Exploring the benefits of pump therapy when steroids are needed for type 1 diabetes

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• No disclosures

History
• 8Y 10M female with type 1 diabetes, (T1DM)
• Diagnosed @ 7Y 3M
  – Has history of severe asthma
• Dad with T1DM
  – Patient part of Trial Net study:
    – 4 antibodies ++++ for T1DM
• Initially on low dose insulin
  – 0.38 mg/kg, (lantus 2 units per day)
  – A1c of 7.2 then 7.1%
• Celiac & thyroid screening: negative
History, cont.

- 7 months post Dx
  - A1c was 7.6%,
  - Total Daily Dose TDD = 0.8 u/kg/day,
  - Lantus 8 units per day.
- 11 months post Dx
  - A1c up to 9.6,
  - TDD 1.1 u/kg/day
  The family & team are working on dose adjustments, sugar averages were around 200

Illness care

- 14 months post Dx: severe asthma flare up,
  - on steroids, hospitalized several days,
  - initially extreme SOB, intense respiratory care, IV fluids.
  - steroids (IV then po) & faded honeymoon caused numbers to remain high, despite diligent sick plan care.
- Next clinic visit, insulin pump therapy suggested
  - Working hard without ability to intensify as desired
- 18 months post Dx: A1c 9.3% on 1.2u/kg/day.
  - Focused on number stabilization; off steroids once again
  - With all classes finished, they are ready for pump therapy.

Starting pump therapy

- TDD 26 units, Lantus 10 units (38%)
- 1.2 u/kg/day
- Target 130, sensitivity 65
- Ratio bkfst 18, lunch 18, supper 16
- A1c 9.3%
- To calc basal:
  - Lantus 10 units x 80% = 8 divide by 24 hours = 0.33
  - TDD 26 x 40% = 10.4 x 80% = 8.32 divide by 24 hr. = 0.35
- Has slight dawn effect starting basal:
  - MN 0.35 u/hr
  - 0400 0.4 u/hr
  - 0900 0.35 u/hr
Adding electronics!

• Pump therapy began!
  – Soon after sensor technology was added!
• School started: slight cold tipped into severe asthma
• Hospitalized again for asthma:
  – IV therapy, steroids, oxygen & continuous breathing treatments for several days
• Sensor use, along with frequent testing
  – PLUS employing extra pump features:
    – (basal pattern A, temporary basal)
• These helped ease the stress as not available on multiple daily injections (MDI)

Hard work pays off: Success

• Follow up A1c 7.6%!!
  – Even with 2 asthma flare ups (one very severe).
  Mom was amazed @ management with pump: (targeted dosing, temp basal, incremental changes every 2 hrs)
  – pattern A @ 160% basal,
  – plus use of temp basal rates b/w boluses, +10-30%
  – sensor use for between meal glucose assessment
  – Pump therapy allow ease of use to keep her safe (100 to 200 area, instead of over 300)
    during the whole illness & as steroid effect waned.

Goal of discussion today:

• Compare insulin action times for multiple daily injections (MDI) and insulin pump therapy
• Discuss sick care using separate basal pattern for illness, temporary basal, and sensor
• Explore benefits to pump therapy as related to overall quality of life.
Type 1 pathology

- Loss of insulin production from islet cells of pancreas (auto-immune)
- Associated with ketone production and diabetic ketoacidosis (DKA)
- Defined: look at clinical picture
  - Random sugar over 200
  - Fasting over 126
  - A1c > 6.5% ** (do 2-hour glucose tolerance)
  - Presence of ketones (+/-)
  - Presence of ICA 512, GAD 65, insulin AB, triangle (to Barbara Davis)

Auto-immune

- Body makes antibodies that destroy the beta cells: unable to make insulin
- Triggers
  - Genetic predisposition (HLA type)
  - Environmental triggers: viral, food, toxins, stress

Other screening labs:

