Stony Brook Children's

Diabetes Mellitus

Clinical Pearls for Residents

Diana Kaplan, D.O. PGY6

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DIABETES CLINICAL PEARLS

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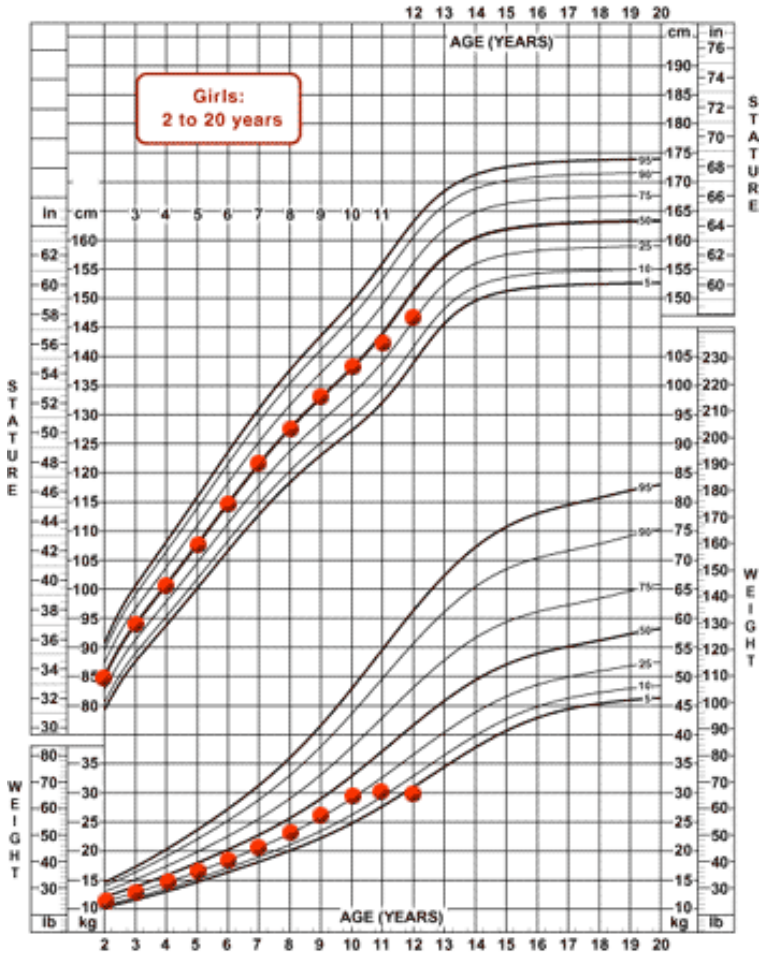
CONTINUITY CLINIC

- 12-year-old female presenting for well child check
- No symptoms or complaints
- **What in office test can you order?**



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CONTINUITY CLINIC

- D-stick:

  - Fasting BG ≥ 126
  - 2 hour post-prandial ≥ 200
  - Random ≥ 200 with symptoms

- Urine dipstick

  - Small/trace ketones → contact endocrine for recommendations
  - **Moderate/large ketones → ER to rule out DKA**

CONTINUITY CLINIC- SCENARIO 2

- 14 year. old male with T1DM presenting with 2 days fever, sore throat, and abdominal pain
- Rapid strep test positive
- **What else can you counsel patient on?**

CONTINUITY CLINIC- SCENARIO 2

- **Sick day management:**

➢ Check urine for ketones: if moderate/large call endocrine

➢ Give corrections for high blood sugar every 2.5-3 hours

➢ If vomiting (without ketones) and having lows, do NOT skip long - acting insulin

PEDS ER – SCENARIO 1

- 11-year-old female with 2 days of nausea, vomiting, and abdominal pain
- Also has had increased thirst and urination over the last several weeks with 2 episodes of bedwetting (very unusual for her)
- 6-pound unintentional weight loss (parents attributed this to her being active over the summer)

PEDS ER- SCENARIO 1

- **Vital signs:** Temp 37.0, HR 152, RR 27, BP 118/70
- **Physical exam**: tired appearing, kussmaul breathing, dry mucous membranes
- **Labs:**
- Chem: Sodium 131, potassium 5.5, glucose 567, bicarb 6, calcium 10.8
- VBG: pH 7.12
- A1c 11.2%
- UA > 500 glucose, large ketones,

Corrected [Na+] = [measured Na+] $+\frac{1.6 \times (\text{glucose} - 100)}{100}$

A1c 5.7-6.4% = pre-diabetes, ≥ 6.4% = diabetes

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PEDS ER- SCENARIO 1

Child with Suspected DKA

Definition of DKA requires all of the following:

Hyperglycemia	Glucose > 200 mg/dL
Ketosis	BOHB > 3 mmol/L
Acidosis	pH < 7.3 ***or*** HCO_3 < 15 mmol/L

SBUH DKA Protocol

Criteria for PICU Admission (any of the following):

Venous pH < 7.25 or serum CO2 < 14 and vomiting.

Venous pH < 7.2 or serum CO2 < 12 regardless of vomiting

Altered mental status

Severe vomiting/dehydration

Glucose > 700

SBUH DKA Protocol

1st hour:

NPO. NG tube if unconscious.

IV, D-stick

•**Labs**: Chem 8, Mg, Phos, CBC, VBG

- o For new onset, also: Anti glutamic acid decarboxylase, anti islet cell and anti insulin antibodies, anti tissue transglutaminase IGA, total IGA, anti TPO antibodies, anti thyroglobulin antibodies, freeT4 and TSH.
- o If type of diabetes uncertain for new onset, add serum insulin and c-peptide.

