New Onset Type I Diabetes and Diabetic Ketoacidosis

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Disclosure

- Nothing to disclose

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- Special thank you to Dr. Al Nofal for sharing some of his slides for this presentation

"You're not allowed to use the sprinkler system to keep your audience awake."

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Objectives

- **Discuss reasons why patients with Type 1 diabetes omit insulin**
- **Review current technologies to help manage Type 1 diabetes**

Case#1

- 7 year old girl presents to the ER with 2 day history of frequent urination, dysuria, lower abdominal pain, and vomiting
- She had 2 episodes of emesis in the last 2 days
- Family did not notice polydipsia
- No weight loss
- No significant past medical history

Case#1

- Vitals are normal except for mild tachycardia
- Exam is positive for tenderness in the lower abdomen on palpation
- Laboratory evaluation:
  - Glucose 135 mg/dl
  - Sodium 141 mg/dl
  - Bicarbonate 22 mmol/l
  - UA shows
    - Glucose – negative
    - Ketones – 15 mg/dl
    - WBC – 15-20
    - Leukocytes esterase - positive

Case#1

- The most likely diagnosis

1. DKA
2. Urinary tract infection
3. Diabetes insipidus
4. Gastroenteritis

Case#2

- 7 year old girl presents to the clinic with 2 day history of frequent urination
- Family reports that she has been “drinking a lot of water this summer”
- Lost 7 pounds over the last month
- No past medical history

Case#2

- Vitals are normal except for mild tachycardia (BMI on the 25th percentile)
- Exam is positive for mild tenderness in the lower abdomen on palpation
- Laboratory evaluation:
  - Glucose 565 mg/dl
  - Sodium 130 mg/dl
  - Bicarbonate 23 mmol/l
  - UA shows
    - Glucose – 1000 mg/dl
    - Ketones – 80 mg/dl
    - WBC – 0-5
    - Leukocytes esterase - negative

Case#2

- The most likely diagnosis

    1. DKA
    2. Urinary tract infection
    3. Diabetes mellitus
    4. Gastroenteritis

Diagnosis of diabetes

- Fasting plasma glucose ≥ 126 mg/dl
- 2-PG ≥ 200 mg/dl during OGTT
- HbA1c ≥ 6.5%
- Random plasma glucose ≥ 200 mg/dl

Case#2

- The first step in management:
  1. Metformin 500 mg BID and follow up in 2 weeks
  2. Glargine 1.2 u/kg/dose SQ daily (first dose in clinic) and schedule an appointment with pediatric endocrinology ASAP
  3. Discharge patient home with follow up with pediatric endocrinology tomorrow
  4. Start an IV, give 10 units of insulin IV STAT and arrange a transfer to the ICU for DKA
  5. Have your nurse contact the family, let them know their child has diabetes, and ask them to schedule a follow up with pediatric endocrinology
  6. Call the pediatric endocrinologist to arrange for admission to the hospital for initiation of treatment

Case#3

- 7 year old girl presents to the ER with 2 day history of frequent urination, abdominal pain, and vomiting
- She had 4 episodes of emesis this morning
- Family reports that she has been “very thirsty this summer”
- 7 pounds weight loss over the last month
- No past medical history

