Diabetes in Children, Adolescents and Young Adults

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Diabetes in Children, Adolescents and Young Adults

Objectives:

• Review management of Type I Diabetes
• Review management of Type II Diabetes
  o Pathophysiology
  o Treatment
    • Types of treatment
    • Goals of treatment
    • Outcomes of treatment
“Diabetes became an epidemic about the same time people started using the Internet. Too much spam and cookies from the computers!”
"Your blood sugar is too high."
Diabetes in Children, Adolescents and Young Adults

• Facts
  o Estimated 167,000 pediatric patients with type I diabetes
  o Two types – autoimmune and idiopathic
  o Having the genes for autoimmune diabetes does not insure clinical diabetes – an environmental trigger (viruses and early nutrition) has to be present
    • Breast fed infants have lower risk of type 1 diabetes
    • Trigger initiates killer T cells to destroy pancreatic islet cells
  o Idiopathic involves destruction of pancreatic islet cells but not genetic originated
Mechanisms for Development of Type 1 Diabetes

Diagram of Possible mechanism for development of Type I diabetes

- Susceptibility
  - Environment
  - Genetic
- Immunological Priming
- Auto-immune Disease
- Islet Cell Destruction
- Insulin Deficiency
- Clinical Diabetes
Effects of Insulin Deficiency

Diagram of the Effects of Insulin Deficiency

- Insulin deficiency
- Fat mobilisation
- Ketogenesis
- Ketonemia
- Polydipsia
- Polyuria
- Weight loss
- Hyperglycemia
- Glycosuria
- Increased appetite
- Muscle wasting
- Metabolic acidosis
- Nausea and vomiting
- Electrolyte losses
- Renal failure
- Coma and death
- Reduced cerebral blood flow
- Hypovolemia
- Dehydration
- Hyperventilation
- Coma and death
Symptoms of Ketocidosis

• Severe dehydration
• Smell of ketones (fruity smell)
• Acidotic breathing – masquerading as respiratory distress
• Abdominal pain
• Vomiting
• Drowsiness and coma
Other Conditions that Mimic Diabetes

- Type 2 diabetes mellitus
- Maturity Onset Diabetes of the Young (MODY)
- Psychogenic polydipsia
- Nephrogenic diabetes insipidus
- High Output renal failure
- Transient hyperglycemia with illness and other stress
- Steroid therapy
Labs

- Blood glucose
- Glycated Hemoglobin (depicts medium and long term control)
- Modified oral glucose tolerance test (to identify cases of MODY)
- Urine glucose
- Urine ketones
- Islet cell antibodies
- Thyroid function tests and antithyroid antibodies
- Antigliadin antibodies (type 1 diabetics may develop celiac)
- Lipid profile
- Urinary albumin
- Renal function tests
Things that will effect treatment

- Age at diagnosis
- Ability of child to communicate
- Eating patterns
- Activity
- Pubertal status and development
- Family dynamics
- Caregiver involvement towards management
- Psychological acceptance to diagnosis
- Daycare and/or school training

A diabetes care team is necessary to provide instruction and support in the outpatient setting.
  - There should be 24/7 access for the patient and parents
Treatment Goals in Children

• PRIMARY GOALS
  • Achievement of near as near normal blood glucose as possible
  • Normal growth and development
  • Avoidance of hypoglycemia
  • Strive for A1c < 7.5%

• SECONDARY GOALS
  • Avoidance of microvascular complications
    o Retinopathy, neuropathy, nephropathy
  • Avoidance of macrovascular complications
    o Heart attack, stroke, circulatory blockade
WHEN YOUR BLOOD SUGAR IS HIGH

AND SOMEONE GIVES YOU YOUR FAVORITE CUPCAKE
Three Main Components for Treatment

• Medical nutrition therapy
  o Monitoring carbohydrate intake is essential to overall treatment
  o Comprehensive nutrition education with annual updates is recommended

• Exercise or activity
  o A goal of 60 minutes of moderate to vigorous-intensity aerobic activity daily with muscle and bone strengthening activity at least 3 days per week
  o Education of patient (parents) about glycemia during and after exercise
    • Glucose monitoring before, during, and after exercise important
      o Before exercise blood glucose levels should be 90-250 mg/dl
      • Insulin dose adjustment may be needed

