

# Management of Diabetes in Children and Adolescents

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## Disclosures:

\*I have no conflicts of interest or other disclosures relevant to this presentation.

## Objectives/Goals

- \* ***Discuss principles of diabetes mellitus (DM) management in childhood through adolescence.***
- \* State goals for HgA1C and blood glucose levels for children/teens with diabetes.
- \* State common emergencies related to children/teens with diabetes.
- \* Recognize developmental stages of children/teens as they relate to managing diabetes.
- \* Review types of insulin pumps and continuous glucose monitoring utilized for glucose management with children and teens.



## Incidence of Diabetes

- \* **Type 1 diabetes has been increasing by 2–5% yearly worldwide**
- \* **CDC reports type 1 increased by 1.8% each year from 2000-2012 in U.S.**
- \* **Type 2 diabetes increased by 4.8% a year from 2000-2012 in youth ages 10-19**
- \* **Prevalence of T1D is approximately 1 in 300 in the US by 18 years of age.**
- \* **Non-Hispanic white youth have the highest rate of new cases of type 1 diabetes**

\* (CDC.org)



## **Type 1 Diabetes Pathophysiology and Diagnosis**

- \* **Auto-immune beta cell destruction with loss of insulin production.**
- \* **May have several positive antibodies: islet cell, GAD, IA-2, IA-2B, or insulin autoantibodies**
- \* **Must have at least 1 of these 3, on at least 2 occasions: Plasma glucose > 200mg/dl with symptoms of diabetes , fasting plasma glucose >126, 2hr glucose during 75 g oral glucose tolerance test >200mg/dl**
- \* **A1C levels between 5.7% and 6.4% are considered to have prediabetes and those with levels of 6.5% or higher are considered to have diabetes.**

## **Management Goals for Children/Teens**

- \* **Normal growth & development : Growth should be assessed every 3-4 months.**
- \* **Optimal glycemic control : Should be individualized to achieve lowest A1c possible with minimal hypoglycemia.**
- \* **Minimal acute or chronic complications: Hyper/hypoglycemia prevention.**
- \* **Positive psychosocial adjustment: Consider developmental stage of child/adolescent**



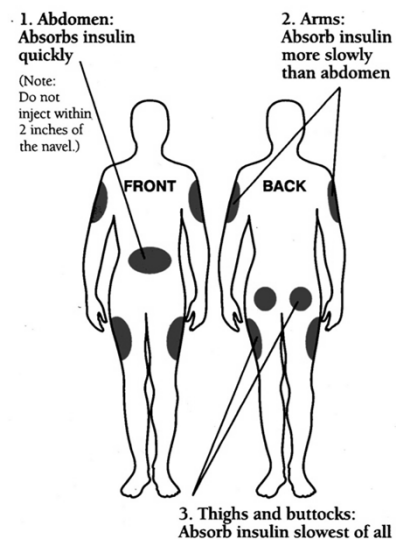
## ADA Recommendations for Glucose Control in Children/Teens

**\* The American Diabetes Association recommends the following blood glucose ranges for children with Type 1 diabetes.**

Age	Before meals	Bedtime-Overnight	Goal A1c
Birth-19 years	90-130	90-150	<7.5%

## Insulin Injection Sites

- \* **Rotate sites . Young children will usually prefer arms, legs, & buttocks.**
- \* **Insulin is absorbed quickest from abdomen, then arms, then legs, and slowest from hips.**
- \* **Assess sites for hypertrophy or thickening before giving injections.**
- \* **Abdomen hips, thighs, and arms can be used for insulin pump sites.**



## Which Insulin Regimen?

\* **Type of insulin used should be based upon:**

- \* **Eating patterns and age of child**
- \* **Family needs/support**

\* **Should be individualized**



## Typical Insulin Dosages Used with Children/Teens

- \* **DOSAGE:** Children typically require 0.7- 1 unit of insulin per kg/body weight if they are out of honeymoon.
- \* Ranges can be 0.5-1.5u/kg/day. Overweight children and children/teens going through puberty may require higher dosages. Consider age, eating patterns, and metabolic requirements.
- \* **During honeymoon** children/teens may need as little as 0.3u/kg/day. Newly diagnosed children detected early may require less insulin.
- \* **Most children/teens enter a honeymoon phase with decreased insulin needs. Can last several weeks-2years**