Case#3

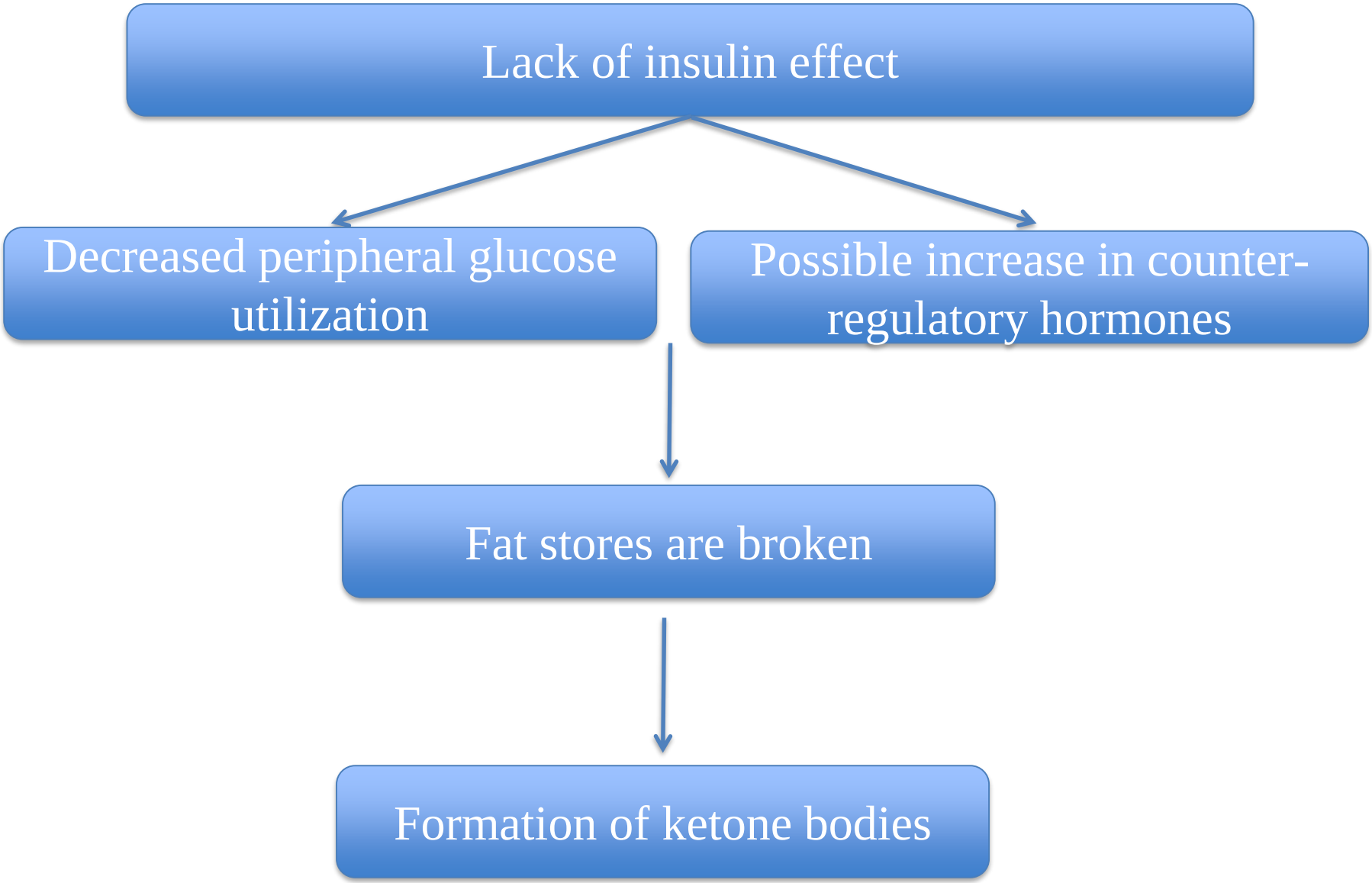
- She is tachypneic and tachycardic.
- Deep and labored breathing
- Exam is positive for tenderness in the lower abdomen on palpation
- Laboratory evaluation:
  - Glucose 456 mg/dl
  - Sodium 129 mg/dl
  - Potassium 5.2 mg/dl
  - Bicarbonate 8 mmol/l
  - UA shows
    - Glucose – > 1000 mg/dl
    - Ketones – 160 mg/dl
    - WBC – 0-5
    - Leukocytes esterase - negative