• Psychological Support
  o Encourage age appropriate family involvement
  o Avoid transfer of diabetes care to the child too early – diabetes burnout
  o Diabetes specific family conflict leads to poorer adherence and glycemic control
  o Start screening for diabetes stress at 7 or 8 years
<table>
<thead>
<tr>
<th>Developmental stages (ages)</th>
<th>Normal developmental tasks</th>
<th>Type 1 diabetes management priorities</th>
<th>Family issues in type 1 diabetes management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infancy (0–12 months)</td>
<td>Developing a trusting relationship or bond with primary caregiver(s)</td>
<td>Preventing and treating hypoglycemia</td>
<td>Coping with stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoiding extreme fluctuations in blood glucose levels</td>
<td>Sharing the burden of care to avoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>parent burnout</td>
</tr>
<tr>
<td>Toddler (13–26 months)</td>
<td>Developing a sense of mastery and autonomy</td>
<td>Preventing hypoglycemia</td>
<td>Establishing a schedule</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Avoiding extreme fluctuations in blood glucose levels due to irregular food intake</td>
<td>Managing the picky eater</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Limit-setting and coping with toddler’s</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>lack of cooperation with regimen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sharing the burden of care</td>
</tr>
<tr>
<td>Preschooler and early elementary school (3–7 years)</td>
<td>Developing initiative in activities and confidence in self</td>
<td>Preventing hypoglycemia</td>
<td>Reassuring the child that diabetes is</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coping with unpredictable appetite and activity</td>
<td>no one’s fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positively reinforcing cooperation with regimen</td>
<td>Educating other caregivers about diabetes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trusting other caregivers with diabetes management</td>
<td>management</td>
</tr>
<tr>
<td>Older elementary school (8–11 years)</td>
<td>Developing skills in athletic, cognitive, artistic, and social areas</td>
<td>Making diabetes regimen flexible to allow for participation in school or peer activities</td>
<td>Maintaining parental involvement in insulin and blood glucose management tasks while allowing for independent self-care for special occasions</td>
</tr>
<tr>
<td></td>
<td>Consolidating self-esteem with respect to the peer group</td>
<td>Child learning short- and long-term benefits of optimal control</td>
<td>Continuing to educate school and other caregivers</td>
</tr>
<tr>
<td>Early adolescence (12–15 years)</td>
<td>Managing body changes</td>
<td>Increasing insulin requirements during puberty</td>
<td>Renegotiating parent and teenager’s</td>
</tr>
<tr>
<td></td>
<td>Developing a strong sense of self-identity</td>
<td>Diabetes management and blood glucose control becoming more difficult</td>
<td>roles in diabetes management to be</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>acceptable to both</td>
</tr>
<tr>
<td>Later adolescence (16–19 years)</td>
<td>Establishing a sense of identity after high school (decisions about location, social issues, work, and education)</td>
<td>Starting an ongoing discussion of transition to a new diabetes team (discussion may begin in earlier adolescent years)</td>
<td>Supporting the transition to independence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrating diabetes into new lifestyle</td>
<td>Learning coping skills to enhance ability to self-manage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Preventing and intervening with diabetes-related family conflict</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Monitoring for signs of depression, eating disorders, and risky behaviors</td>
</tr>
</tbody>
</table>
Medical Management

• Treatment should be with intensive regimens via multiple daily injections or continuous subcutaneous infusion
  • Automated insulin delivery systems appear to improve glycemic control
• Treatment regimen must be adapted quickly to the child’s dynamic growth and development
• Glucose should be monitored up to 6-10 times a day
  o There is a relationship with frequency of glucose monitoring and glycemic control
  o The development of the continuous blood glucose monitor has revolutionized monitoring!
• Blood glucose targets:
  o Age related
• Targets may have to be adjusted based on hypo/hyper glycemic episodes
• An A1C target of < 7.5% should be considered
# Blood Glucose Goals in Children

<table>
<thead>
<tr>
<th>AGE</th>
<th>BLOOD GLUCOSE GOAL</th>
<th>A1c GOAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 6 years</td>
<td>Fasting 100-180</td>
<td>7.5%-8.5%</td>
</tr>
<tr>
<td></td>
<td>Bedtime 110-200</td>
<td></td>
</tr>
<tr>
<td>6-12 years</td>
<td>Fasting 90-180</td>
<td>&lt; 8%</td>
</tr>
<tr>
<td></td>
<td>Bedtime 100-180</td>
<td></td>
</tr>
<tr>
<td>13-19 years</td>
<td>Fasting 90-130</td>
<td>&lt; 7.5%</td>
</tr>
<tr>
<td></td>
<td>Bedtime 90-150</td>
<td></td>
</tr>
</tbody>
</table>
## Insulin Pharmacokinetics