•**IV Fluids:**

- o 10 mL/kg 0.9% NaCl fluid bolus over 60 minutes
- o If poor perfusion or shock is present, hand push fluid bolus and consider additional bolus if shock not resolved

•**Insulin:** Goal of therapy is to resolve the ketoacidosis – insulin is necessary to do this.
Start insulin therapy provided BS > 200 mg/dl (see below)

•Order insulin drip (100 units Regular insulin / 100 mL Normal Saline): 0.05- 0.1 units/kg/hr

SBUH DKA Protocol

2nd hour:
Contact Peds Endo and PICU
Start 2nd IV (for blood withdrawal)
Repeat dextrose stick ← q1hr d-sticks while on insulin drip
Continue 0.9% NaCl at 1 ½ times maintenance
If available, start insulin drip (may be piggy backed into IV fluids)
Correct electrolyte abnormalities

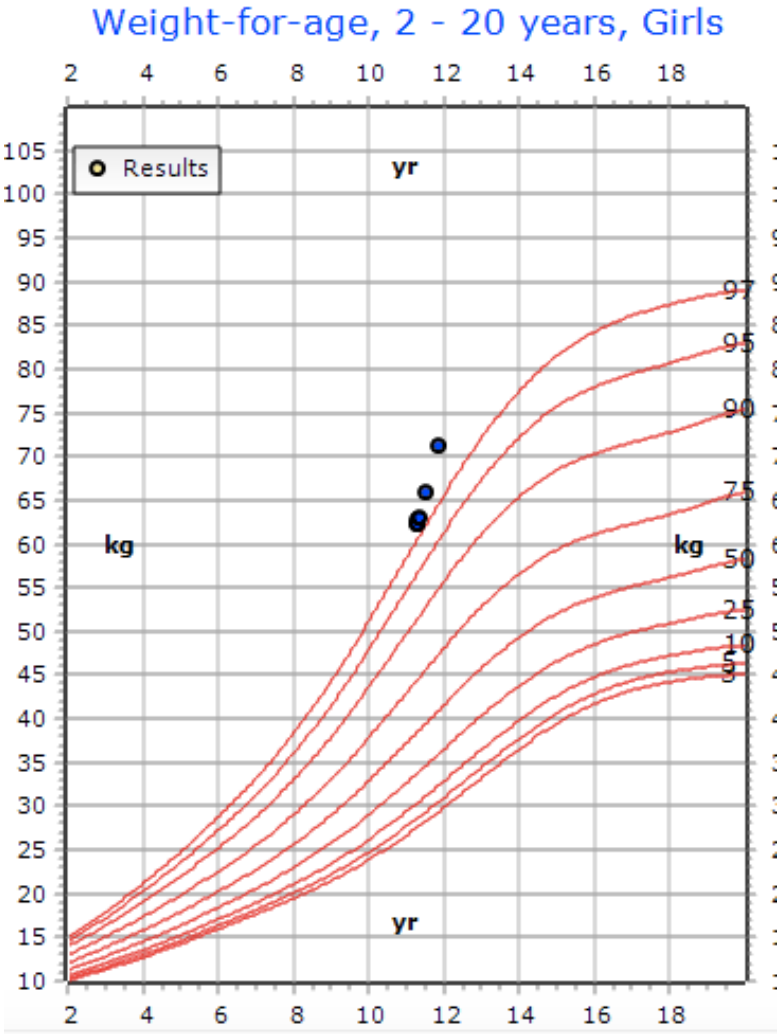
3rd hour:
By 3rd hour, patient should be in ICU
Start / continue insulin drip
Change fluids to contain potassium (see below)

PEDS ER – SCENARIO 2

- 14-year-old female referred to ER for abnormal outpatient labs ordered by PMD (blood glucose on chemistry 354)
- No polyuria, polydipsia, or unintentional weight loss
- No family history of diabetes
- Has gained about 15 pounds over pandemic
- Family has noticed darkening of the skin around the neck which they thought was from her necklace

PEDS ER – SCENARIO 2

- **Vital signs:** within normal limits
- **Physical exam:** well-appearing, NAD, acanthosis on anterior/posterior neck and axilla region
- **Labs:**
- Glucose 280
- Bicarb 22
- pH 7.36
- UA with trace ketones
- hemoglobin A1c 8.0%



RECOMMENDATION (B)

Screening and Diagnosis

- Children and adolescents with overweight or obesity in whom the diagnosis of type 2 diabetes being considered should have a panel of pancreatic autoantibodies tested to exclude the possibility of autoimmune type 1 diabetes.

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RECOMMENDATION **(A)**

Management

Pharmacologic Management:

- In incidentally diagnosed or metabolically stable patients with an A1c < 8.5% and asymptomatic, Metformin is the initial pharmacologic treatment of choice if renal function is normal

↓

Get baseline LFTS

RECOMMENDATION (B)

Management

Pharmacologic Management:

- Youth with markedly hyperglycemia with blood sugar ≥ 250, A1c ≥ 8.5 (without acidosis) at diagnosis who are symptomatic with polyuria, polydipsia, nocturia, and/or weight loss, should be treated initially with basal insulin while metformin is initiated and titrated.

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RECOMMENDATION (E)

Management

Pharmacologic Management:

- Patients treated with basal insulin up to 1.5 units/kg/day who do not meet A1c target should be moved to multiple daily injections with basal and premeal bolus insulins.

PEDS ER – SCENARIO 3

- 18-year-old male with T1DM with 3 days of vomiting and abdominal pain. Blood sugars have been ranging 60-150
- **Physical exam:** tired appearing, oral mucosa dry, delayed capillary refill
- **Labs:**
- Glucose 100
- Bicarb 20
- pH 7.35
- UA with negative ketones ←

Don't forget patients with diabetes can also get… gastroenteritis, appendicitis, UTIs etc.