- Thyroid antibodies: free T4, TSH, (17-30%);
- Celiac (TTG IgA, IgA) (1-16%),
- Look at growth, weight loss, diarrhea, abdominal pain, malabsorption, unexplained lows and deteriorating A1c, erratic blood sugars, fatigue may need to re-screen
- Random cholesterol
- If question the type of diabetes: IC 512 & Gad 65 AB, Insulin AB, Triangle test, zinc transport AB

Trial Net study

- Status: Recruiting over 200 sites
- Eligibility Criteria
  - To be screened, you must fulfill at least one of the two conditions below:
    - 1 to 45 years of age and have a brother, sister, child, or parent with type 1 diabetes
    - 1 to 20 years of age and have a cousin, aunt, uncle, niece, nephew, half sibling, or grandparent with type 1
- About this Study
  - Study Development of T1DM: study people at increased risk T1DM, learn how T1DM occurs.
  - TrialNet is screening close blood relatives of people with type 1 diabetes
  - Relatives of people with T1DM have a 10 to 15 times greater risk for developing the disease than people with no family history.
- Screening
  - The study divided into two parts: Screening and Monitoring.
  - Screening tested for diabetes-related autoantibodies in the blood.
  - Autoantibodies are proteins made by the body’s immune system. If these proteins present, it could mean that cells in the pancreas which produce insulin are damaged. Certain kinds of autoantibodies can be found in the blood years before type 1 diabetes occurs.
  - If the screening blood tests show that you have autoantibodies, we will ask you to participate in the monitoring part of the study.
- OGT1 annual
Type 1 Incidence

- 5-10% of total population with diabetes
  - 85% pediatric diabetes is type 1
  - 30% are overweight at diagnosis
  - 1 in 300-400 kids
  - Most common auto-immune condition in children
- Can occur at any age
  - Average age of onset is 4-11 years
- Equal incidence: gender, socioeconomic status

Type 1 Diabetes

- Insulin producing cells are destroyed by antibodies = hormone deficiency
- Requires insulin injections to sustain life → hormone replacement therapy
- Chronic Condition
  - Child < 6-7 years not recognize lows
  - < 5 year at risk for permanent cognitive impairment post severe low
  - Younger diagnosed: ↑ risk for Beta cell failure

Symptoms

- Frequent urination
- Increased thirst
- Hunger
- Night time urination
- Bed wetting
- Weight loss
- Muscle pains and cramps
- Weakness, malaise
- Abdominal pain
- Shortness of breath
- Vomiting
- Confusion, coma
- Signs of concurrent infection

*On pump: abdominal pain & vomiting may be 1st symptom*
Insulin action times

- **Basal:** Lantus = 24 hours, Levemir (bid)
- **Bolus:** insulin analogs
  - Humalog, Novolog, Apidra
    - Start in 5-10 min., peak in 60-90 min.,
    - Lasts 120-180 minutes
- **Other:**
  - NPH:
    - Starts in 1-2 hours, peaks in 6-8 hrs., gone in 12 hours (rarely used, helps with dawn effect)
  - Regular is the only insulin used in IV

Multiple daily injections (MDI): Safer
- Allows for flexibility: amount, timing, the frequency one eats, plus allows adjustment for activity.
- Reduces wide fluctuations in BGs
- Allows for sick care dosing every 2 hours

Treatment: Flexible insulin Dose Calculations

Multiple daily injections (MDI)

- **Math for mealtime (Bolus)**
  - Correction if blood sugar is over target
  - PLUS bolus for food

Terms:
- **Target** is listed in mg/dl; is age specific
- **Sensitivity** = how much 1 unit decreases the sugar (age specific)
- **Ratio** = amount of insulin needed for food: may vary meal to meal

Why Flexible?