<table>
<thead>
<tr>
<th>Insulin Prep</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration of Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lispro/Aspart/Glulisine (rapid acting)</td>
<td>5-15 min</td>
<td>1-2 hours</td>
<td>4-6 hours</td>
</tr>
<tr>
<td>Human Regular (short acting)</td>
<td>30-60 min</td>
<td>2-4 hours</td>
<td>6-10 hours</td>
</tr>
<tr>
<td>Human NPH (intermediate acting)</td>
<td>1-2 hours</td>
<td>4-8 hours</td>
<td>10-20 hours</td>
</tr>
<tr>
<td>Glargine (long acting)</td>
<td>1-2 hours</td>
<td>Flat</td>
<td>24 hours</td>
</tr>
<tr>
<td>Detemir (long acting)</td>
<td>1-3 hours</td>
<td>Flat</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Degludec (ultra long acting)</td>
<td>30-90 min.</td>
<td>Flat</td>
<td>42 hours</td>
</tr>
</tbody>
</table>
Blood Concentrations of the Different Insulins
Types of Insulin Errors

• Similar names – especially in computer menus
  o Humulin versus Novolin or Humulin versus Humalog or Novolin versus Novolog
  o Look alike vials

• Sound alike/look alike names with other meds – Lovenox versus Lantus

• Misreading the abbreviation “U” as a zero or number 4
  o Never write the abbreviation u – computer programs will not let you
Insulin Requirements

- Nine months to two years = 0.25 to 0.5 units/kg/day
- One year to six years = 0.5 to 0.6 units/kg/day
- > 7 years to puberty = 0.75 units/kg/day
  - 60-70% of daily dose given in the morning and 30-40% in the evening
- Post puberty 1-1.5 (up to 2) units/kg/day
  - 1/3 of daily dose given as short acting and remainder medium to long acting
- Basal/Bolus relationship
  - 50% of daily dose long acting and 50% short acting at meals
- Continuous infusion relationship with bolus
  - 50% via pump continuous infusion using short acting and 50% short acting at meals
Improving Control

• Improving control comes from matching these two needs:

  o The need for background (basal) insulin
    • Achieved by one or more injections of Lantus or Levemir or Degludec
    • Achieved by an insulin pump

  o The need to cover for food intake
    • Short acting or rapid acting insulin like Humulin R, Novolin R, Humalog, Novolog, Apidra

  o A third need - to correct high blood sugars for too low basal dose, a carb dose that is too low, increase insulin need due to illness, exercise, menses, etc. This is called the correction dose
Types of Dosing

• Basal Insulin
  o Longer duration of action – daily dosing
  o Provides a steady level of daily insulin – mimicks physiological action
  o Pediatrics will require twice a day dosing with detemir and many patients will require twice a day glarine dosing

• Bolus Insulin
  o For meal-time coverage
  o For correcting high blood sugar aside from basal and bolus
  o Short acting (Regular insulin) has to be given 30 minutes before meal
    • Less desirable for mealtime
  o Rapid acting (Humalog, Novolog, Apidra) can be given just prior, during, or after a meal – most optimal 15 min. prior

• For most people, basal and bolus make up 50% of TDD each.
Calculation Factors

CARB FACTOR

The 500 rule to determine carb factor

500 divided by total daily insulin dose = grams of carbohydrate covered by one unit

CORRECTION FACTOR

The 1800 rule to determine correction factor

1800 divided by total daily dose = ____ mg/dl – blood sugar
One unit of insulin will decrease blood sugar by ____ mg/dl
Carb Factor Example

\[
\frac{500}{\text{Total Daily Insulin Dose in units}} = \text{Carb Factor}
\]

Total Daily Insulin Dose in units

\[
\frac{500}{20 \text{ units}} = 25 \text{ grams of carbs covered by 1 unit of bolus insulin}
\]
Correction Factor Example

\[
\frac{1800}{\text{Total Daily Insulin Dose in units}} = \text{Correction Factor}
\]