ACUTE PEDIATRICS – SCENARIO 1

- Sign out from day team → night team
- "13-year-old female with new onset diabetes (likely type 1), presented with polyuria, polydipsia, and weight loss not in DKA , now admitted to pediatrics for initiation of insulin and diabetes education. Glargine due at 10 PM increased to 24 units, ICR 8, ISF 30. Page endocrine with dinner d-stick, and then 10 PM and 2 AM if d-stick > 250"

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Total daily dose (TDD):
0.5-1 units/kg/day

- 50% → long acting
- 1500 -1800 / TDD → ISF
- 450-500 / TDD → ICR

Age	Starting total daily insulin
0-5 yrs	0.4 - 0.5 units/kg/d
5 yrs-puberty	0.6 - 0.8 units/kg/d
Puberty -18 yrs	0.9 - 1.2 units/kg/d

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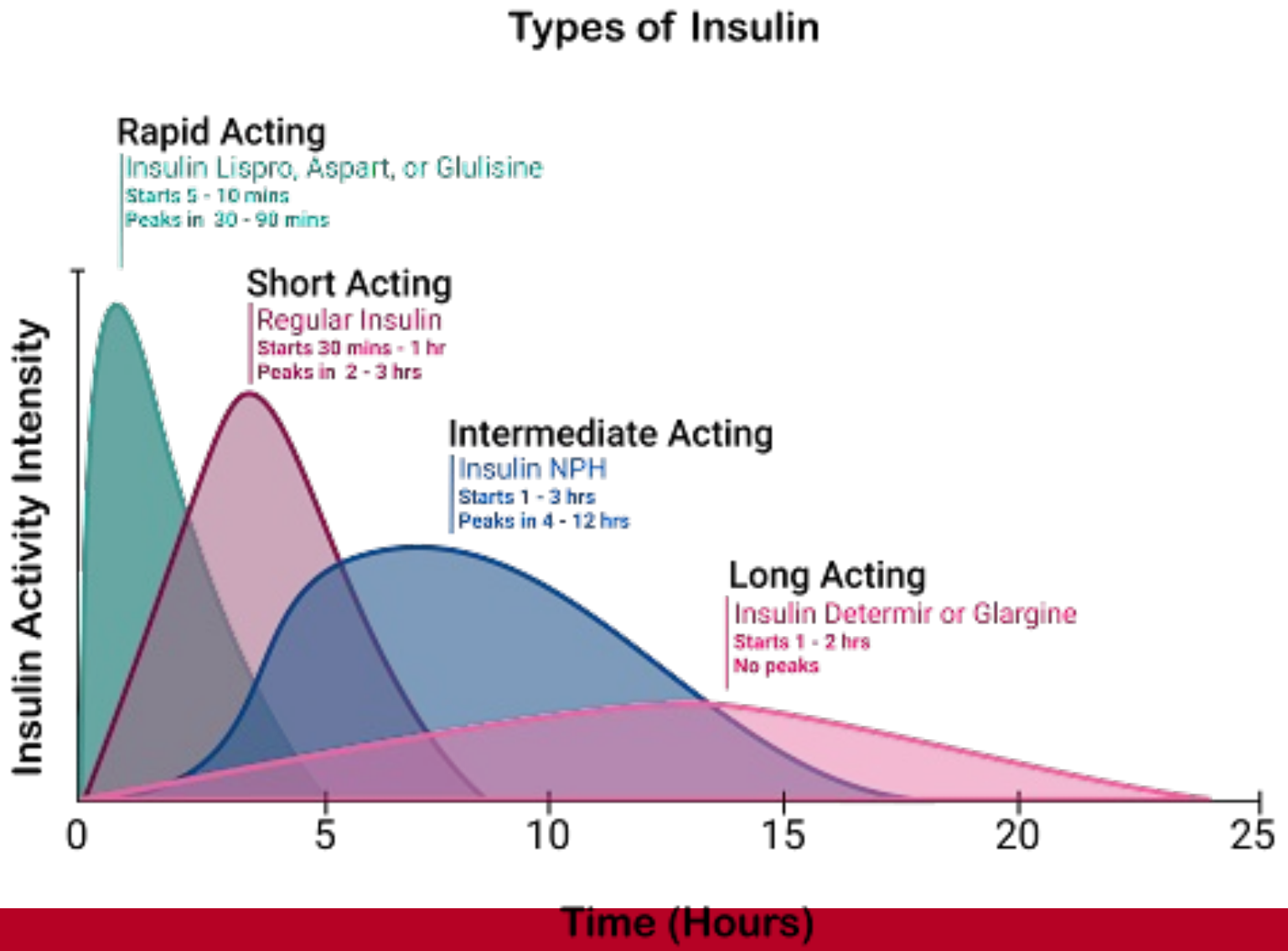
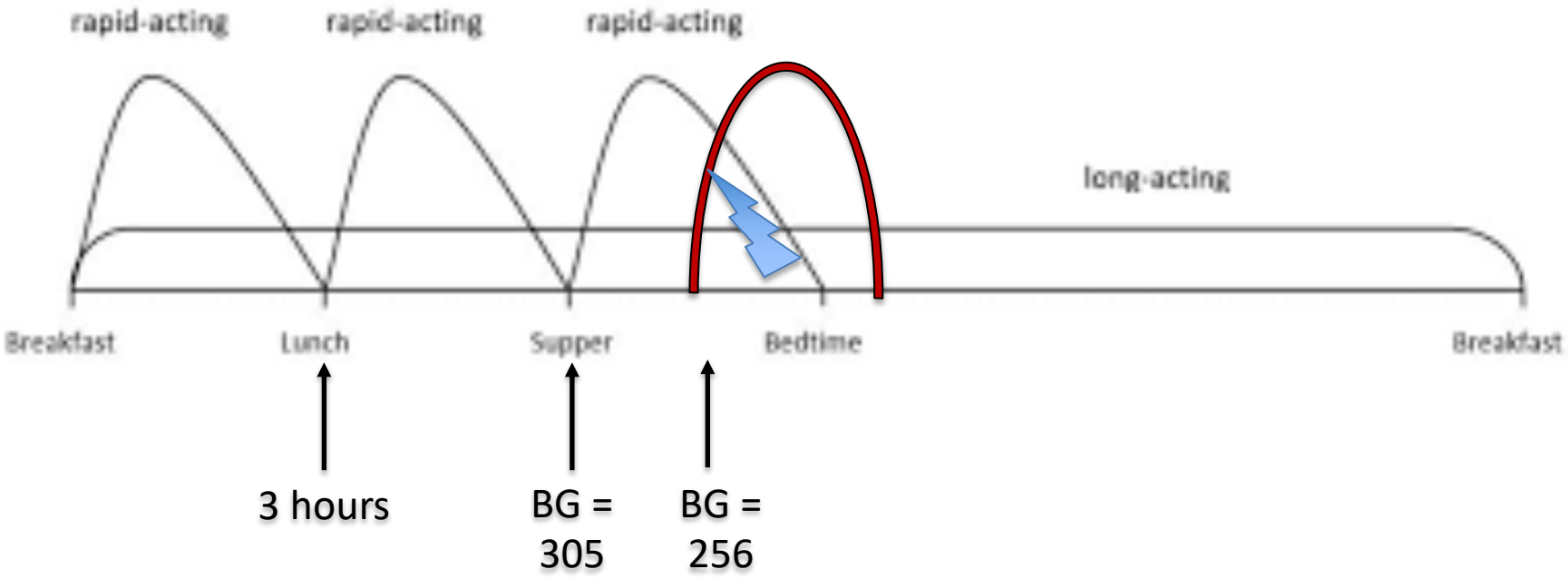
INSULIN ACTION CURVES



