



Caring for Students with Diabetes

Katie O'Sullivan, MD
 Amy Hess Fischl, MS, RDN, LDN, BC-ADM, CDCES
 Kovler Diabetes Center
 UChicago Medicine
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Objectives:

1. Review types of diabetes and goals of treatment
2. Review the Diabetes Medical Management Plan (DMMP)
3. Recognize the symptoms of hypoglycemia and how to respond
4. Understand when to screen for and how to manage ketones
5. Updates regarding newest diabetes technology and devices
 - Continuous glucose monitors
 - Insulin pump therapy
 - Smart pens
6. Have awareness of how physical activity may affect diabetes






Katie O'Sullivan, MD
 Assistant Professor, Adult & Pediatric Endocrinology

Disclosures:

No Conflict of Interest




Case: 13 year old Mexican American female with diabetes and obesity

- Recently diagnosed with diabetes at 12 years old when she was hospitalized for diabetic ketoacidosis. Hemoglobin A1c at diagnosis was 9.7%. Her father and maternal grandmother have type 2 diabetes.
- Medication regimen:
 - Basaglar (glargine) insulin 18 units every night at bedtime
 - Admelog (lispro) insulin 1 unit for every 10 grams of carbohydrates with meals
 - Admelog (lispro) insulin hyperglycemia correction scale with meals if glucose:
 - 151-200: 1 unit
 - 201-250: 2 units
 - 251-300: 3 units
 - 301-350: 4 units
 - >350: 5 units

Case Questions

1. What type of diabetes does she have?
2. What are the goals of diabetes treatment?




Diabetes in Children

- Diabetes is one of the most common chronic diseases of childhood
- T1DM affects 200,000 youth less than 20 years old in the US
 - 21% increase in prevalence between 2001-2009
- T2DM affects at least 12.5 per every 100,000 youth in the US
 - Accounts for ~ 20% of all pediatric diabetes cases
 - Accounts for ~ 50% of diabetes among adolescent minority populations
 - ~ 200% increase in prevalence from 2019-2020 (due to COVID!)

What is Diabetes?

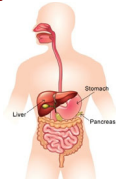
- Level of blood glucose (= "sugar") is higher than normal
- Diagnosis of diabetes is made in children when:

	Prediabetes	Diabetes
Fasting glucose	≥ 100-125 mg/dL	≥ 126 mg/dL
2-hr glucose on OGTT	≥140-199 mg/dL	≥ 200 mg/dL
Hemoglobin A1c	5.7-6.4 %	≥ 6.5 %



What happens to glucose in the body?

- Carbohydrates break down into glucose
- Glucose enters the blood.
- Pancreas makes insulin.
- Insulin allows glucose to enter the cells.

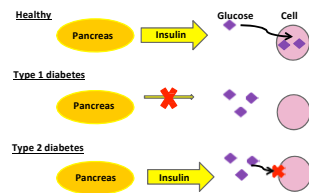


Types of Diabetes

- **Type 1 Diabetes:** pancreas does NOT produce insulin
- **Type 2 Diabetes:** body fails to use insulin properly; aka "insulin resistance"

Other types of diabetes:

- **Drug-induced Diabetes:** diabetes after taking certain medications like steroids
- **Monogenic Diabetes:** caused by over 20 different gene mutations
- **Diseases of the pancreas causing diabetes** like cystic fibrosis



Clinical features	Type 1	Type 2
Age of diagnosis (yrs)	Any age in childhood	Always at puberty or older
Weight	Usually thin, but overweight becoming more common	>90% are overweight
Autoantibodies	Present	Absent
Insulin dependent	Yes	Maybe
Insulin sensitivity	Normal when controlled	Decreased
Family history/Genetics	Infrequent (5-10%)	Frequent (75-90%)
Risk of DKA	High	Low/Medium

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Goals of Treatment

- Significant link between glucose control and later development of diabetes complications
- **Glycemic targets should be individualized**
 - **Higher glucose targets in younger children and children with T1DM, frequent hypoglycemia or hypoglycemia unawareness**
 - **Typical targets:**

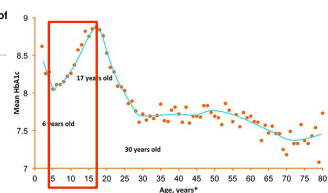
	Type 1	Type 2
A1c	≤ 7.5%	≤ 6.5%
Pre-Meal glucose	90-130 mg/dL	70-130 mg/dL
2-hr post-meal glucose	< 180 mg/dL	< 150 mg/dL

