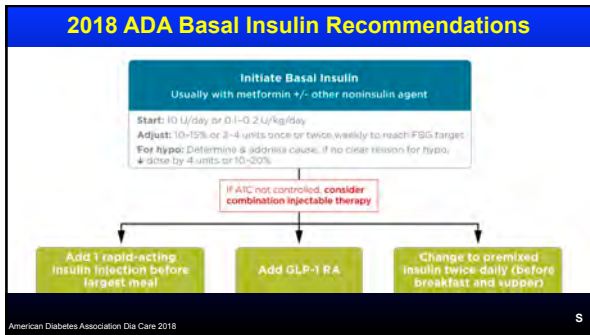
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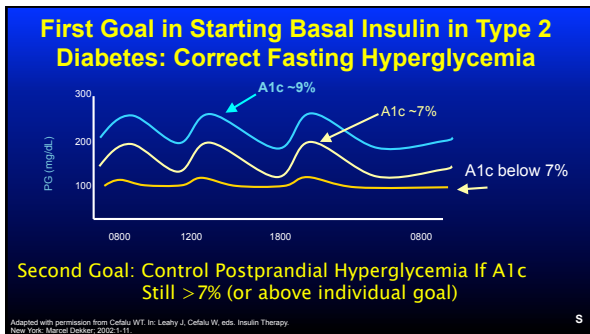
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- ### Combination Therapy: Adding Basal Insulin to Oral Agents an Effective Strategy to Initiate Insulin Therapy In T2D
- Only 1 injection per day is typically required
  - No need for mixing different types of insulin
  - Convenience (usually given at night or first thing in the morning)
  - Slow, safe, and simple titration
  - Low dosage needed compared to a full insulin regimen
  - Limited weight gain – especially compared to insulin only regimens
  - Effective improvement in glycemic control by suppressing hepatic glucose production
- Edelman SV, Henry RR. Diagnosis and management of type 2 diabetes. 12<sup>th</sup> Edition. Professional Communications, Inc., Greenwich, CT 208 pages, 2014. S

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## Second Pitfall in Initiating and Titrating Basal Insulin (First one is too slow titration after starting)

### Not Paying Attention To The Bedtime Glucose Value

1. Ask the patient to do paired testing (test at bedtime and again the next morning).
2. If the bedtime BG is high, then that needs to be addressed by either lifestyle modification including reduced caloric consumption and/or post dinner exercise.
3. Other options include prandial insulin or a GLP-1 RA

Edelman SV, Henry RR. Diagnosis and management of type 2 diabetes. 12<sup>th</sup> Edition. Professional Communications, Inc., Greenwich, CT. 288 pages, 2014.

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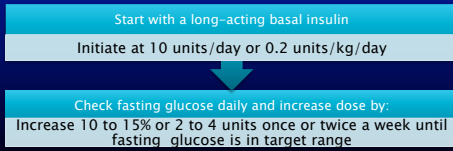
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## Appropriate Self-Titration is Critical to the Success of Insulin Therapy

- ▶ An ADA/EASD consensus algorithm for the initiation and adjustment of basal insulin:



ADA, American Diabetes Association; EASD, European Association for the Study of Diabetes. Nathan et al. Diabetes Care. 2019.

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## Simple Daily Self-Titration Option\* (much easier to follow by the patient than the once or twice a week method)

Increase by **1 to 2 Units** every **1 day** until  $FPG \leq 120$  mg/dL

### EXAMPLE

Less than 100: decrease by 2 units  
Between 100 and 150: no change  
Over 150: increase by 2 units

The goal can be individualized

\*Adjust dose subsequently to patient's need.  
†Doseage was not increased if there were any episodes of documented hypoglycemia (<72 mg/dL) during the preceding week. FPG, fasting plasma glucose.  
Gerstein HC et al. Diabet Med. 2009;23:736-742.