INSULIN REGIMEN

MDI = multiple daily injections



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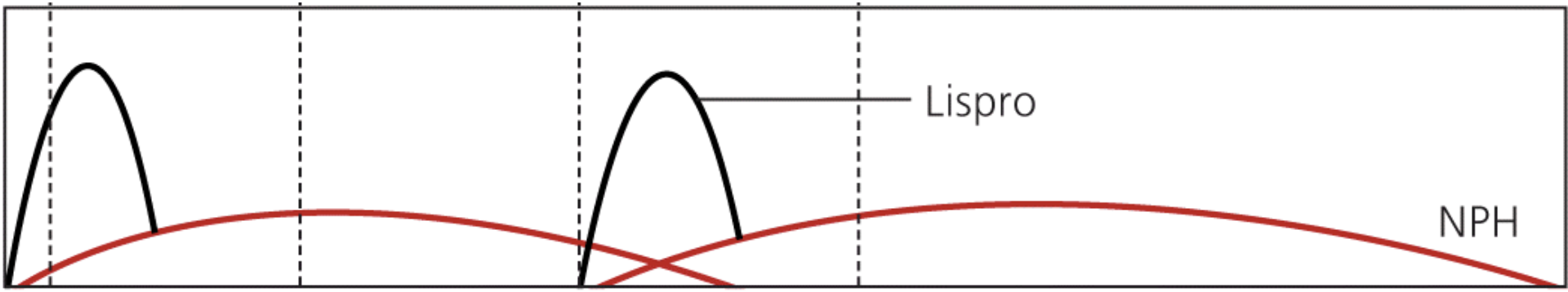
INSULIN REGIMEN

Twice daily injections

75 g carbs 75 g carbs 75 g carbs



B L D

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INSULIN REGIMEN

Twice daily injections

17-year-old male takes 40 units of 75/25 mixed pen in AM and 20 units in evening

40 x 0.75 = 30 units NPH
40 x 0.25 = 10 units lispro in AM

and

20 x 0.75 = 15 units NPH
20 x 0.25 = 5 units lispro in PM

ACUTE PEDIATRICS – SCENARIO 1

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Long-acting insulin: Glargine, Lantus, Basaglar, Levemir should be given once every 24 hours – always check the MAR!

ACUTE PEDIATRICS – SCENARIO 1

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How do we decide on insulin dose changes?

Pre-breakfast: 321
Pre-lunch: 180
Pre-dinner: 140
Bedtime: 151
2 AM: 290

Pre-breakfast: 101
Pre-lunch: 280
Pre-dinner: 300
Bedtime: 320
2 AM: 140

Pre-breakfast: 150
Pre-lunch: 170
Pre-dinner: 110
Bedtime: 280
2 AM: 54

ACUTE PEDIATRICS – SCENARIO 1

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Insulin to carbohydrate ratio aka ICR:

- **Grams of carbs / 8**

Insulin sensitivity factor aka ISF:

- **(Blood sugar – 120) / 30**

Add and round to nearest unit for total meal time dose

ACUTE PEDIATRICS – SCENARIO 1

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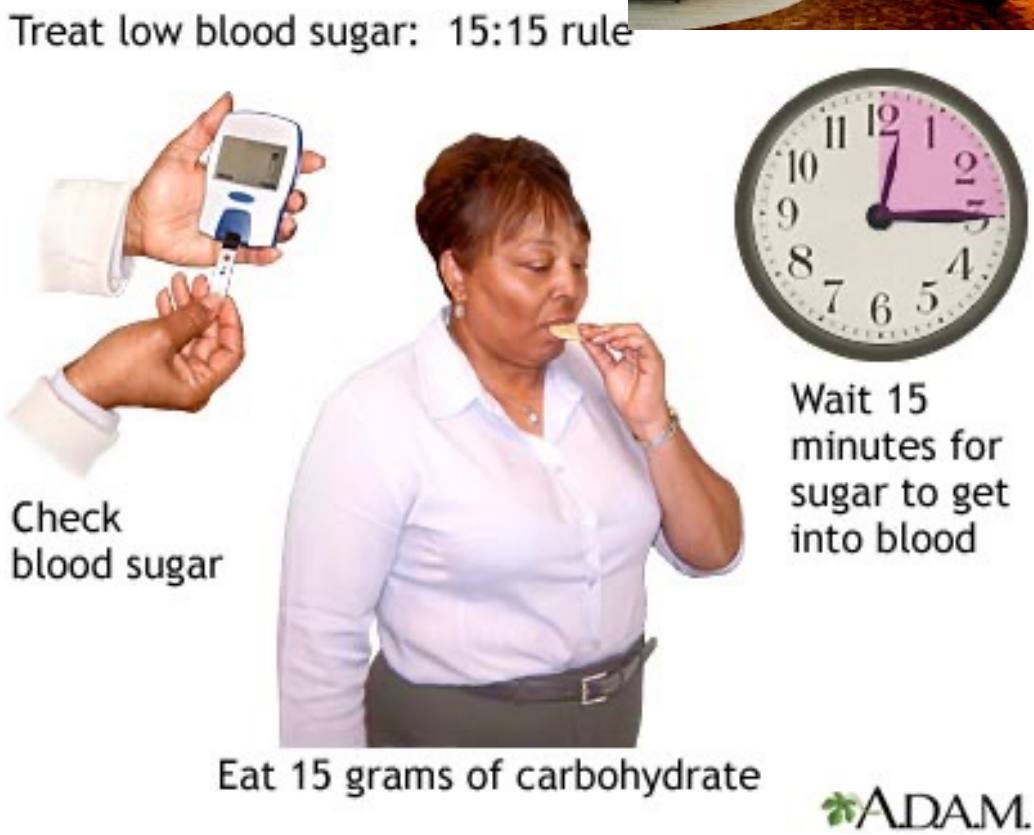
At diagnosis, may be more sensitive to insulin – more cautious with overnight corrections, want to avoid hypoglycemia