Case#3

- The most likely diagnosis

    1. DKA
    2. Urinary tract infection
    3. Diabetes insipidus
    4. Gastroenteritis

Pathophysiology



Diagnosis of DKA

- What are the clinical findings of DKA?
  - Abdominal pain, nausea, vomiting
  - Deep, labored breathing
  - Dehydration/Tachycardia
  - Altered mental status
- Laboratory findings?
  - Hyperglycemia (glucose > 200 mg/dl)
  - Acidemia (pH < 7.3 and/or Bicarbonate < 15 mmol/l)
  - Presence of blood or urine ketones

Case#3

- The first step in management:
  1. Start an IV, give 10 units of insulin IV STAT and arrange a transfer to the ICU for DKA
  2. Start an IV, give a 10-20 cc/kg normal saline bolus
  3. Start an IV, give 4 mg of Zofran IV, start insulin drip
  4. Start an IV, start insulin drip at 1 unit/kg/hour
  5. Discharge patient home and follow up with PCP in 2 days

Initial management of DKA

- Assessment and disposition
- Fluid replacement
  - 5-10% dehydrated
  - Start with isotonic solutions
  - Rehydration should take place over 48 hours
  - Fluid therapy will result in reduction of blood glucose concentration

Case#3

- After giving a normal saline bolus, the next step in management is:

    1. Give another 20 cc/kg NS bolus
    2. Administer 1 u/kg of short acting insulin SQ
    3. Reassess the patient, recheck glucose level, start on 1.5 maintenance fluids, and start 0.1 unit/kg/h regular insulin drip
    4. Give IV insulin bolus until transfer to the ICU
    5. Discharge patient home with follow up in 2 days

Initial management of DKA

- Reassess frequently

- Fluid replacement
  - Adjust fluids content based on the patient's electrolytes abnormality
  - Monitor electrolytes closely

Initial management of DKA

- Insulin
  - Essential to correct the metabolic acidosis
  - Should be initiated after starting fluid replacement
  - IV insulin bolus has been associated with increased risk for cerebral edema
  - Initial infusion rate of 0.1 u/kg/h of IV regular insulin is generally an effective dose

Case#3

- 2 hours after patient was started on 1.5 maintenance NS IV fluids, and a 0.1 u/kg/h insulin infusion, her laboratory findings were as follows:

Sodium 143 meq/l
Chloride 110 meq/l
Potassium 4.2 meq/l
Glucose 221 mg/dl
Bicarbonate 10 mmol/l
Phosphorus 3.2 mg/dl

Case#3

- What is the next step in management

1. Give another 20 cc/kg NS bolus
2. Stop the insulin infusion and start SQ insulin since her glucose level is dropping nicely
3. Stop IV fluids but continue the insulin infusion
4. Switch her fluids to ½ NS, add potassium and phos, and decrease her insulin infusion rate to 0.02 u/kg/h
5. Switch her fluids to ½ NS, add potassium and phos, and add dextrose to her IV fluids
6. Discharge patient home with follow up in 2 days

Management of DKA

- Ketosis and metabolic acidosis will not correct without adequate insulin administration

- Glucose should be added to IVF when the blood glucose levels falls below 250-300 mg/dl

Management of DKA/electrolytes

- Sodium:
  - Commonly low at the initial evaluation
    - Osmotic diuresis
    - Intracellular to extracellular shift of water
  - 2 important concepts to watch for:
    - Low rate of rise in sodium concentration during treatment of DKA is associated with higher risk of cerebral edema
    - Excessive sodium and chloride delivery may lead to hyperchloremic metabolic acidosis
  - Monitoring sodium concentration is essential
  - A 0.45-0.9% saline is often used to prevent excessive sodium and chloride delivery

Management of DKA/electrolytes

- Potassium:
  - Can be elevated, normal, or low at the time of presentation
  - With initiation of insulin treatment, potassium level declines
  - Adding 20 meq/l of potassium acetate and 20 meq/l of potassium phosphate to the IVF works well for most patients
  - Potassium concentration should be monitored closely

Management of DKA/electrolytes

- Phosphorus:
  - Concentration is variable prior to initiation of treatment
  - With initiation of insulin treatment, phosphorus level declines
  - The addition of potassium phosphate to the hydration solution is safe and effective