## Which Insulin is Best?

- \* When deciding on insulin types to be used , the diabetes team should take into account changing food intake, insulin requirements (based on weight /pubertal status) , and physical activity
- \* Consider availability of parents or school nurse to supervise lunch injections. Basal/bolus regimens are used most often.
- \* 50% TDD – Usually given as long acting – basal insulin once daily
- \* On some occasions NPH may be used twice daily as basal insulin
- \* Other 50% given as rapid acting insulin to prevent hyperglycemia with meals/snacks or as correction

## Basal/Bolus Regimen

- \* Insulin glargine (Lantus, Basaglar), detemir (Levemir), and degludec (Tresiba) are 24 hour basal insulins. These should not be mixed in the same syringe with any other insulin.
- \* Dose should be based on weight or previous total daily insulin dose (TDD). Dose is approximately 50% of TDD.
- \* Child/teen does not need to have scheduled snacks unless increased activity is planned, such as: PE, recess, or sports. Typically add 10 gram carb snack without insulin coverage during increased activity.



## Rapid Acting Insulin for Carbohydrate Coverage

- \* **Insulin lispro (Humalog and Admelog), aspart (Novolog), & glulisine (Apidra) insulins are used to cover carbohydrates with meals and snacks. These are rapid acting insulins.**
- \* **The diabetes team will prescribe an insulin to carbohydrate ratio. Parent's are taught to watch for patterns of high/low blood glucose and how to adjust ratio's at home**



## Adjusting Carbohydrate Ratios

- \* **If blood glucose is over target 3 hours after meals or under target 1-3 hours after meals, consider adjusting the ratio.**
- \* **Older school age children and teens should be able to take insulin before the meal for carbs and high blood glucose. This will cut down on missed class time and help prevent post prandial hyperglycemia.**

## Insulin Dosing for Children/Teens Split /Mixed dosing

- \* **Very rigid regimen, requiring set doses of insulin at set times with set amount of carbohydrates at meals**
- \* **Greater risk of hypoglycemia with peaks of NPH insulin**
- \* **Insulin is usually dosed with : 2/3 total daily dose (TDD) in AM before breakfast and 1/3 in PM. Further broken down to : AM 1/3 rapid acting insulin and 2/3NPH. PM: 50% rapid acting insulin and 50% NPH**
- \* **NPH may be given at bed to help prevent hypoglycemia in middle of night**

## Comparing Insulin Regimens

### Basal/Bolus

- \* **Insulin must be taken with every meal and snack (unless participating in strenuous exercise)**
- \* **Typically do not have a set amount of carbohydrates**
- \* **3 meals and 1-2 snacks**
- \* **Free foods may be used without insulin coverage**

### Split/Mixed

- \* **Set doses of carbohydrate to match set doses of insulin**
- \* **Typical eat 3 meals and 1-2 snacks**
- \* **Snacks are given to counteract insulin peak times**
- \* **Free foods can be consumed between planned meals/snacks**

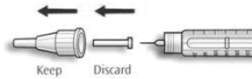


## Non-disposable Insulin Pens

\***NovoPen Echo** - Dosing starts at 0.5 units. Increments are in 0.3 units thereafter. Has a memory that shows last dose given. Waste 2 units before dialing dose.

\* **HumaPen Luxura-HD** - Newer version starts with 0.5 units.