ACUTE PEDIATRICS – SCENARIO 2

- Nurse informs you 2 AM blood sugar is 67
- Hypoglycemia < 80
- Rules of 15's



ACUTE PEDIATRICS – SCENARIO 3

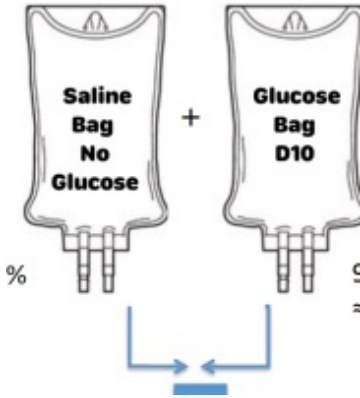
- Rapid response called – patient with new onset T1DM is having seizure
- D-stick is 32
- < 20 kg: 0.5 mg of glucagon, > 32 kg 1 mg glucagon IM

ACUTE PEDIATRICS – SCENARIO 4

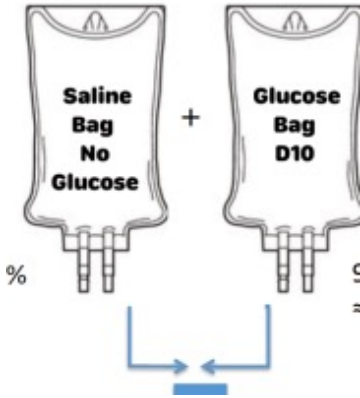
- Nurse informs you patient vomited 4 times and has abdominal pain
- Checked MAR and never got glargine dose
- UA with large ketones, bicarb now 8, pH 7.19
- **What next?**
- Transfer to PICU for insulin drip

PICU- SCENARIO 1

- " 6-old-male with new onset diabetes (likely type 1), admitted to PICU with DKA. Was started on insulin drip and 2 bag system per DKA protocol. D-sticks q1hr, page endocrine once patient transitioned."



2 Bag System to Allow Rapid Titration of Dextrose:



- Each bag contains 0.45% NaCl + the appropriate amount of potassium.

The bags **differ** as follows:
Bag A: 0.45% NaCl +/- 20 mEq/L KCl + 20 mEq/L Kphos
Bag B: Contains D10% + 0.45% NaCl +/- 20 mEq/L KCl + 20 mEq/L Kphos

Potassium concentration: Add equal amounts of KCl and Kphos
If K < 5: Add 20 mEq KCl/L + 20 mEq Kphos/L
If K > 5: Decrease the total K+ in the fluids to 20 mEq/L
If K > 5.5: Omit the K+ from the fluids

Dextrose: Add when serum glucose is < 350 mg/dL. The rate should be periodically adjusted to maintain the blood sugar in the **150-300 mg/dL range**

- Increase dextrose by increasing the rate of Bag B and decreasing the rate of Bag A.
- Decrease dextrose by decreasing the rate of Bag B and increasing the rate of Bag A.

Table: Two bag system method: calculating delivered dextrose.

Desired Dextrose Delivery Concentration	Total Rate (as %) of Bag A (D_0)	% Total Rate of Bag B (D_{10})	Glucose
D_0	100 %	Off	> 350
D_5	50%	50%	250-350
D_{10}	Off	100%	< 250
Bag A → D0 1/2NS +/- Kphos +KCLo ← D10 1/2NS +/- Kphos +KCLo ← Bag B			< 150 *Decrease the insulin drip with the PICU attending

2 Bag System to Allow Rapid Titration of Dextrose:

Sodium bicarbonate is almost never necessary in the treatment of DKA.

Any consideration of bicarbonate administration requires the input of the Endo or PICU attending.

Neurological Complications

o Every patient with DKA is at risk for cerebral edema.

o Signs and symptoms – change in mental status, bradycardia, hypertension, dilated or unequal pupils, respiratory failure, incontinence, vomiting after initial improvement

o For neurologic deterioration consider mannitol (0.5 – 1 gram/kg) and head CT

If intubation is necessary use strict increased ICP precautions

PICU- SCENARIO 2

- " Patient's anion gap close, ready to transition to subcutaneous insulin"
- Resolution of DKA = improved acidosis with HCO3 > 15-18 and closing of anion gap
- Transition to subcutaneous insulin at mealtime / when patient is ready to eat

Sample Menu: Carb Counting

Breakfast:
1/2 cup orange juice= 15
2 slices (2 oz.) whole-wheat toast= 30
1 soft-cooked egg= 0
2 tsp. Margarine= 0
Total grams carb= 45

Lunch:
2 slices (2 oz.) rye bread= 30
2 oz. sliced turkey= 0
2 lettuce leaves= <1
1 tsp. mayonnaise= 0
1 small bag (3/4 oz.) pretzels= 15
1 small (4 oz.) apple= 15
Total grams carb= 60

Dinner:
3oz. baked chicken breast= 0
1/2 c. mashed potato= 15
1/2 c. cooked carrots= 5
1 small (1 oz.) dinner roll= 15
2" brownie square= 15
Total grams carb= 50

Snack:
1/2 c. juice-packed fruit cocktail= 15
10 peanuts= 0
Total grams carb= 15

1. Order pediatric diabetic diet
2. Order glargine STAT
3. Once Glargine given, discontinue insulin drop AND all fluids 20-30 minutes later
4. When meal tray arrives → get pre-meal d-stick → page endo for lispro dosing BEFORE eating if > 6 years and AFTER eating if < 6 years or very picky → order lispro STAT
5. Transfer to endocrine service for continued DM education