Continuous glucose monitor: 70% time in range (70-180 mg/dL), < 4% hypoglycemia

ADA Standards of Care 2020

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Average A1c of patients with T1DM by Age



710 Exchange 2015

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Diabetes Medical Management Plan (DMMP)

- **Plan developed by health care provider along with parent/guardian**
- **Specifically addresses the following:**
 - 1. Blood glucose monitoring**
 - Frequency of blood glucose checks
 - Use of continuous glucose monitoring (CGM)
 - 2. Insulin or other medication administration**
 - Dose, injection times
 - What parent/guardian adjustments to dose can be made
 - 3. Meal Plan and Snacks** (content, amount, timing)
 - 4. Hypoglycemia:** Specific symptoms and treatment
 - 5. Hyperglycemia:** Specific symptoms and treatment
 - 6. Checking for ketones** and appropriate actions
 - 7. Participation in Physical Activity** and Sports
 - 8. Emergency instructions, contacts**
 - 9. Contact information for medical provider**

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Diabetes Medical Management Plan

- **Lays out level of student's self-care skills. For example:** "Student's self-care blood glucose checking skills":
 - Independently checks own blood glucose
 - May check blood glucose with supervision
 - Requires a trained diabetes personnel to check blood glucose

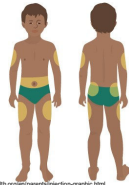
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Sample DMMP

- <http://main.diabetes.org/dorg/PDFs/living-with-diabetes/diabetes-medical-management.pdf>

Insulin Therapy

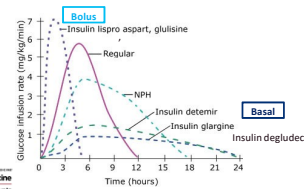
- Insulin is delivered under the skin via a pen, syringe, or an insulin pump



Insulin Therapy

	Onset	Duration	Examples
Rapid-Acting	15 min	2-4 hrs	Aspart (Novolog, Fiasp) Lispro (Humalog, Admelog) Glulisine (Apidra)
Regular	30 min	3-6 hrs	Insulin regular (Novolin R)
Intermediate	1-2 hrs	12 hrs	NPH (Novolin N)
Long-acting	2 hrs	24 hrs	Glargine (Lantus, Basaglar) Detemir (Levemir)
Ultra-Long acting	6 hrs	36-42 hrs	Degludec (Tresiba) Glargine U-200 (Toujeo)

Insulin Activity Profiles



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Four types of Insulin Regimens

1. Adjustable Bolus Insulin Therapy:

- Child receives long-acting insulin once or twice a day at home or at school (if noted in DMMP)
- Child receives short-acting insulin for **meals/snacks**
 - Example: 1 unit for every 10 grams of carbohydrates
- Child receives short-acting insulin for **high blood sugar correction**
 - Example A: 1 unit for every 50 mg/dL > 150 mg/dL
 - Example B: 151-200: 1 unit; 201-250: 2 units, etc.
 - Example C: sensitivity = 50, target BG = 100
 - # units of insulin given = [Current BG – target BG]/sensitivity

Types of Insulin Regimens

2. Fixed Bolus Insulin Therapy:

- Child receives long-acting insulin (same as prior plan)
- Child receives **FIXED DOSE** short-acting insulin for **meals/snacks**
 - Example: 5 units with lunch, 2 units with snack
 - Typically there is a carb goal with meals (example 60-75 grams /meal)
- Child receives short-acting insulin for high blood sugar correction (same as prior plan)

3. Intermediate Insulin/Regular Insulin:

- Child receives intermediate + regular insulin prior to breakfast AND prior to dinner
 - Example: Novolin 70/30 10 units before breakfast, 5 units before dinner

Types of Insulin Regimens

4. Insulin pump therapy

- Only uses rapid-acting insulin to provide doses of:
 - Basal insulin = small amount of insulin is administered continuously and automatically 24 hours/day
 - Bolus insulin = insulin given with food and for treatment of hyperglycemia with user intervention

Hypoglycemia (Low level of glucose in blood)

- **Must be treated immediately**
- **May progress to unconsciousness and brain damage if untreated**
- **Definition:**
 - Mild = glucose < 70 mg/dL
 - Moderate = glucose < 54 mg/dL
 - Severe = low glucose + mental status change
- **Symptoms:**
 - Sweaty, shaky, heart racing, extreme hunger
 - Combative, restless, irritable, confused, sleepy
 - Severe: unresponsive, unconscious, seizures (jerking movements)