1800

\[
\frac{20 \text{ units}}{= 90 \text{ mg/dl drop in blood sugar per 1 unit of bolus insulin injected}}
\]

20 units
## Sample Correction Table

<table>
<thead>
<tr>
<th>Correction</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>dose</td>
<td>dose</td>
<td>dose</td>
<td></td>
</tr>
<tr>
<td>150-200</td>
<td>1 units</td>
<td>1 units</td>
<td>1 units</td>
<td>0 units</td>
</tr>
<tr>
<td>201-250</td>
<td>2 units</td>
<td>2 units</td>
<td>2 units</td>
<td>1 units</td>
</tr>
<tr>
<td>251-300</td>
<td>3 units</td>
<td>3 units</td>
<td>3 units</td>
<td>2 units</td>
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<tr>
<td>301-350</td>
<td>4 units</td>
<td>4 units</td>
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<td>3 units</td>
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<td>351-400</td>
<td>5 units</td>
<td>5 units</td>
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<td>4 units</td>
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<td>401-450</td>
<td>6 units</td>
<td>6 units</td>
<td>6 units</td>
<td>5 units</td>
</tr>
<tr>
<td>451-500</td>
<td>7 units</td>
<td>7 units</td>
<td>7 units</td>
<td>6 units</td>
</tr>
<tr>
<td>&gt;501</td>
<td>8 units</td>
<td>8 units</td>
<td>8 units</td>
<td>7 units</td>
</tr>
</tbody>
</table>
### Basal Dose & Carb Coverage Table

<table>
<thead>
<tr>
<th>TDD</th>
<th>DAILY BASAL DOSE (50% TDD)</th>
<th>ONE UNIT INSULIN COVERS X GRAMS OF CARBS Rule of 500</th>
<th>ONE UNIT OF INSULIN LOWERS BLOOD GLUCOSE X AMOUNT (MG/DL) Rule of 1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>8</td>
<td>31</td>
<td>113</td>
</tr>
<tr>
<td>18</td>
<td>9</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>25</td>
<td>90</td>
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<td>22</td>
<td>11</td>
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<td>21</td>
<td>75</td>
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<td>19</td>
<td>69</td>
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<td>14</td>
<td>18</td>
<td>64</td>
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<td>30</td>
<td>15</td>
<td>17</td>
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</tr>
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<td>32</td>
<td>16</td>
<td>16</td>
<td>56</td>
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<td>34</td>
<td>17</td>
<td>15</td>
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<td>36</td>
<td>18</td>
<td>14</td>
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</tr>
<tr>
<td>36</td>
<td>18</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>44</td>
<td>22</td>
<td>11</td>
<td>41</td>
</tr>
<tr>
<td>48</td>
<td>24</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>52</td>
<td>26</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>56</td>
<td>28</td>
<td>9</td>
<td>32</td>
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<td>60</td>
<td>30</td>
<td>8</td>
<td>30</td>
</tr>
<tr>
<td>65</td>
<td>32.5</td>
<td>8</td>
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<tr>
<td>70</td>
<td>35</td>
<td>7</td>
<td>26</td>
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<td>75</td>
<td>37.5</td>
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<td>80</td>
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<td>90</td>
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</tr>
<tr>
<td>100</td>
<td>50</td>
<td>5</td>
<td>18</td>
</tr>
</tbody>
</table>
# Insulin Dose Table

<table>
<thead>
<tr>
<th>Fitness &amp; Stress</th>
<th>TDD for 45 kg weight</th>
<th>TDD for 55 kg weight</th>
<th>TDD for 64 kg weight</th>
<th>TDD for 73 kg weight</th>
<th>TDD for 82 kg weight</th>
<th>TDD for 91 kg weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physically fit</td>
<td>20</td>
<td>24</td>
<td>29</td>
<td>33</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td>Mod activity</td>
<td>26</td>
<td>32</td>
<td>37</td>
<td>42</td>
<td>48</td>
<td>53</td>
</tr>
<tr>
<td>Sedentary/Adolescent</td>
<td>31</td>
<td>38</td>
<td>45</td>
<td>51</td>
<td>57</td>
<td>64</td>
</tr>
<tr>
<td>Mod stress/2nd trimester</td>
<td>36</td>
<td>43</td>
<td>51</td>
<td>58</td>
<td>66</td>
<td>73</td>
</tr>
<tr>
<td>&gt; stress/3rd trimester</td>
<td>40</td>
<td>49</td>
<td>57</td>
<td>65</td>
<td>74</td>
<td>82</td>
</tr>
<tr>
<td>Severe stress</td>
<td>45</td>
<td>55</td>
<td>64</td>
<td>73</td>
<td>82</td>
<td>91</td>
</tr>
<tr>
<td>Infx/DKA/steroid intake</td>
<td>50-90</td>
<td>60-108</td>
<td>70-126</td>
<td>80-144</td>
<td>90-162</td>
<td>100-180</td>
</tr>
</tbody>
</table>