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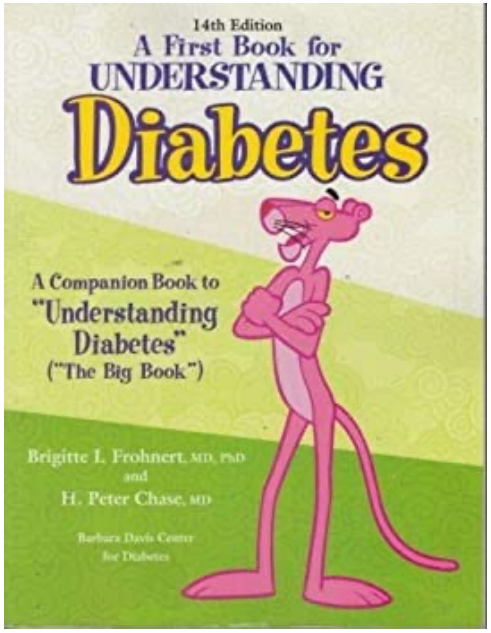
PICU- SCENARIO 2

- What happens during diabetes education?



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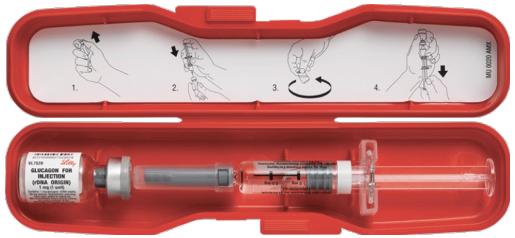
DIABETES SUPPLIES



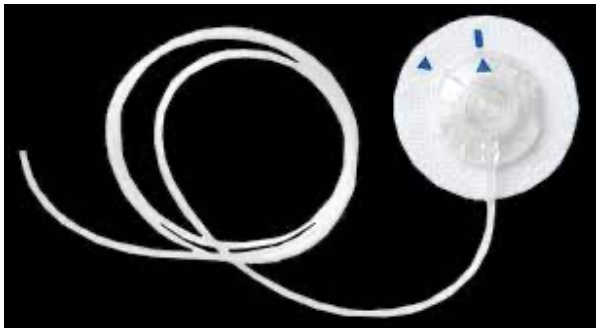
PICU- SCENARIO 3

- " Patient admitted to PICU with known T1DM in DKA secondary to pump failure, now with improved acidosis ready to transition to subcutaneous insulin"
- Does patient have pump supplies and insulin with them?
- What are pump supplies?

Insulin

Pump

Reservoir



Infusion set

OUTPATIENT ENDOCRINE CLINIC

- 7-year-old female with T1DM here for follow up visit
- Currently wears Omnipod and Dexcom CGM
- “Concerned that she has been having lows with exercise"

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INSULIN PUMPS

T-slim = control IQ →

↑

Omnipod = tubeless

Medtronic = auto-mode →

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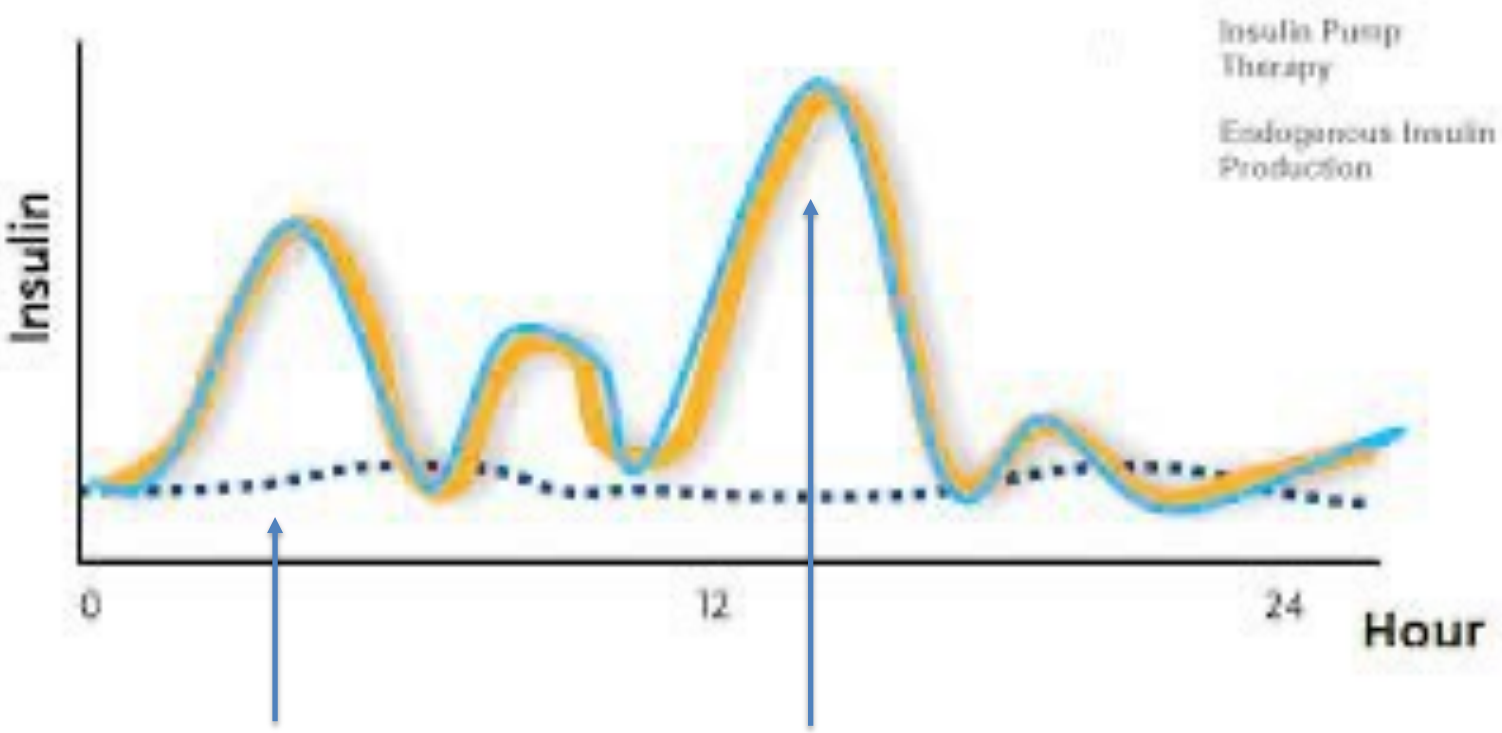
INSULIN PUMPS