- In all age groups, flexible is associated with reaching glucose targets (easier to obtain control)
- Less fluctuation in BG numbers linked to better academic performance
- Children in optimal control → adults in optimal control?
- Complication reduction?
- Sick care based on insulin action time
- If miss 1 meal bolus qod: ^ Alc by 1%
Long acting insulin

• Lantus (or levimir)
  – TDD (40%)
  Lower amount if
  • Lean
  • Athletic
  • Young in age group
  • ? Less ill at diagnosis
  At DX: 0.2 u/kg

• Impacted by
  – Developmental age
  – Food choices
  – Level of athleticism
  – Genetics
  – Stage of diabetes
  • (honeymoon)

Activity Profiles of Different Types of Insulin

Daily insulin pattern on MDI
Emergencies

- **Low blood sugar**
  - (treated with quick acting carbohydrate)
  - Less than 80 mg/dl with symptoms
  - Less than 70

- **Diabetic Keto-acidosis: not enough insulin**
  - (treated with insulin and hydration)
  - The body uses alternate fuel (fatty acids, proteins)
  - The waste product of this is ketones (poisons)
  - Ketones make the body more acid

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**Low Blood Glucose Level and treatment**

<table>
<thead>
<tr>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG less than 70</td>
<td>BG less than 60</td>
<td>Mental Status changes &amp;/or seizure</td>
</tr>
<tr>
<td>- With or without symptoms</td>
<td>- With or without symptoms</td>
<td>- BG less than 50 +/- mental status changes</td>
</tr>
<tr>
<td>- No change in mental status</td>
<td>- No change in mental status</td>
<td>- Give Glucagon</td>
</tr>
<tr>
<td>- Give fast acting carb</td>
<td>- Re-check BG in 15 mins</td>
<td>- Suspended or disconnect pump</td>
</tr>
<tr>
<td>- Re-check BG in 15 mins</td>
<td>- Re-treat until BG above 80</td>
<td>- Call 911</td>
</tr>
<tr>
<td>- Re-treat until BG above 80</td>
<td>- For pump, consider suspend or disconnect until BG over 80</td>
<td>- Follow up with clinic</td>
</tr>
</tbody>
</table>

**Rule of 15’s**

- Position on side
- Call 911

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**Glucagon Review**

- **When to use Glucagon**
  - Unresponsive low

- **How to mix Glucagon**

- **Dose of Glucagon**
  - Age specific: over age 5 full amount (1 mg)
  - Under 0.5 cc (0.5 mg) half the amount

- **Things to do after Glucagon**
  - Position on side
  - Call 911
Diabetic Keto-Acidosis

- DKA = Too little insulin to transport glucose into cells
- Glucose (BS) accumulates in blood (>250 mg/dl)
- DKA can evolve quickly causing
  - ketosis,
  - dehydration,
  - electrolyte imbalance
  - acidosis
- It occurs more often with type 1 diabetes
  - Anything that increases BS & decreases insulin action can contribute to DKA
- You can have ketones with a normal sugar!!
- Persons can get ketones with illness

DKA in general

DKA = deficiency of insulin

DKA = most common diabetes-related death in childhood

Without insulin = 100% mortality,
Current mortality 2-5%

25-30% of new onset present in DKA
Greatest risk: young, poor access to care, lower income and parental education

DKA, cont.

Younger than age 5 years at greatest risk

Treatment may cause life threatening, predictable and avoidable complications (AADE)

Younger: DKA more at onset of new diagnosis
Adolescent: more often after diagnosis (female > male)
DKA Symptoms

Symptoms of Acidosis

- Central
  - Headache
  - Sleepiness
  - Confusion
  - Loss of consciousness
  - Coma
- Respiratory
  - Shortness of breath
  - Coughing
- Heart
  - Arrhythmia
  - Increased heart rate
- Muscular
  - Seizures
  - Weakness
- Intestinal
  - Diarrhea
- Gastric
  - Nausea
  - Vomiting

Situations contributing to inadequate insulin

- New onset / decompensate subclinical type 1 (30%)
- Illness
- Infection
- Some medications
  - steroids
- Inadequate dosing
- Increased resistance
- Suboptimal treatment plans
- Cumulative: in 2 small studies prior to admission:
  - large volume of high calorie fluids prior to DKA (type 1)
  - alcohol consumption (type 2)

Inadequate insulin, cont.