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**Starting/Adjusting Long-Acting Basal Insulin**

1. Give **Basal insulin** once a day at **Morning**
2. Starting dose: 20 units
3. Every 1 day(s), adjust your dose based on your fasting blood sugar that morning before eating or drinking:
  - a. If fasting blood sugar is over 140, then increase your dose by 2
  - b. If fasting blood sugar is under 90, then decrease your dose by 2
  - c. If fasting blood sugar is between 90 and 140, then keep the same Lantus dose

**Important:**  
The purpose of long active basal is to provide a background amount of insulin throughout the day and at night while you sleep. It is not meant to treat high blood sugars caused by eating food, so you should not change your dose based on blood sugar numbers during the day when you are eating.

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**Case: 61 Year Old Overweight Male With Type 2 Diabetes For 8 years**

- › Initial A1c was 9.5%
- › Eventually started on metformin, sequentially followed by a sulfonylurea a DPP-4 inhibitor and a SGLT-2 inhibitor over a 4 year period.
- › PMH: HTN, CHF, dyslipidemia, arthritis and ED
- › Exercises irregularly and “tries to follow a diet”

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**Case continued**

- › Staggered testing results (asked to test one to two times a day at different times)

Time	Blood glucose range	Blood glucose average
Pre-Breakfast	148 - 229 mg/dL	(~175 mg/dL)
Pre- Lunch	111 - 182 mg/dL	(~147 mg/dL)
Pre- Dinner	91 - 155 mg/dL	(~139 mg/dL)
Bedtime	148 - 231 mg/dL	(~184 mg/dL)
No reports of hypoglycemia		

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Which of the following would you suggest if he was your patient?

A	Start a pre-mixed insulin at dinner time
B	Initiate basal insulin
C	Start a GLP-1 RA
D	Start pioglitazone

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### Case continued

- U-300 Glargine was added at night (20 units) and titrated up to 120 units over the next 10 weeks
- I asked him to test 2x/day (bedtime and the next morning)
- It is important to make sure the patient is not going to bed high

Pre-Breakfast	82 - 155 mg/dL	(~122 mg/dL)
Pre-Lunch	----	----
Pre-Dinner	----	----
Bedtime	128 - 183 mg/dL	(~145 mg/dL)

- A1c dropped to 7.1%, no hypoglycemia. Gained 2 lbs in 3 months
- Oral agents can be continued unless hypoglycemia occurs during the day, in which case the sulfonylurea should be reduced or withdrawn

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### Domino Effect

If you control the blood glucose at a particular time of the day, the subsequent number will also improve. **Make one change at a time!**



Edelman SV. Taking control of your diabetes: a patient oriented book on diabetes. Fifth Edition Professional Communications Inc. Greenwich, CT. 944 pages, 2017.

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### Case 62 year old female with type 2 diabetes for 12 years

- Currently on maximum doses of 3 oral agents: metformin, SFU and a DPP-4 inhibitor.
- A1c > 8.5% for the past 2 years
- She was started on basal insulin and the HCP titrated her dose based on her morning glucose value. Her current dose is 78 units
- Current SMBG (mg/dl) below:

	Pre-Breakfast	Pre-Lunch	Pre-Dinner	Bedtime
Monday	243	----	----	---
Tuesday	221	----	---	----
Wednesday	54	----	----	---
Thursday	267	----	---	----

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Which of the following is the single most likely explanation for her low glucose value of 54 mg/dl?

A	She did an unusual amount of exercise that morning
B	She had a much lighter dinner than usual
C	She took twice the amount of basal insulin by accident
D	The value from her glucose meter was not correct

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### Case continued

- She was asked to do some paired testing (bedtime and the next morning for several days in a row)

	Pre-Breakfast	Pre-Lunch	Pre-Dinner	Bedtime
Friday	201	----	----	244
Saturday	192	----	---	154
Sunday	82	----	----	239
Monday	212	----	---	267

- Her basal dose has been titrated up too high and the main issue is that she is going to bed too high.