\***Check pens to see if pen starts with 0.5 or 1 unit. Waste 2 units before dialing dose.**



## Disposable Insulin Pens

\* **Disposable pens available for insulin aspart (Novolog Flexpens) and insulin lispro (Humalog Kwikpens and Admelog SoloStar). Doses are dialed in 1 unit increments. Waste 2 units before dialing dose.**

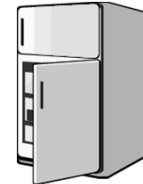
\* **Pen needles - Always use a new needle. Mini pen needles do not require pinching of skin and should go straight in with needle. Count to 10 before removing needle.**

\* **Always remove the needle after use and do not store the pen with the needle on.**



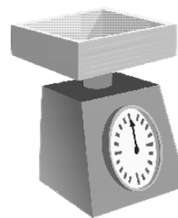
## Insulin Storage

- \* Rapid acting insulin pens or cartridges in use, can be kept at room temp for 28 days. Not above 86 degrees
- \* Unopened vials and pens should be kept in refrigerator
- \* Always check expiration date
- \* Premixed pens and NPH pens in use, can be kept at room temp for 10-14 days- always check package insert
- \* Pen needles should be removed after use and new needle used with every injection



## Carbohydrates and Diabetes

- \* **Diabetes management is a balancing act. We are constantly balancing insulin with food, exercise, and other factors.**
- \* **Carbohydrates are the foods that affect the blood glucose the most. They are broken down to sugar. They are our energy foods.**



# Healthy Nutrition

- \* It is not recommended to eliminate carbohydrates so that an insulin injection is not needed
- \* Encourage healthy food choices using the plate method
- \* Do not recommend sweet sodas or fruit punch drinks. Only 1 fruit or juice per meal



# Carbohydrate Counting

Nutrition Facts	
Serving Size 2 crackers (14 g)	
Servings Per Container About 21	
Amount Per Serving	
Calories 60	Calories from Fat 15
% Daily Value*	
Total Fat 1.5g	2%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 70mg	3%
Total Carbohydrate 10g	3%
Dietary Fiber Less than 1g	3%
Sugars 0g	
Protein 2g	
Vitamin A 0%	Vitamin C 0%
Calcium 0%	Iron 2%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.	
Calories: 2,000 2,500	
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2400mg 2400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g

- \* In this example 2 crackers = 10 grams carbohydrate.
- \* If your ratio is 1:20, then you would give 0.5units insulin aspart (Novolog), lispro (Humalog, Admelog), or glulisine (Apidra)
- \* If they ate 4 crackers, you would give 1 unit of insulin
- \* If you calculate 0.7units and child is going to PE then give 0.5units (round down) ; if they are running high round up or follow medication orders

## Carbohydrate Counting

\* Food labels and Calorie King are great references

\* ADA Exchange List is another great resource



## Type 2 Diabetes Facts

- \* **Underlying feature is insulin resistance**
- \* **Leads to increased insulin production – hyperinsulinemia with subnormal response to this insulin**
- \* **Insulin resistance is likely hereditary and may be associated with puberty**

## Goals for Management type 2 diabetes

- \* **Goal is to get to ideal body weight with increased exercise and healthy meal planning**
- \* **Decrease risk of co-morbidities associated with insulin resistance**
- \* **Prevention of long term complications**
- \* **Treatment of Type 2 Diabetes is similar to type 1 treatment, with increased focus on lifestyle modification**



## Blood glucose goals for type 2 diabetes

- \* **ADA recommends fasting blood glucose <126**
- \* **Normal A1c**
- \* **Should monitor for complications- dilated eye exam and micro albuminuria screen yearly**
- \* **Screening for BP, lipids, foot exam, and macro vascular disease should be performed, but time frame is not defined.**



## Type 2 Diabetes Management

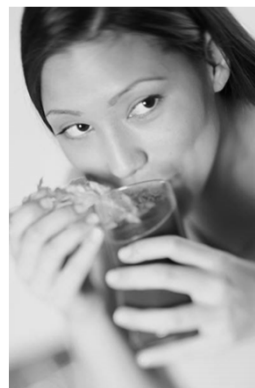
- \* **Metformin (Glucophage) is only oral agent currently approved for children ages 10-16 years of age**
- \* **Recommended starting dose is 500mg BID. Can be increased in 500mg increments for max dose of 2000 mg per day**
- \* **Often need insulin at diagnosis to get blood glucose under control and A1C down**



## Hypoglycemia

### Possible causes

- \* **not enough food**
- \* **exercise without snack**
- \* **too much insulin**
- \* **Stress**
- \* **injection site**
- \* **nausea and vomiting**





## Hypoglycemia

### \* Symptoms:

- mild: sweating, trembling, difficulty concentrating, lightheadedness
- severe: inability to self-treat due to mental confusion, lethargy, unconsciousness

- \* Sugar is the main source of fuel for the brain. Young children may not recognize symptoms of shakiness, fast heart rate, and may go quickly to symptoms of drowsiness, behavior change, confusion, double vision, loss of consciousness, and/or seizure.