Management of DKA/electrolytes

- Bicarbonate:
  - Current evidence does not support the use of bicarbonate in emergent treatment for DKA
  - There are no studies on children with profound DKA (pH<6.9)
  - Some patients with cardiovascular dysfunction caused by severe acidosis or hyperkalemia may benefit from cautious alkali administration

Complications

- Mortality
  - Mortality rate with treatment is < 0.5%
  - Most of the deaths are due to cerebral edema

Complications

- Cerebral edema
  - Clinically apparent cerebral edema happens in 1% of children with DKA
  - 20-25% mortality rate
  - Permanent neurological consequences in survivors

Complications/Cerebral edema

Which of the following is NOT a risk factor for cerebral edema

1. Fast administration of insulin before fluid replacement
2. Low rate of rise of sodium
3. Treatment with bicarbonate
4. More severe acidosis at presentation
5. Older age

Complications/Cerebral edema

- Signs: (increased intracranial pressure)
  - Headaches
  - Altered mental status
  - Elevated blood pressure
  - Bradycardia
- Management:
  - Brain imaging
  - Manitol
  - Hypertonic saline

Case#3

- After 24 hours of initiation of treatment, patient is awake and alert. She reports no abdominal pain or nausea.
- Her laboratory evaluation shows the following:
  - Glucose 185 mg/dl
  - Sodium 139 meq/l
  - Potassium 3.8 meq/l
  - Bicarbonate 18 meq/l

Case#3

- What is the next step in management:

1. Discontinue IVF and insulin drip, monitor patient in the hospital for 4 hours, and discharge home with insulin prescription
2. Continue current treatment until her bicarbonate is over 25 mmol/l to ensure DKA does not recur
3. Transition patient to SQ insulin regimen while in the hospital
4. Discharge patient home with follow up in 2 days

Converting to Subcutaneous Insulin

- Should be considered when serum bicarbonate is greater than 16-18 mmol/l, and patient is able to begin oral intake
- If DKA has occurred in patient with previous history of DKA, home regimen may serve as a guide for insulin dosing
- For newly diagnosed children with diabetes, a starting dose of insulin at 0.5-1 u/kg/day is reasonable
- Dose is adjusted based on patient's meal plan, level of activity, sensitivity to insulin, pubertal status, etc.

Case # 3

Which of the following regimens is appropriate for this patient?