Basal Insulin = background insulin / takes place of long-acting insulin (units/hr)

Bolus Insulin = Uses programed ICR and ISF

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INSULIN PUMPS

Basal

Maximum Basal Rate	35.00 U/hr
Temp Basal Type	Insulin Rate (U/hr)

Standard (active)

24-Hour Total	15.70 U

TIME	U/hr
0:00	0.40
8:00	1.05
11:00	0.60
17:00	0.85
22:00	0.75

Pattern A

24-Hour Total	66.80 U

TIME	U/hr
0:00	1.85
5:30	3.05
12:00	3.25
18:00	3.30
22:00	2.05

Pattern B

24-Hour Total	197.20 U

TIME	U/hr
0:00	8.50
11:30	6.80
17:30	10.20
22:30	5.10

Bolus

Maximum Bolus	25.0 U
Dual/Square (Variable)	On
Blood Glucose Reminder	Off

Easy (Audio) Bolus	On
Entry (Step)	0.50 U

Bolus Wizard	On
Units	g, mg/dL
Active Insulin Time (h:mm)	8:00
Insulin Concentration	–

Missed Bolus Reminder	–

Start (h:mm)	End (h:mm)
--	--

Carbohydrate Ratio (g/U)

TIME	Ratio
0:00	20.0

Insulin Sensitivity (mg/dL per U)

TIME	Sensitivity
0:00	40

Blood Glucose Target (mg/dL)

TIME	Low	High
0:00	80	160

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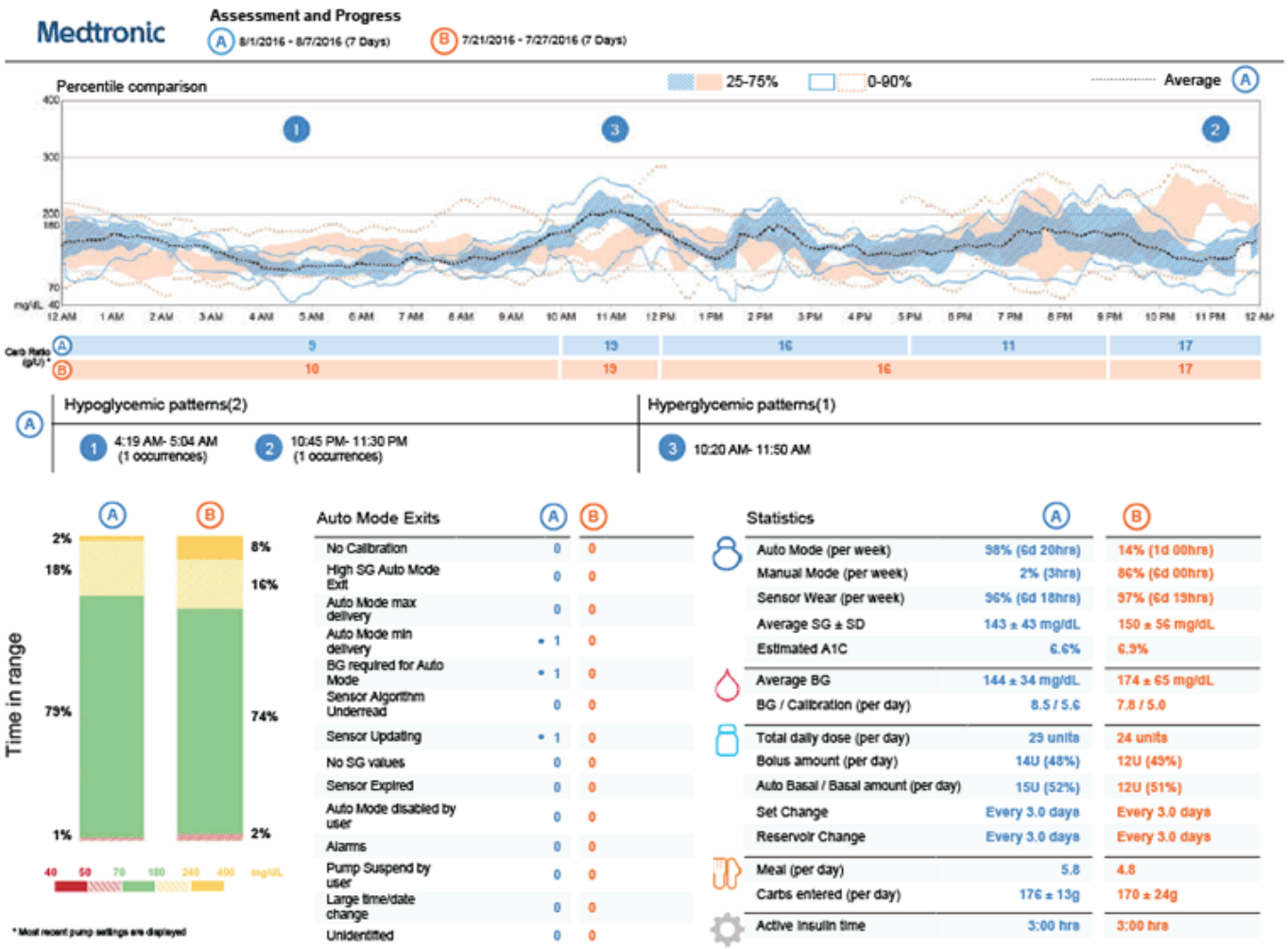
INSULIN PUMPS