- Psychological reasons
  - Insulin omitted for weight control (11-25 year olds, up to 36% report insulin misuse)
  - Psychological problems complicated by eating disorder
  - Insulin omitted to avoid hypoglycemia (fear of low)
  - Avoid injecting in public
  - Needle issues
- Lack of testing, planning/knowledge
- Inadequate sick day management
- Poor absorption
  - lipohypertrophy or lipoatrophy
DKA problem: not enough insulin

Normal Biology: (Green Zone / activity triangle)
Blood sugar > 250
Insulin available
Cells need fuel
Liver → holds
BS → decreases

DKA problem: not enough insulin

Acidosis Biology (yellow & red zone)
Blood sugar > 250
Low Insulin
Cells need fuel
Liver → secretes more sugar
FFA → Ketones → poisons: lower pH, more insulin needed
Blood sugar → increases

Guidelines For Adequate Fluid Intake

- How Much Fluid Should They Have?

**Age:**
- Under 1 year
  » Minimum Amount to Prevent Dehydration:
  32 ounces/day
  → 2 ounces each hour for 16 hours
- 1-4 years
  » 48 ounces/day
  → 3 ounces each hour for 16 hours
- Over 5 years
  » 64 ounces/day
  → 4 ounces each hour for 16 hours
**DKA Education**

- Early diagnosis & treatment, causes
- Monitoring and self management during illness
- Stress management
- Reinforce sick day care over and over....
- Monitor BS, ketones, fluid intake, timing of insulin
- Key contributing factors
  - Rely on how you feel
  - Skip insulin if not eating
  - Inadequate monitoring
  - Use of expired insulin
  - Increased needs during growth or hormonal spurts
  - Preoccupied with life—not in tune to needs at the moment

**DB care = non-negotiable**

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**MDI sick care/ steroid effect**

- Basal harder to adjust
- Can’t increased basal rate incrementally
- Can’t adjust basal for a targeted time of day
- Bolus is similar, does not have decimals
- It is a lot of pokes

Prednisone/steroids
- Calms inflamed tissues
- Glucocorticoids powerful on BS metabolism
- Prednisone stimulates glucose production in liver
- Decreased glucose transport to adipose & muscles
- Decreased glucose clearance

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**Pumps and sensors**

- Age limit, cost
Pumps in general

- Person changes set every 2-3 days
  - No basal: increased risk DKA
  - Basal is quick acting insulin infusing 24/7
- With meals enter blood sugar & carbs
  - Math done by pump
- Pump can be downloaded at home or clinic
  - From my desk log on to website for printouts
- Pumps can be more work, especially in the beginning
- Transfer MDI on to pump
- Improved quality of life

Settings A1c 7.5%!

<table>
<thead>
<tr>
<th>Normal</th>
<th>Sick care for steroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN 0.5</td>
<td>MN 0.85</td>
</tr>
<tr>
<td>0400 0.475</td>
<td>0400 0.75</td>
</tr>
<tr>
<td>0800 0.3</td>
<td>0800 0.475</td>
</tr>
<tr>
<td>1800 0.45</td>
<td>150 0 0.55</td>
</tr>
<tr>
<td>2230 0.475</td>
<td>1800 0.725</td>
</tr>
<tr>
<td>Total 9 units</td>
<td>Total 14.075</td>
</tr>
</tbody>
</table>

Ratios 1:14, supper 1:12, target 130, sensitivity 55
TDD 39.7 basal 15.2
A1c 7.5%!!!