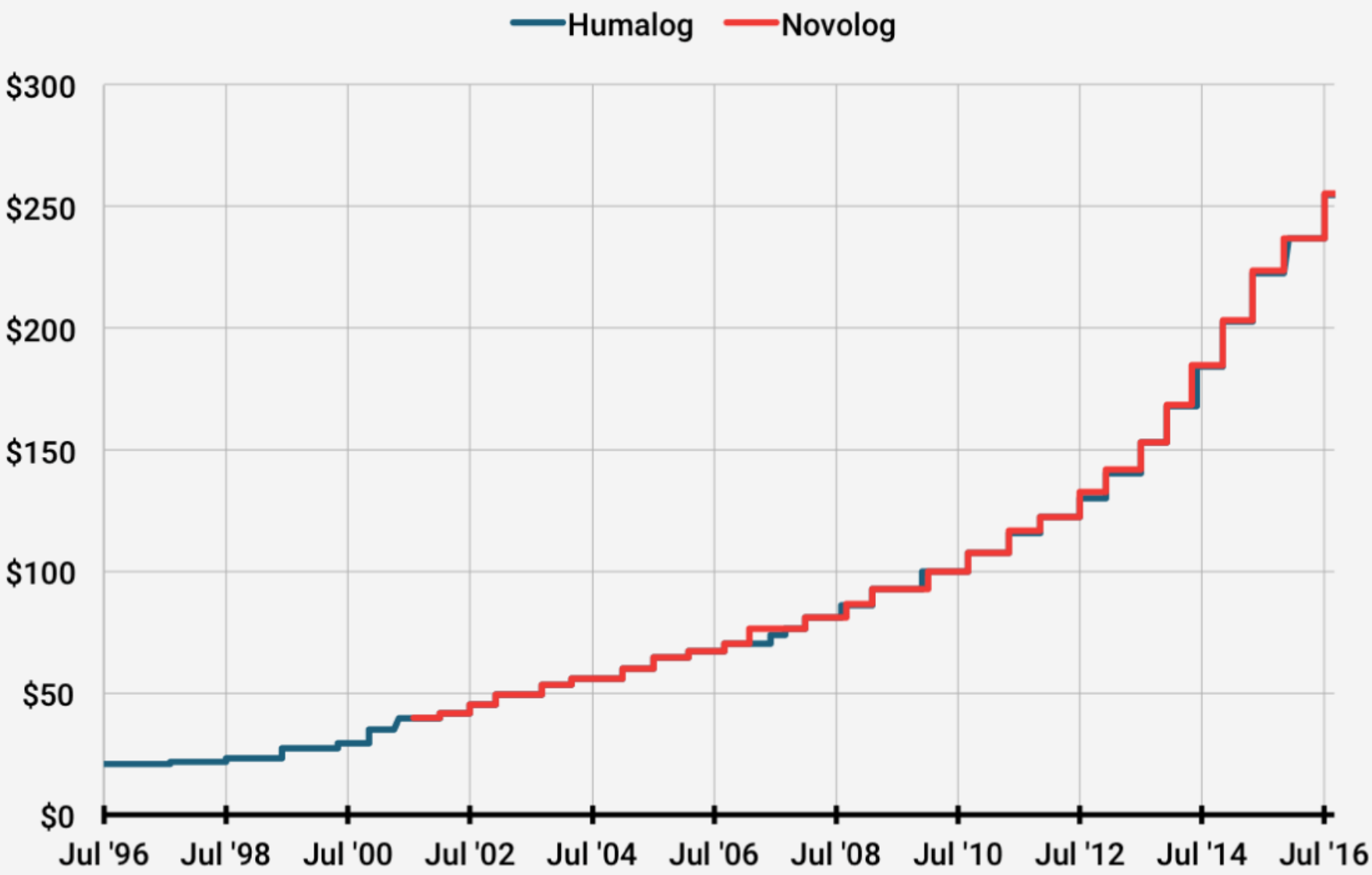
(She is 7 years old, 23 kg)

1. Glargine 10 units in the morning, Aspart 3 units with every meal, ~60 grams of carbs with every meal
2. Glargine 10 units at bedtime, Aspart 1 unit for every 20 grams of carbohydrates
3. Detemir 5 units in the morning and 5 units at night, Aspart 1 unit for every 18 grams of carbohydrate
4. Detemir 11 units in the evening, lispro 1 unit for every 25 grams of carbohydrates
5. All of the above are reasonable regimens

Reasons children/adolescents with known Type 1 diabetes omit insulin

- Weight loss
- Cost
  - 10 mL/1000 unit vial of insulin costs approximately $300
  - For 1500 units in 5 pens costs nearly $600
  - Patients using 1-5 vials per month depending on age and weight of patient
- Family discord (divorce rate is high)
- Needle phobia