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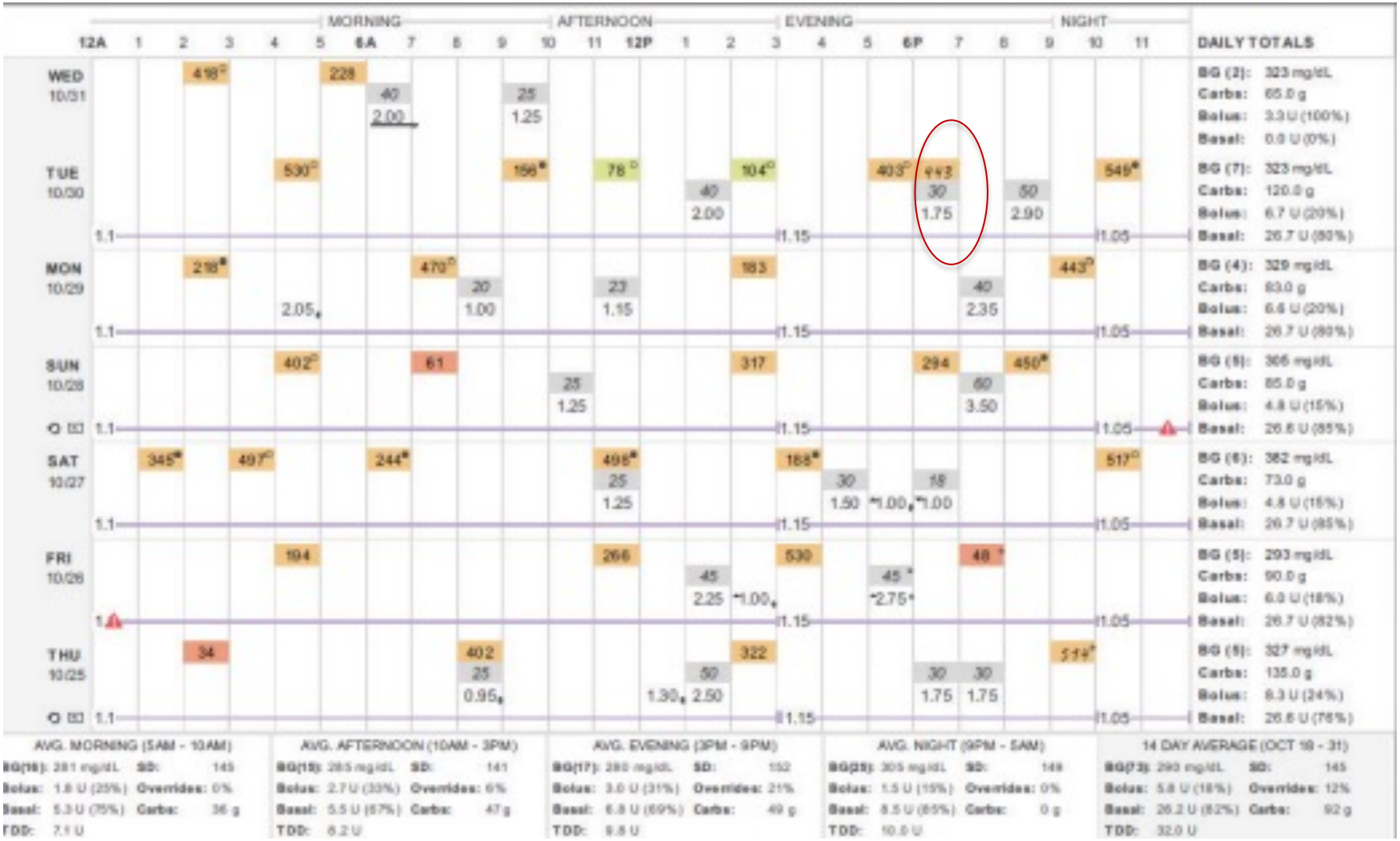
INSULIN PUMPS



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CONTINUOUS GLUCOSE MONITORING

Dexcom G6

Medtronic Guardian

Freestyle Libre

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CONTINUOUS GLUCOSE MONITORING

Average Glucose

151 mg/dL

Time in Range

4% Very High

20% High

74% In Range

1% Low

<1% Very Low

Target Range:
70-180 mg/dL

Sensor Usage

Days with CGM data

100%

14/14

Standard Deviation

52 mg/dL

GMI

6.9%

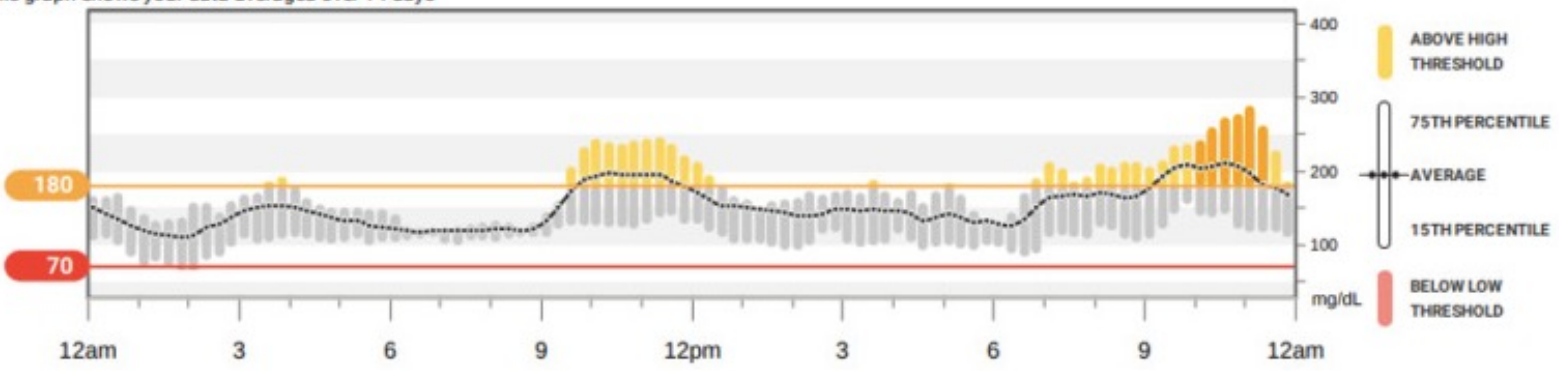
Avg. calibrations per day

0.0

Top Patterns

1. had a pattern of nighttime highs
   had a pattern of significant highs between 10:15 PM and 11:25 PM.
2. best glucose day was January 22, 2021
   glucose data was in the target range about 89% of the day.

This graph shows your data averaged over 14 days



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AUTOMATION

QUESTIONS?