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### Clinical Pearls: Combination Therapy with Basal Insulin

-1-	Start with 10 to 20 units (also consider FBS, weight)
-2-	The key to success is frequent follow up after initiation to avoid "failure" (most patients will need 40 to 70 units/day)
-3-	Have the patient follow a self-titration regimen and return to clinic or follow up in some other manner (phone, fax, email, telehealth, etc.) <u>relatively soon</u>
-4-	You can usually limit SMBG to only once a day in the morning but check at bedtime once in awhile to make sure the pt. does not need pre dinner fast acting insulin or a GLP1-RA

Edelman SV, Henry RR. Diagnosis and management of type 2 diabetes. 12th Edition. Professional Communications, Inc., Greenwich, CT 288 pages, 2014.

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### IS or Intermittent Sensing Is Excellent For Type 2s



- Goes on easily
- 12 hour warm up time
- Lasts 10 days
- Swipe to get a number
- Has trend arrows
- No calibration
- No alerts or alarms
- No sharing feature



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**Every Day Is  
Different For A  
Person With Type 1  
Diabetes**

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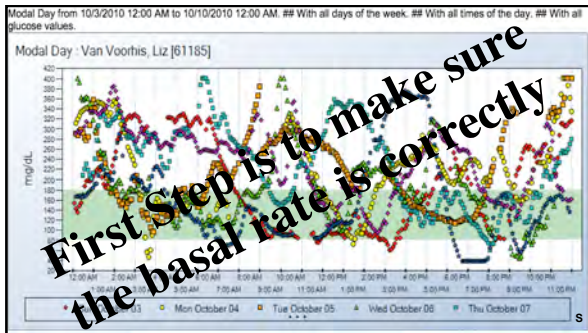
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**Despite Following all of the Rules**

1. Unexpected highs
2. Unexpected lows
3. Carb:Insulin ratio not working consistently
4. Correction Factor not working consistently
5. Not responding to insulin and exercise consistently



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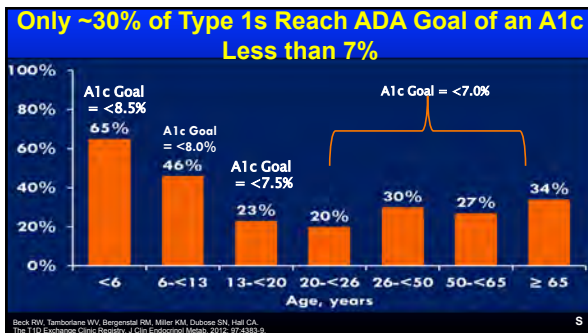
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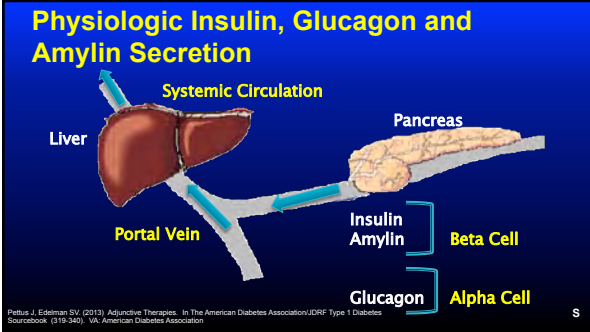
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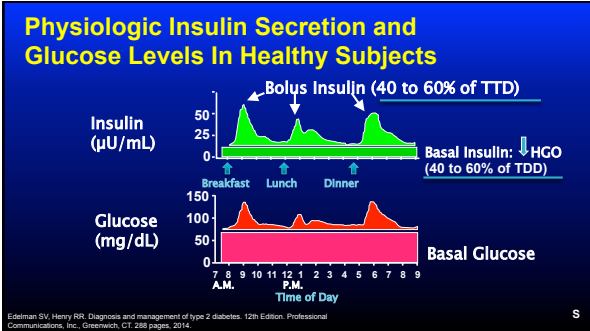
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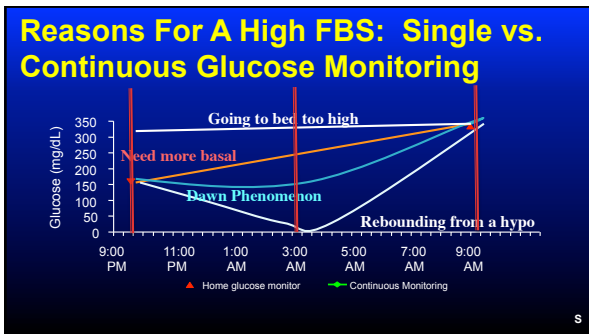
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### Testing The Basal Rate In Type 1 Diabetes