RISING INSULIN PRICES

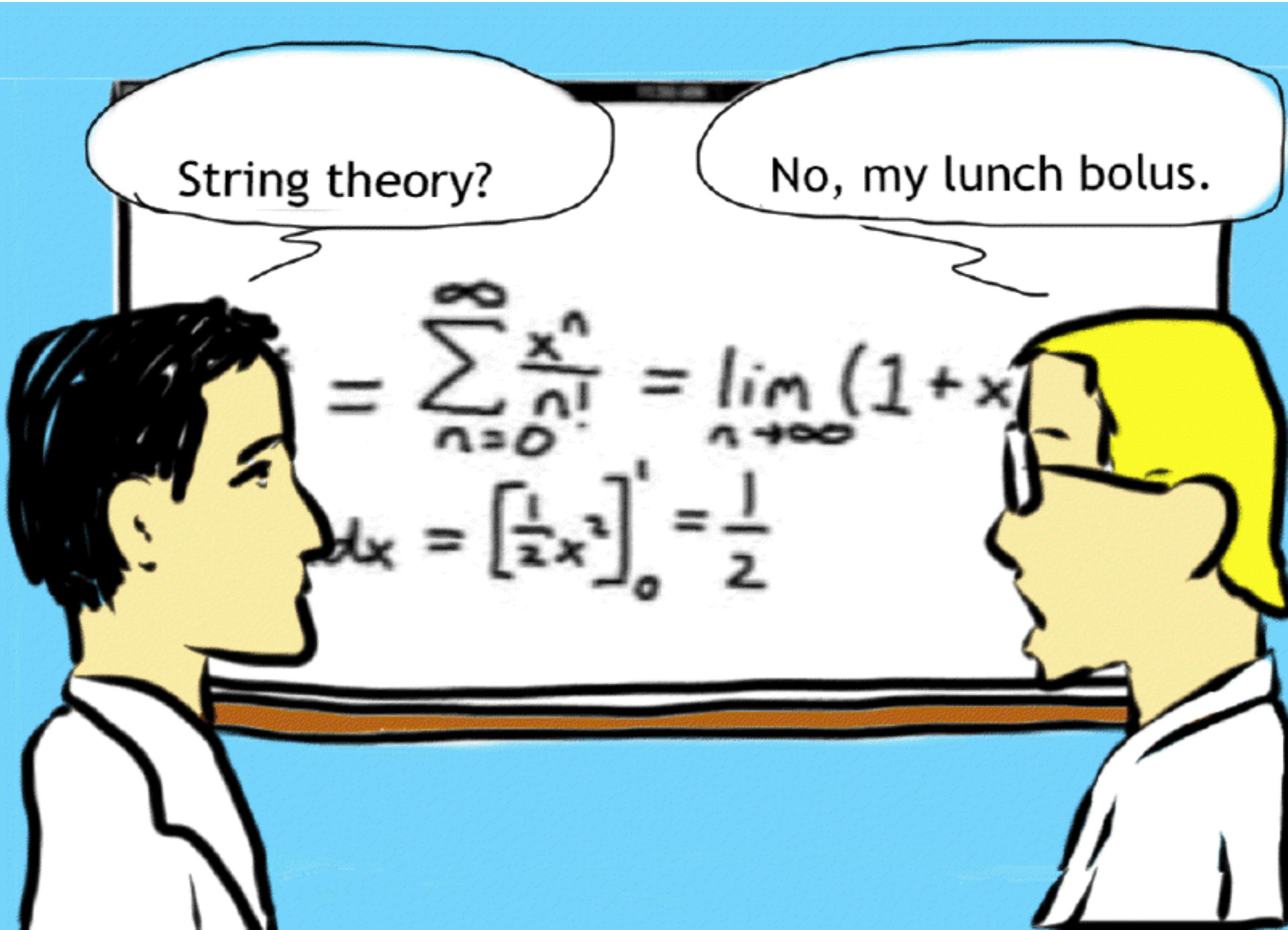


SOURCE: Truven Health Analytics

BUSINESS INSIDER

if diabetics ran the world

- Frustration
  - Maintaining “perfect” blood sugars can be difficult and frustrating
- Don’t want to be different
  - Afraid to give shots or check blood sugars in front of others
  - Bullied or Teased
- Depression
- Pump malfunction/kinked catheter


String theory?
No, my lunch bolus.
$= \sum_{n=0}^{\infty} \frac{x^n}{n!} = \lim_{n \to \infty} (1 + x$
$dx = \left[\frac{1}{2}x^2\right]_0^1 = \frac{1}{2}$

When you feel really confident about your carb counting, then test later on and you're really high...