Comparing Insulin Regimens in Youth with Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>1 Pump</th>
<th>2 MDI: Glargine/Rapid</th>
<th>3 MDI: Glargine/Rapid+ other</th>
<th>4 MDI: No Glargine</th>
<th>5 One-Two Injections No Glargine</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1C, mean % (SD)</td>
<td>8.0 (1.2)</td>
<td>8.5 (1.6)</td>
<td>8.9 (1.6)</td>
<td>8.6 (1.6)</td>
<td>8.6 (1.7)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Adjusted*†</td>
<td>9.0 (0.1)</td>
<td>9.5 (0.1)</td>
<td>9.7 (0.1)</td>
<td>9.4 (0.1)</td>
<td>9.3 (0.1)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Hypoglycemic Episodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage ≥ 1</td>
<td>10.3</td>
<td>13.7</td>
<td>12.5</td>
<td>11.4</td>
<td>13.5</td>
<td>.30</td>
</tr>
<tr>
<td>Rate Ratio*†</td>
<td>1 (Referent)</td>
<td>1.13 (0.31)</td>
<td>1.70 (0.56)</td>
<td>0.69 (0.22)</td>
<td>1.12 (0.3)</td>
<td>.14</td>
</tr>
<tr>
<td>ER visits</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Percentage ≥ 1</td>
<td>14.2</td>
<td>22.6</td>
<td>19.9</td>
<td>25.6</td>
<td>22.6</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Rate Ratio*†</td>
<td>1 (Referent)</td>
<td>1.36 (0.19)</td>
<td>1.24 (0.23)</td>
<td>1.46 (0.24)</td>
<td>1.08 (0.16)</td>
<td>.06</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage ≥ 1</td>
<td>3.2</td>
<td>8.2</td>
<td>10.5</td>
<td>7.0</td>
<td>7.8</td>
<td>.0003</td>
</tr>
<tr>
<td>Rate Ratio*†</td>
<td>1 (Referent)</td>
<td>2.49 (0.75)</td>
<td>6.25 (2.30)</td>
<td>2.32 (0.80)</td>
<td>1.84 (0.59)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

*Regression analyses adjusted for sex, race, center, household income, parental education, insurance, age at visit, duration of DM, FCP, and number of blood sugar checks per day.
†Linear regression-estimates reported are least squares means (SE).
‡Poisson regression-estimates reported are rate ratios (SE).
Delivery Mechanisms

Vials

Pens

Prefilled Syringes
Insulin Pens

• Pen-like devices with cartridges holding 150-300 units of insulin; packs of 5 cartridges
• Pen limited to one type of insulin at a time. If mixing insulin -- for example, NPH and Regular -- need one pen device for each type of insulin.
• For pump users, pens are excellent backups
• Must keep needle in skin for 5 – 10 seconds
• Use disposable needles
• Dial insulin dosage and inject; replace after each injection
Pen Considerations

- **Pros:**
  - Portable, discreet, convenient, saves time = better compliance
  - More accuracy with small doses

- **Cons:**
  - More $ (1.5 – 2X) - check with insurer, can’t mix insulins,
  - partial loss of dose with early needle removal,
  - increased risk of needle sticks