#### Testing Overnight

1. Ask the patient have an early dinner, make sure the post prandial BS is between 140 and 180mg/dl (may need a correction dose) with a horizontal trend arrow
2. Fast until the next morning
3. If not on a CGM then he/she needs to test the BS every few hours

#### Testing During The Day (different day than testing pm)

1. Ask the patient if he/she can skip breakfast and fast as long as possible.
2. If patient wants to eat a small breakfast then make sure the post breakfast BS is between 140-180mg/dl with a horizontal trend arrow

Diabetes 21: The essentials of your diabetes: a patient oriented book on diabetes. 8th Edition Professional Communications Inc., Greenwich, CT 544 pages, 2017

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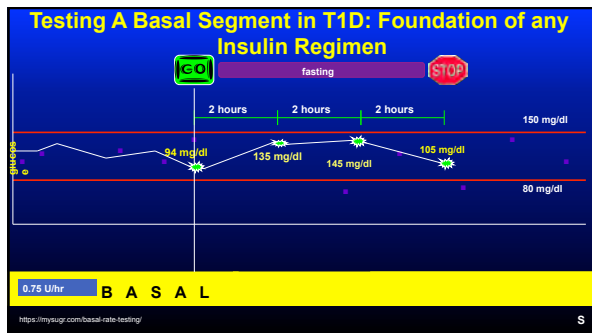
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**39 year female with T1D for 2 years on an insulin pump (0.6 U/hr). Her main problem is that she goes to bed with a good BS level and then wakes up with a high value. What is the most likely cause?**

A	Not bolusing enough for her bedtime snack
B	Early morning resistance to insulin (dawn phenomenon)
C	Eating a snack at 3am without any insulin
D	Gastroparesis

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### Insulin Pumps: Advantages

- Improved glycemic control
  - More precise, physiologic insulin delivery
  - Greater ability to handle **dawn phenomenon**, stress and other conditions that alter insulin requirements
- In some situations (but not all) freedom and flexibility in lifestyle
  - Eliminate multiple daily injections (1 stick every 3 days) Very easy to respond to CGM results
  - Reduce restrictions on eating, exercise and sleeping patterns; could have the same benefits with MDI
  - Greater flexibility with sports, travel, work schedule and other activities (not with water sports)

Eidelman SV. Taking control of your diabetes: a patient oriented book on diabetes. Fifth Edition Professional Communications Inc., Greenwich, CT. 544 pages, 2017.  
Walsh JA, Roberts R. Pumping insulin 5th edition, 2011.

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25 y/o male with T1D on insulin detemir. Good values at bedtime and high in the morning. He also c/o occasional night sweats.  
 What is/are the possible cause for the high morning BS?