WHAT?! ...COME ON!!!

Case # 3

Which of the following statements is/are correct about continuous insulin infusion device (insulin pumps)

1. Once patients start using insulin pump they don't need to count carbohydrates
2. Once patients start using insulin pumps they don't need to check their glucose levels
3. Patients on insulin pumps can't play sports
4. Children younger than 8 years of age can't be on insulin pumps
5. Patients using insulin pumps still need to receive long acting insulin daily.
6. Research shows quality of life improvement on insulin pumps compared to injections.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ACT


102


10:37
OK

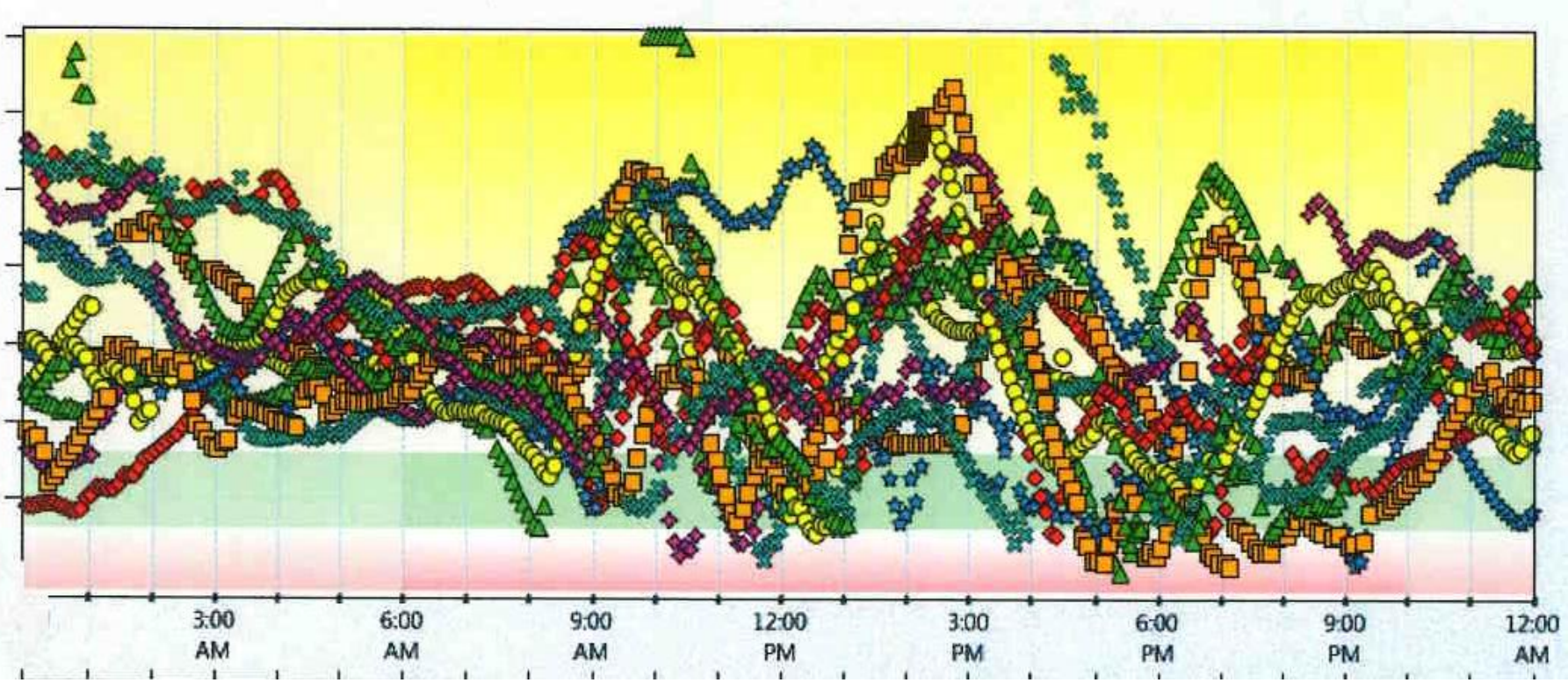

10:10 AM
BOLUS
OPTIONS

Case # 3

- Which of the following is/are correct about continuous glucose monitoring devices (CGM)