## Hypoglycemia Prevention

- \* Instruct patient/family to call for low blood glucose reading patterns.
- \* Instruct patient/family to check blood glucose before bed. If blood glucose is less than 100-125 add at least 10 grams of complex carb with protein/fat at bed
- \* Recheck blood glucose at 2 am if needed



## Hypoglycemia Treatment

\* **Blood glucose < 70-80 give 3-4 glucose tabs (15 grams) and recheck blood glucose in 15 minutes. Repeat as needed until over 70**



\* **If unable to chew tabs use 3-4 ounces of juice or 15 grams glucose gel in cheek**



## Unconscious Hypoglycemia Treatment

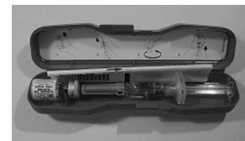
\* **Glucagon is a hormone secreted by the pancreatic alpha cells. It stimulates the body to release glucose that is stored in liver/muscle**

\* **Inject in thigh muscle and immediately turn child to side due to high risk of nausea/vomiting**

\* **Dosage:**

\* **1 mg IM for adults and children >20kg**

\* **0.5 mg IM for children < 20kg**







## Hyperglycemia



- \* **If blood glucose is > 240, urine ketones should be checked**
- \* **Utilize correction scale if it has been 3 hours since last meal, snack, or correction insulin. Use insulin pump if ketones are negative-follow bolus calculator**
- \* **Encourage copious amounts of water, at least 8oz every hour**
- \* **If unable to drink, if vomiting, or if metabolic panel indicates acidosis- IV fluids and IV insulin are often needed**
- \* **Ketones do not occur from “eating the wrong foods,” they occur from missed insulin doses- usually long acting insulin [insulin glargine (Lantus, Basaglar), insulin detemir (Levemir), or NPH]**

## Sick Day Rules for Type 1 Diabetes

- \* **It is important to have a sick day plan**
- \* **Do not skip long acting insulin--ever**
- \* **Check blood glucoses every 2 hours**
- \* **Check urine for ketones with every 2 hours, regardless of blood glucose.**





## Sick Day Rules

- \* **If child/teen has a stomach virus with vomiting /diarrhea diabetes team may lower long acting insulin dose for several days – never skip**
- \* **May not give rapid acting insulin until child is able to keep down solid food**
- \* **During colds, sore throats, and respiratory illnesses, blood glucose usually goes up. Give entire insulin dose and cover hyperglycemia with correction insulin every 3 hours**
- \* **Encourage yearly flu vaccine**

## Sick Day Rules for Diabetes

- \* **If blood glucose is running low may need to drink at least 10-15 grams carbohydrates in the form of sugar containing fluids every hour**
- \* **Fluids are typically tolerated in 0.5-2 ounces every 10-15 minutes. Good choices are Pedialyte, Ricelyte Gatorade**



## **Sick Day Rules for Diabetes**

- \* For children/teens with type 2 diabetes on insulin, follow insulin and sick day diet guidelines for type 1 diabetes**
- \* Hold metformin with nausea or vomiting. This may increase symptoms of GI upset**



## **Sick Day Rules for Diabetes**

**For nausea and vomiting with moderate to large ketones, call the diabetes team or provider on call**





## ER Visits

- \* **The family of any child who has moderate to large ketones with vomiting should page the Pediatric Endocrinology team**
- \* **If the physician directs a family to take the child to the ER then they should do this immediately**
- \* **If a child has moderate to large ketones with shortness of breath they should call EMS and get to the nearest ER**



## Exercise with Diabetes

- **May need to add more carbohydrates depending on intensity of exercise and pre-exercise blood glucose**
- **Some children/teens like to sip G2 (Gatorade 2) during exercise to keep blood glucose up-don't over treat**
- **Some children/teens notice an increase in blood glucose after exercise- adrenaline response**