- **Waste?**
## Pen Brands Comparison

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Pen</th>
<th>Durable</th>
<th>Max Dose (Units)</th>
<th>Dosing Increments (Units)</th>
<th>Dial Up &amp; Down</th>
<th>Dose Window Returns to “0” to Confirm Dose</th>
<th>CANNOT Dial Past the # Units Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanofi-Aventis</td>
<td>SoloSTAR®</td>
<td>√</td>
<td>80</td>
<td>1</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>OptiClik®</td>
<td>√</td>
<td>80</td>
<td>1</td>
<td>√</td>
<td>√ Returns to “0” two min after injection</td>
<td>√</td>
</tr>
<tr>
<td>NovoNordisk</td>
<td>FlexPen®</td>
<td></td>
<td>60</td>
<td>1</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>InnoLet®</td>
<td></td>
<td>50</td>
<td>1</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>NovoPen® 3</td>
<td>√</td>
<td>70</td>
<td>1</td>
<td>Must Reset to “0”</td>
<td>√</td>
<td>Displays # of units NOT injected</td>
</tr>
<tr>
<td></td>
<td>NovoPen® Junior</td>
<td>√</td>
<td>35</td>
<td>½</td>
<td>Must Reset to “0”</td>
<td>√</td>
<td>Displays # of units NOT injected</td>
</tr>
<tr>
<td>Eli Lilly</td>
<td>KwikPen®</td>
<td></td>
<td>60</td>
<td>1</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Humalog®/Humulin® Pen</td>
<td></td>
<td>60</td>
<td>1</td>
<td>√ (+) or (−)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HumaPen® Luxura®™ HD</td>
<td>√</td>
<td>30</td>
<td>½</td>
<td>√</td>
<td>√</td>
<td>Displays # of units NOT injected</td>
</tr>
<tr>
<td></td>
<td>HumaPen® Memoir®™</td>
<td>√</td>
<td>60</td>
<td>1</td>
<td>√ “Ready Mode”</td>
<td>√</td>
<td>Displays # of units NOT injected</td>
</tr>
<tr>
<td>Owen-Mumford</td>
<td>AutoPen® AN3800</td>
<td>√</td>
<td>42</td>
<td>2</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AutoPen® AN3810</td>
<td>√</td>
<td>21</td>
<td>1</td>
<td>√</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Insulin Pump Therapy

Advantages
- Elimination of multiple daily injections
- Increased flexibility in meal planning
- Ease of decreasing insulin for physical activity
- Fewer hypoglycemic events
- Ability to deliver small amounts of insulin - more precise dosing

Disadvantages
- More frequent blood glucose monitoring
- Always being tethered to the pump
- Increased risk of DKA because only rapid acting insulin can be used, discontinuation of insulin delivery can result in ketone production within hours
Most Insurance Companies require 6 months of injections before approving a pump
Insulin Pumps

MiniMed 670 G Smart Guard
Features:
• Adjusts basal insulin every 5 minutes based on CGM
  • Fewer lows and highs day and night
• Stops insulin 30 minutes before reaching preset low limits
  • Automatically restarts when BS recovers

https://you.tube/h4a3f5RWg-o
Insulin Pumps (cont.)

Pumps (Cont.)

Tandem t: slim X2
Used with
Dexcom G6
CGM system
Omnipod

Pod - Insulin stored here

Has basal and bolus capabilities

Personal Diabetes Manager – Communicates with Pod
### Sample Basal Rate with an Insulin Pump

<table>
<thead>
<tr>
<th>Time</th>
<th>Units/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN - 4am</td>
<td>1.4 units/hour</td>
</tr>
<tr>
<td>4am - 6am</td>
<td>1.6 units/hour</td>
</tr>
<tr>
<td>6am - 8am</td>
<td>1.45 units/hour</td>
</tr>
<tr>
<td>8am - MN</td>
<td>1.45 units/hour</td>
</tr>
</tbody>
</table>

- Patient can program more than one basal schedule in pump
Continuous Blood Glucose Monitors

- Give constant feedback on blood glucose status - useful for tracking TRENDS
- Sensor inserted under skin
- Monitors interstitial plasma – NOT blood glucose
- Does NOT eliminate finger sticks
- Cannot be used to identify hypoglycemia
- Requires separate insertion site
When non-diabetics get together:

“OMG are those new shoes?”