1. CGM replaces the need for any blood glucose checks
2. With the current technology, patients using CGMs don’t need to count their carbohydrate intake
3. Research shows no change in quality of life in patients receiving CGM
4. CGM use has been shown to reduce risk of nocturnal hypoglycemia


Start New Sensor
Get Sensor Data
FreeStyle Libre Pro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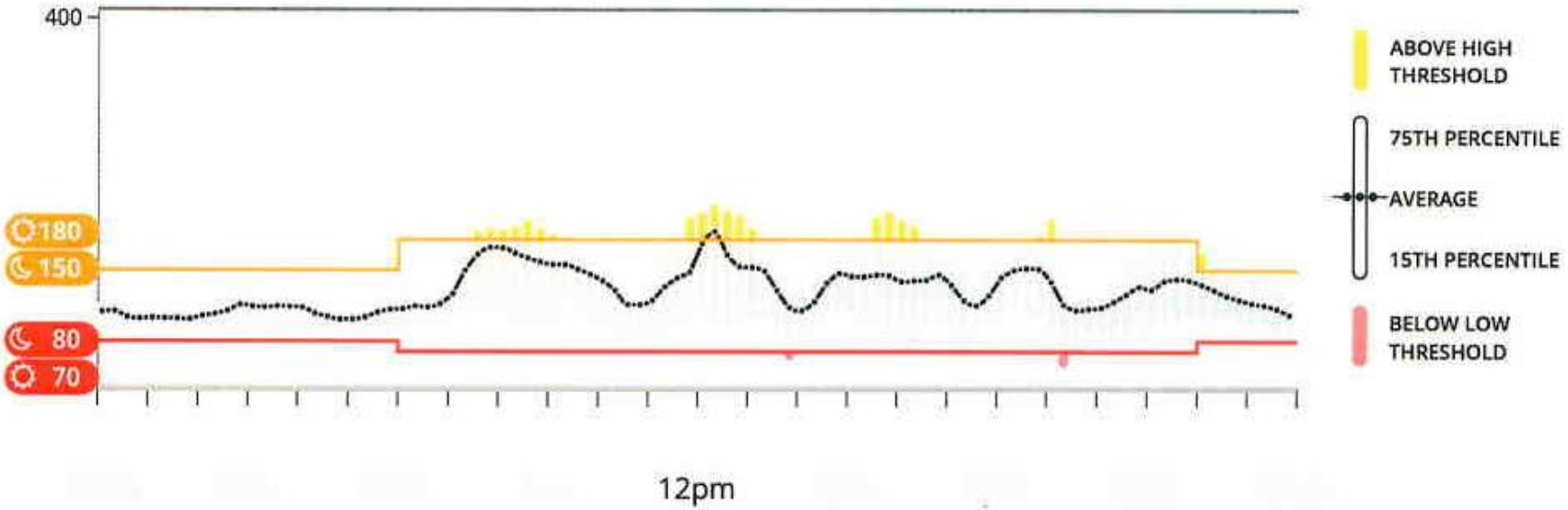
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180
150
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ABOVE HIGH THRESHOLD
75TH PERCENTILE
AVERAGE
15TH PERCENTILE
BELOW LOW THRESHOLD

Take Home Points

- It is critical to recognize signs and symptoms of Diabetes mellitus and DKA in children
- Management of DKA includes rehydration and insulin therapy
- In managing diabetes, children are NOT small adults
- Diabetes technology advancement is opening new doors to better diabetes outcomes and quality of life for patients with diabetes


one day
I would love to say that
I USED
to have
DIABETES

QUESTIONS?

THANK YOU