- A Bolusing fast-acting insulin at bedtime
- B Too much basal insulin
- C Going to the 24 hour gym at midnight
- D All of the above

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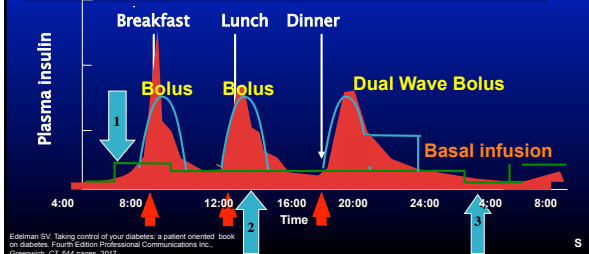
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**Variable Basal Rate Capability**  
 (Total daily basal dose/24) - (10 to 20%)




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**Smart Phone Clarity App**

Mean glucose value

Standard Deviation

Time in Range

24 hour multiday profiles

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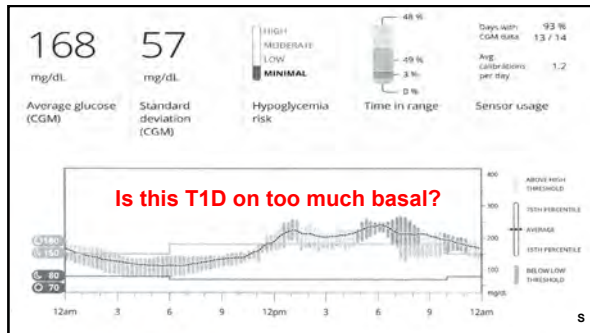
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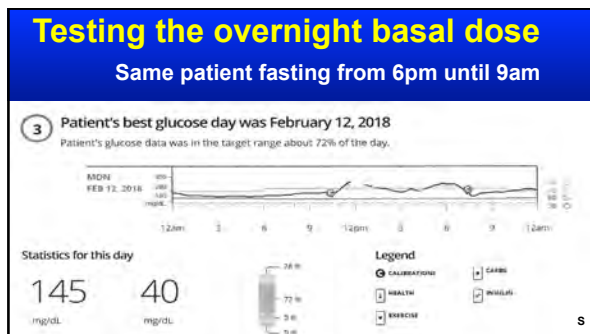
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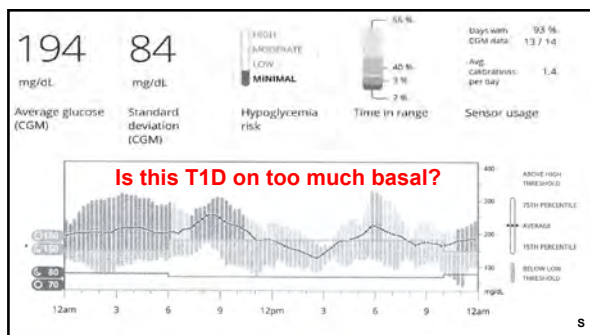
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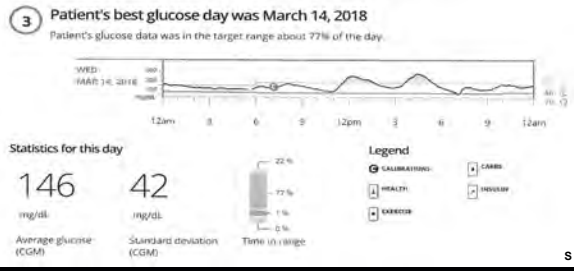
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## Same pt. fasting from 9pm until 7am




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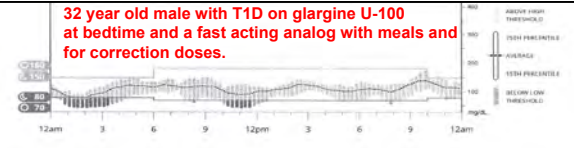
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What is the best treatment option to help this patient with his overnight values?

- Decrease the basal insulin
- Switch the U-100 glargine for U-300 glargine or degludec
- Have a larger bedtime snack
- Do not exercise after 7pm

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### Summary and Conclusions

Type 1 and Type 2 Diabetes are very different conditions including the approach to basal insulin therapy

In Type 2 diabetes self titration is important to reach an adequate FBS and paired testing is important to make sure the bedtime glucose value is in range

In Type 1 diabetes the basal dose should be tested by overnight and daytime fasting.

CGM is the standard of care in T1D and will shortly be used more and more in type 2 Diabetes

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