## Erikson's Psychosocial Stages

- \* **Trust vs. Mistrust** – 1<sup>st</sup> year of life. Administer injections/finger sticks with calm attitude. Show affection during/after procedure
- \* **Autonomy vs. Shame/Doubt**- Toddler. Offer simple choices of which finger, but must be firm with limits
- \* **Initiative vs. Guilt**- **Preschool ages 3-5**  
Conscience develops . Magical thinking. May view procedures as punishment. Worried about intactness of body. Offer band aids and simple explanations



## Erickson's developmental stages

- \* **Industry vs. Inferiority**- School age. Has a conscience, can share,& cooperate. Slowly introduce some diabetes management task. Supervision is essential!
- \* **Identity vs. Role Confusion**- Adolescents.  
Early adolescents are acutely aware of body image. Middle adolescents peer group is very important. Late Adolescents have greater separation from family, peers become less important and self identity is more important.



## Cognitive Developmental Stages/considerations



- \* **Infant/Toddler( birth- 2years)-** Sensorimotor stage- Period of rapid growth and development. Need to fit sleep/naps into regimen.
- \* Infants usually nurse or eat predictably. Toddler eats erratically as growth slows.
- \* **Differentiation** begins 4-5 months, separation-individuation 6 months, crawling 9 months, 10-12 month walking & manual skills – described as having “love affair with world.”

## Infant/toddler



- \* **Consider every 3-4 hour feedings to prevent hypoglycemia**
- \* **Frequent monitoring- use fingers, toes, lateral aspect of heel.**
- \* **Diabetes in early years has been associated with impaired abstract and visual reasoning and attention deficits. May be associated with undiagnosed hypoglycemia or seizures.**

## Preschool age 3-5 years



### **Preoperational stage-** Ages 2-7

- \*Developing motor skills
- \*Period of “magical thinking”
- \*Body integrity or intactness is important
- \*Have difficulty understanding need for insulin injections when they feel well.
- \*Allow for some choices with injection sites, finger sticks.
- \*Play therapy or allowing child to use dolls, etc... help them cope
- \*Consider eating/insulin patterns, day care education, and ability to report symptoms hypoglycemia



## School age child- ages 6-10 years

### **Concrete operational stage**

- \* Avoids failure in school and activities
- \* Parent-child sharing and supervision is important in regards to diabetes task
- \* Consider school forms, PE, insulin, and nutritional needs
- \* Begins to think logically about concrete events





## Adolescent

### Formal Operational Stage - Abstract reasoning

- \* **Early Adolescence or preadolescence (12 years)**
- \* **Middle adolescence (13-15 yrs)**
- \* **Late adolescence (16-21yrs)**
- \* **Becomes aware of body image, struggles between parent/child, more involved with peers, parental criticism difficult for child**
- \* **Onset of puberty can cause need for increased insulin dose due to relative state of insulin resistance due to hormonal changes.**



## Adolescent issues/concerns

- \* **Diabetes can interfere with normal adolescent development. Concerns with appearance of injection sites and with self-identification as “a diabetic.”**
- \* **Physical growth and sexual maturation concerns**
- \* **Experimentation and rebellion usually centers around diabetes management**
- \* **Educate on substance abuse, prevention of STD's/ pregnancy**
- \* **Driving safety issues**
- \* **DKA- with girls may be weight loss plan**





# Diabetes Management

## Insulin Pump Therapy and Continuous Glucose Monitoring



## Things to Consider Before Switching to Pump Therapy

- **Willing to monitor blood glucose at least 4 times day**
- **Responsible parent/caregiver &/or adolescent**
- **Ability to count carbohydrates or designated person to assist with carbohydrate counting**
- **Ability to troubleshoot hyper/hypoglycemia**
- **Ability/willingness to keep in contact with diabetes team**
- **School plan for bolusing for meals / snacks**
- **Prefer A1C to be under 9%**
- **Age of child at time of diagnosis**