Treatment of Mild Hypoglycemia

- Intervene right away. Don't leave child unattended. Follow DMMP.
- Verify low blood sugar. If no meter, treat low blood sugar.
- Follow "RULE of 15"
 - Eat/drink 15 gram fast-acting carbohydrate (less if young child)
 - 4 ounce juice, 6 ounce regular soda, 4 tsp sugar
 - 3-4 glucose tabs, 1 tube glucose gel
 - Check blood glucose 15 min after treatment
 - Repeat 15 gram treatment if blood glucose is still low

Treatment of Severe Hypoglycemia

- Place student on his/her side, Lift chin to keep airway open
- Inject Glucagon, per student's DMMP
- Call 911
- Call parent/guardian
- Student should respond in 10-20 min
- Remain with student until help arrives
- When student is able to swallow, have them drink a fast-acting source of sugar (juice) and eat a long-acting source of sugar (cheese + crackers)

Types of Glucagon



Ketones and Diabetic Ketoacidosis

- Ketones = sign of severe insulin deficiency or insulin resistance
- High ketones + acidic blood = Diabetic Ketoacidosis
- Symptoms of DKA:
 - Hyperglycemia (T1DM glucose > 250 mg/dL, T2DM glucose > 300)
 - Nausea, vomiting
 - Abdominal pain
 - Fast breathing and/or shortness of breath; Fruity breath
 - Confusion

How to check for Ketones? How to treat?

- Check ketones using:
 - Urine test strip
 - Blood ketone meter
- Treatment =
 - If vomiting, unable to drink, or appears ill -> go to the ER
 - Give correction dose w/ fast-acting insulin
 - via pen/syringe, not via the pump
 - Extra Water
 - Rest (no gym class)
 - Notify parents +/- endocrine clinic
 - Repeat ketone check in 2 hours. May need to go to ER if still present.



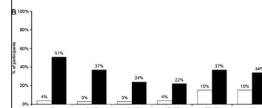
Disclosures:

Abbott Diabetes Care – speakers bureau
Xeris – speakers bureau

Amy Hess Fischl, MS, RDN, LDN, BC-ADM, CDCES

Technology use and school children

- Europe -- Increase from 1-53% -- pump use; Increase from 3-38% -- CGM use
 - USA -- T1D Exchange --% change from 2010-2012 to 2016-2018
- CGM:**
- Increase from 50-68% <age 6
 - Increase from 58-68% ages 6-12



Technology use and school children

- **Current technology**
 - Blood glucose monitors
 - Continuous glucose monitors
 - Insulin pumps
 - Hybrid closed loop (HCL) systems
 - Do-It-Yourself (DIY) HCL
 - Smart pens
- **Charts of current BG monitors, CGMS, pumps – Diabetes Forecast annual Consumer Guide:**
 - <http://www.diabetesforecast.org/2020/02-mar-apr/consumer-guide-2020.html>

Use of CGM in schools

- Can uncover undetected hypoglycemia and other glucose trends
- Provide direction and rate of change of glucose
- Can provide alerts if glucose is traveling outside target range
- Can contribute to improved glucose control
- Ongoing and frequent use is recommended to maximize benefits
- Can reduce the number of fingersticks

CGM alarms

- CGM settings are prescribed by the health care provider with input from the student and parents/guardians
- Some CGMs are capable of sharing data real-time with caregiver(s) remotely
 - Data sharing while in school should be specified in the student's 504/IEP Plan – discuss pros/cons of use by staff
- Hypoglycemia is an acute risk and is usually set as an audible alarm
 - Other alarms are usually used conservatively to avoid unnecessary disruption of the student's school activities

CGM alarms

- If the CGM alarms for a low or high glucose, follow the instructions in the student's DMMP to determine treatment
 - CGM data should **not** be used to make treatment decisions unless specifically stated otherwise in the DMMP
 - Those managing diabetes independently may choose to respond to alarms and provide treatment without assistance
 - Those who cannot self-manage independently will require help responding appropriately to CGM alarms
- All students, regardless of level of independence, will require assistance when they experience severe hypoglycemia

CGM and treatment decisions

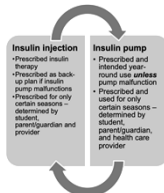
- Specific guidelines should be outlined in the student's DMMP; if not, use blood glucose for all treatment decisions
- **These are general guidelines, follow DMMP for each student:**