When diabetics get together:

“OMG is that a new meter?”
Continuous Blood Glucose Monitors

Free Style Libre
Continuous Blood Glucose Monitors

Dexcom 7 plus
# Continuous Glucose Monitors

<table>
<thead>
<tr>
<th>Indication Age</th>
<th>Device Cost</th>
<th>Minimum Sensor Cost (monthly)</th>
<th>Sensor Change (days)</th>
<th>Reading Intervals (mins.)</th>
<th>Calibration (after insertion)</th>
<th>Misc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>~$1000</td>
<td>~ $400</td>
<td>5</td>
<td>1</td>
<td>10, 12, 24 and 72 hrs</td>
<td>Built in monitor</td>
</tr>
<tr>
<td>≥ 7 years</td>
<td>~$1000</td>
<td>~ $400</td>
<td>3</td>
<td>5</td>
<td>2, 8, 20, 32, 44, 56, and 68 hrs</td>
<td>Info displayed on pump</td>
</tr>
<tr>
<td>≥ 7 years</td>
<td>~$1300</td>
<td>~ $400</td>
<td>3</td>
<td>5</td>
<td>2, 8, 20, 32, 44, 56, and 68 hrs</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>~$800</td>
<td>~ $250</td>
<td>7</td>
<td>5</td>
<td>2 (x2), and every 12 hrs</td>
<td>AutoUpload with One Touch Ultra</td>
</tr>
</tbody>
</table>
Pediatric Candidates for Insulin Pump Therapy

- Elevated A1c levels on injectable therapy
- Recurrent, severe hypoglycemic episodes
- Very young children
- Wide fluctuations in glucose levels regardless of A1c
- Current treatment is not compatible with lifestyle needs
- Presence of microvascular complications and/or risk factors for these complications
- Specific populations: athletes, pronounced Dawn Effect, needle phobia, ketosis prone, pregnant teens
Insulin Pump in Very Young Children

• Study of 14 patients ranging from 6-11 years
• HA1c decreased on average 0.79% over 24 weeks
• Average daily insulin requirement decreased
• Average blood glucose decreased
• Satisfaction with therapy on an Analog Scale increased
• Compliance with treatment increased

Clinical Diabetes and Endocrinology (2019)5:7
Hypoglycemia: Blood Glucose < 50 mg/dl

• If alert, able to take po, and can cooperate
  o 15-15 rule: 15 grams of carbohydrate and recheck BS in 15 minutes
  o Give snack if not eating within 30 minutes

• Unconscious
  o Glucagon, glucose gel and call 911
Type II Diabetes in Children

• Between 1982 and 1994, the yearly incidence increased from 0.7 to 7.2 per 100,000 children (Cincinnati, Ohio)
• Between 1976 and 1995, the yearly incidence increased from 0.2 to 7.3 per 100,000 children (Japan)
• One-third of new cases of diabetes in the 10-19 year old age group were classified as Type II
• The incidence of Type II diabetes has been steadily increasing in children once thought of as primarily an adult condition
Type II Diabetes in Children

• Contributing Factors
  o Begin testing at puberty (or >10 years) who are overweight/obese + genetic H/O, certain race, signs or conditions assoc. w/ insulin resistance
    • Races – Native/African/Asian American, Latino, Pacific Islander
    • Genetic – maternal H/O, family H/O
    • Insulin resistance – Hypertension, dyslipidemia, polycystic ovary syndrome

• Pathophysiology - past thinking
  o Impaired insulin secretion due to declining pancreatic beta cell production
  o Insulin resistance leading to decreased glucose uptake by peripheral tissues
  o Increased glucose production by the liver due to augmented gluconeogenesis
Type II Diabetes (cont.)

• Pathophysiology current
  o Decreased insulin production
  o Increased glucagon secretion (variable in children)
  o Central dysregulation of appetite control
  o Insulin resistance
  o Impaired incretin effect
  o Hepatic glucose over-production
  o Increased renal reabsorption of glucose
  o Increased lipolysis
"My diabetic research shows that test subjects are 98% more likely to take their diabetic pills if the pills are covered in chocolate."
Type II Diabetes (cont.)

• Criteria for Diagnosis of Type II Diabetes
  o A1C ≥ 6.5
  o FPG ≥ 125 mg/dl (no calorie intake for at least 8 hours)
  o Two hour plasma glucose ≥ 200 mg/dl

  o Abnormal A1C associated with higher overall and nighttime average glucose on CGM
  o Abnormal OGTT associate with more time spent above the normal glucose range during the day

  o Clinical presentation can vary from minimally asymptomatic (discovered on testing) to symptomatic hyperglycemia leading to DKA
Type II Diabetes (cont.)