## Types of Insulin Pumps

- \* **Commonly used insulin pump brands are: Medtronic, Omni Pod, T-Slim**
- \* **All pump companies have a 24 hour customer service hotline and will assist with mechanical questions/alarms.**



## Basics of Insulin Pumps

- \* **Only insulin aspart (Novolog) or insulin lispro (Humalog) is approved for use in insulin pumps**
- \* **Selecting an insulin pump is based on lifestyle and insulin needs**
- \* **Insulin pumps are either tubeless or use tubing for insulin delivery**
- \* **Some insulin pumps integrate with continuous glucose monitors**
- \* **Sites are changed every 2-3 days**
- \* **Always have insulin pens or vials as back up therapy**

## Tandem T-Slim

- \* **Set up to 24 different basal rates**
- \* **Lowest basal rate is 0.1 units/hour**
- \* **Can adjust up to 0.001 units**
- \* **Basal IQ will adjust basal rates based on blood glucose levels if using Dexcom G6**



## Medtronic 670G

- \* **Set up to 24 different basal rates**
- \* **Lowest basal rate is 0.025 units/hour**
- \* **First hybrid closed loop system**
- \* **Integrated with guardian continuous glucose monitor sensor for optimal glucose control**



# Omnipod

- \* Set up to 24 different basal rates
- \* Lowest basal rate is 0.05 units/hour
- \* Only tubeless insulin pump
- \* Is not integrated with any continuous glucose monitors



## Treatment of Hyperglycemia on Insulin Pump

- \* Blood glucose > 240, check urine ketones
- \* **If ketones are negative**, give a high blood glucose bolus via pump if it has been 3 hours since last meal, snack or bolus.
- \* **If ketones are positive** - DO NOT use the pump, give an injection of insulin aspart (Novolog), lispro (Humalog, Admelog), or glulisine (Apidra) based on MD orders.
- \* Change pump site



## Treatment of Hyperglycemia with Insulin Pump

- Drink at least 8 ounces water every 30-45 minutes or give IV fluid bolus
- Recheck blood glucose in 1-2 hours to make sure blood glucose is coming down.



## Treatment of Hypoglycemia with Insulin Pump

- Check blood glucose and treat low
- Continue to treat low blood glucose until glucose is above 70
- Adjust insulin doses to prevent hypoglycemia if hypoglycemia becomes persistent



## Continuous Glucose Monitors (CGM)



- \* Dexcom G6, Medtronic Guardian, and Freestyle Libre are most commonly used CGM in children
- \* Some devices are integrated with insulin pumps
- \* CGM can be used with all types of insulin therapy
- \* CGM can reduce the amount of daily finger sticks
- \* Recommend blood glucose monitor as a double check

## Closing Tips To Keep On Target



- \* **Because children with diabetes are still growing, their insulin doses require frequent adjustments. Recommend Endocrine visits every 3 months**
- \* **Monitoring blood glucose at least 4 times per day is important to identify trends requiring insulin dose, diet and/or exercise regimen changes.**

### **Learning Assessment Question #1**

**\* What are the best tests or indicators to differentiate type 1 from type 2 diabetes?**

**\* A. Islet cell antibodies, GAD, anti-insulin antibodies**

**\* B. Genetic testing**

**\* C. Family history**

**\* D. Obesity vs. thin build**

### **Learning Assessment Question #2**

**\* Which of the following is the goal A1c recommended by the ADA for children (birth to 19 years)?**

**\* A. <6.0%**

**\* B. <6.5%**

**\* C. <7.0%**

**\* D. <7.5%**

### **Learning Assessment Question #3**

- \* Which of the following should be done on a sick day?**
- \* A. Skip long acting insulin dose**
- \* B. Check blood glucoses every 6 hours**
- \* C. Check urine for ketones if blood glucose is >300**
- \* D. Hold metformin if nauseous or vomiting**

### **Learning Assessment Question #4**

- \* An insulin pump may be a good option in:**
- \* A. An irresponsible patient with little caregiver involvement**
- \* B. A patient who does not want to monitor their blood glucose numerous times per day**
- \* C. A patient with an A1c of >10%**
- \* D. A patient experienced with carb counting**



## References

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