Steroid given at 1800 daily
MDI practice

DAY 1
- 0600 BS 366
- 0900 BS 245
- 1100 230
- 1300 364
- 1600 262
- 1900 256
- 2200 164

DAY 2
- 0600 BS 264
- 0900 BS 416
- 1100 430
- 1300 359
- 1600 --
- 1900 243
- 2200 164

BS - 130 divide by 55, lantus 10,
Bk, lunch 1:14, supper 1:12
Learned after, so lantus not adjusted
Encouraged to call if steroids needed in future
For practice

Sick care for steroids
- MN 0.85
- 0400 0.75
- 0800 0.475
- 1500 0.55
- 1800 0.725
- Total 14.075
- Ratios 1:14, supper 1:12,
- target 130, sensitivity 55
- TDD 39.7 basal 15.1
- A1C 7.5%!!!

Lunch: sugar 211, carbs 27 gms
- BS = 130/55 = 2.4
- 27 / 1.9 total 4.3 infused
- Temp basal + 30% for 2 hrs
- 1430: BS 327-130/55 = 3.58
- Reset temp basal +40%
- 1700 BS 235 - 130/55 = 1.9
- Carbs 51/4.25 total 6.15
- Temp basal =40%
- 1930 BS 392 - 130/55 = 4.8
- Ate 14 grams /12 =1.2 =6
- Set temp basal +50% for 2
- 2130 BS 313 – 130/55= 3.3
- Set temp basal + 50% for 2 hours

continued

- MN BS 295
- 0500 BS 171
- 0800 BS 142
- 1200 BS 298
- 1600 BS 206
- Steroid PO
- 2200 BS 356
- 0100 BS 304
- 0300 BS 231
- 0800 BS 121
- 1200 BS 273
- 1800 BS 106
- 2200 BS 160
- Next day 0100 BS 184
- Normal all am
- 1700 > 400 (site?)
- 2100 BS = 281
- MN BS = 398
General concepts on insulin

- Monitor glycemic patterns
- For asthma, take steroid in evening; # high overnight, lower early am
  - If took in am: have normal fasting, number high til post supper
- Anticipate higher numbers for at least 6-10 hours
- Set up pattern A to reflect needs
- Also added temp basal until the next check PRN
- Better control with use of technology
- Safer than injections

Diabetes Quality of life

- Last admission: bad experience
- ED did not start steroids ASAP (was over 6 hrs)
- Worked with asthma team: another town
- ED- could not breathe!!
- Called for nebulizer- not there 5-10 min
- O2 mask- working too hard
- Orapred 13 ml (3mg/ml Q pm needed 46 mg

While inpatient
- Parent regulate diabetes
- Did not need to wait for the team
- Sensor = amazing!
- High at HS
- Low early am
- Can direct basal according to numbers
- Option to suspend, or disconnect if needed

Parent as health coach

- Parent able to test, replace insulin every 2 hrs.
- Nurses needed to know number, but left pump on and parent in charge
- Use of home meter: saved time, same technology as at home,
- Home meter result did not always match unit meter
- The ability to adjust basal every 2-3 hours is priceless
Insulin action time

- Starts in 5-10 min, peaks in 60-90-120
  - Some lasts 180 min
- We dose every 2 when sick
- Really, insulin lasts up to 6 hours
- Need to worry about “tail” (steroids, goal under 200)
- Insulin on board does not always minus for food
- Intake was minimal when ill, often just 20-30 grams
- 30 grams minimal recommended if not hungry
  - Important to prevent starvation ketones.

Basal adjustments

- 1 unit basal over 24 hours = 0.04 units/hour
- ½ unit basal over 24 hours = 0.02 units/hour
- On lower doses, can micro manage better
- Assign the increase for the time needed
- Example, if high in the morning, need to determine if:
  - This is R/T overnight, or are they going to bed high
- PM basal: test supper, 2 hours later & every 2 until
  - MN – then look at MN to am
- Or use sensor data
- Or test every 2-3 in the over night

Future

- More wireless
- Communication cell phone
- Closed loop
questions
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references
Chase, P. & Maahs, D. 2011 Understanding Diabetes, Barbara Davis Center 12 ed.