• Other treatment considerations
  o Diabetes Education
  o Psychosocial Factors
  o Lifestyle Modification
    • Healthy eating patterns – nutrient dense, high quality foods
    • Exercise – 30 to 60 minutes of vigorous activity 5 X week (strength training 3 X week)
    • 7 – 10% decrease in % overweight
    • Should be attempted as 1st line therapy for a 3-6 month trial
## Glycemic Targets in Type II Diabetes

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>NORMAL</th>
<th>ADA</th>
<th>ACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premeal plasma glucose (mg/dl)</td>
<td>&lt;100</td>
<td>70-130</td>
<td>&lt;110</td>
</tr>
<tr>
<td>Post-prandial plasma glucose (mg/dl)</td>
<td>&lt;140</td>
<td>&lt;180</td>
<td>&lt;140</td>
</tr>
<tr>
<td>HbA1c</td>
<td>4-6%</td>
<td>&lt;7%</td>
<td>&lt;6.5%</td>
</tr>
</tbody>
</table>
Type II Presentation and Treatment Algorithm

- **Type 2 DM Presentation**
  - **Mild hyperglycemia:**
    - FBG < 150
    - 2 hr post 75 g glucose < 300
    - Exercise & Diet 3-6 month trial
      - Successful:
        - FBG < 100 mg/dl
        - HbA1c < 6%
        - 2 hr post glucose < 140 mg/dl
      - Unsuccessful
    - Unsuccessful

  - **Severe hyperglycemia:**
    - FBG > 150
    - 2 hr post 75 g glucose > 300
    - BG < 350
      - ketoacidosis
      - Metformin
        - Unsuccessful
        - Add additional agent
    - BG > 350
      - +/- ketoacidosis
      - Insulin
Metformin

• Only hypoglycemic agent currently FDA approved for treatment in pediatric population

• Biquanide that lowers blood glucose by:
  o Decreasing hepatic glucose production
  o Increasing insulin sensitivity
  o Reducing intestinal glucose absorption

• Risk of hypoglycemia and weight gain is minimized
  o Does not increase insulin secretion

• In adults, doses of up to 2500 mg/day have shown decreases in FBG of -52 mg/dl and reductions of HbA1c of -1.4%

• In children dosing NOT mg/kg
When Metformin alone not effective

- Patients with blood glucose > 250 mg/dl or A1C > 8.5 w/o acidosis at diagnosis but have symptomatic polyuria, polydipsia, nocturia, and/or weight loss should be treated with basal insulin while metformin is titrated.

- Patients presenting with ketosis/ketoacidosis should be treated with SQ or IV insulin to rapidly correct the hyperglycemia and metabolic dearrangement. Once acidosis is resolved, metformin should be initiated while SQ insulin is continued.
  - Insulin can be tapered when glucose target are being met at home.
  - If glucose target cannot be met - treat as Type 1 diabetic.
Dosing in children: start with 500 mg twice a day, increase in 500 mg increments to a max of 2000 mg per day.

Metformin intolerance or renal deterioration – add long acting basil insulin such as glargine, detemir, degludec

If metformin + basal insulin does not meet glycemic target:
- suspect medication nonadherence
- Increase basal insulin dose and/or add rapid acting meal time doses
- Basal insulin doses of > 1.5 units/kg/day may be needed – consider concentrated insulin – 200 units/ml (Tresiba), 300 units/ml (Toujeo), 500 units/ml Humalog.
Metformin (cont.)

• Adverse Effects
  o Abdominal pain – extended release product minimizes
  o Diarrhea
  o Nausea and vomiting
  o Headaches
Metformin Summary

- Metformin, titrated up to 2000 mg/d, improved glycemic control (FPG, HbA$_1^c$) in children with type 2 diabetes
- No adverse effects on body weight, BMI, or lipid profile
- Well tolerated; AEs similar to adult population – gastrointestinal upset
Other Type II Medications

• Adult Type 2 medications
  o There 25 medications approved for adults – none approved for patients < 18 years
  o Rosiglitazone has been studied
Type II Take Home Points

• All the dynamics concerned with Type 1 Diabetes applies to Type 2 diabetes
• As with Type 1 Diabetes, there is a concern for microvascular and macrovascular complications
• Transitioning from pediatric to adult a challenge
References


References (cont.)


• Paid 1 Scale. Retrieved from: https://diabetesclinicevaluation.weebly.com/paind-1scale.html

References (cont.)


References (cont.)