Meals	CGM values may be used to make treatment decisions the CGM is approved for use for dosing and the DMMP states the student can use the device to make treatment decisions
Hypoglycemia (lows)	<ul style="list-style-type: none"> • If the student feels low or if the CGM displays < 60, then check BG with meter and treat according to value, per DMMP • If the CGM displays low, but the student is not symptomatic, then check BG and treat according to meter value, per DMMP
Hyperglycemia (highs)	CGM values may be used to make treatment decisions if the CGM is approved for use for dosing and the DMMP states the student can use the device to make treatment decisions

Use of pumps in schools

-In cases of pump or site malfunction – always notify the parent/guardian but implement:

- DKA prevention guidelines:
 - If BG >250, correct and re-check BG in 1 hour
 - If BG has not started to decrease or if CGM arrow is rising, change site and give a manual injection for glucose level



Use of pumps in schools

- How to deliver routine boluses for carbs and high blood glucose
- Signals/symptoms that pump site may need to be changed
- When an injection by pen or syringe is indicated
- How to disconnect or "suspend" the pump
 - In the event the student becomes unconscious/unresponsive to current oral carbohydrate treatment and glucose levels dropping fast and unable to consume enough carbohydrate to raise it quickly
 - If instructed by the parent/guardian or diabetes care provider – during PE

Use of Hybrid Closed Loop (HCL) pumps in schools

- More advanced HCL systems self-adjust insulin delivery based on sensor data**
- Two pumps and 1 DIY pump on the market partially automates insulin delivery to help students stay in a target glucose range
 - Can be used in hybrid closed loop or manual mode (basic pump and sensor therapy without automated delivery)
 - Blood glucose testing with a meter or CGM that allows for dosing changes is still required by student for treatment decisions, per DMMP
 - Important to address alerts:
 - "enter BG"
 - calibration requests (only necessary for one version of HCL)
 - Students must bolus before meals/snacks to stay in HCL
 - If insulin is given by injection for ketones, HCL should be disabled
 - Students who cannot self-manage independently will require assistance

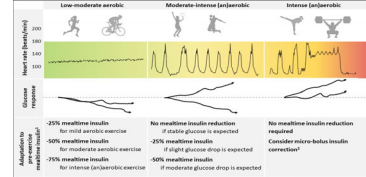
Use of smart pens

- Reusable pen for both short and long acting insulin
- Uses insulin cartridges (300 units) and pen needles (change every time)
- Connected to a phone app that uses:
 - Insulin to carb ratios
 - Correction factor
 - Active insulin time
- Utilizes pump bolus calculation concept
- Minimizes stacking
- Can set reminders to dose for meals and snacks
- Reports can be sent to HCP
- Can also be connected to certain CGM systems

Physical activity guidelines

- Physical activity will impact glucose levels and amount of insulin doses needed
 - Recess vs PE vs after school or travel sports
- DMMP will specify instructions before, during and after activity
 - Typically added carbs or insulin adjustments are needed to reduce hypo
- General rules – suspend activity if glucose is:
 - dropping below target range
 - consistent with hypoglycemia
 - elevated with ketones
 - >300 with or without ketones

Physical activity guidelines using technology



Physical activity guidelines using technology General carb requirements

	30-45 minutes of exercise	>45 minutes exercise
Meal consumed pre-exercise	~1.5 g carb/kg/BW for intense exercise (regular IOB) ~0.25 g carb/kg/BW for intense exercise (less IOB)	~0.4 g carb/kg/BW for pre HS snack if evening/late afternoon exercise
Meal or snack immediately pre-exercise	10-15 g carb depending on IOB and sensor glucose reading	10-15 g carb depending on IOB and sensor glucose reading
Meal consumed after exercise	Some carbohydrate intake essential for glycogen replenishment Small amount of protein (20-30g) may be beneficial for muscle protein synthesis	

Physical activity guidelines using technology General insulin adjustment based on activity

Bolus insulin dose reduction	-25% for mild aerobic -50% for moderate and intense aerobic 25% for mixed aerobic/anaerobic up to 50% post exercise	-50% for mild aerobic -75% for moderate and intense aerobic 50% for mixed aerobic/anaerobic up to 50% post exercise
Basal dose adjustment	MDI -20% for evening/late afternoon exercise Pump Up to 50% 90 min pre-exercise -20% for post-exercise night-time	MDI -20% for evening/late afternoon exercise -30-50% for all-day/unusual activities Pump Up to 80% 90 min pre-exercise -20% post-exercise night-time

Contact Information:

Katie O'Sullivan, MD
Phone: 773-702-6138
Email: kosullivan@medicine.bsd.uchicago.edu

Amy Hess Fischl, MS, RDN, LDN, BC-ADM, CDCES
Phone: 773-702-0123
Email: amy.fischl@uchospitals.edu