Section 4: Type 1 Diabetes

SECTION OVERVIEW
- Definition and Symptoms
- Insulin
- Insulin Delivery
- Sharps Disposal
- Blood Glucose Monitoring
- Healthy Eating
- Physical Activity

Definition and Symptoms

Type 1 diabetes occurs when the pancreas produces little or no insulin. Our bodies break down the food we eat into sugar. This sugar is commonly called glucose. Insulin is a hormone made by the pancreas that helps turn glucose into energy. People with type 1 diabetes must give themselves insulin to survive. Students with type 1 diabetes monitor blood glucose levels at least four times per day and balance the amount of food eaten and physical activity with the amount of insulin required to maintain and control blood glucose levels. Type 1 diabetes can develop at any age but is found more commonly in children and young adults. Symptoms of high blood glucose (hyperglycemia) and type 1 diabetes include:

- Frequent urination/bedwetting in children
- Extreme thirst/dry mouth
- Sweet, fruity breath
- Tiredness/fatigue
- Increased hunger
- Blurred vision
- Flushed skin
- Lack of concentration
- Nausea/vomiting
- Stomach pain/cramps
- Dry, itchy skin
- Unusual weight loss
- Labored breathing
- Weakness
- Confusion
- Unconsciousness
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Awareness of symptoms of type 1 diabetes is important. Symptoms of high blood glucose can go unnoticed, therefore delaying the diagnosis of type 1 diabetes. Early recognition of symptoms, prompt diagnosis, and treatment can reduce the risk of life-threatening diabetic ketoacidosis. The tip sheet “Signs and Symptoms of High Blood Glucose (Hyperglycemia),” found in Section 2: Quick Tip Sheets, may be helpful in identifying symptoms of diabetes.

Students with a new diagnosis of type 1 diabetes commonly experience a “honeymoon period.” During the honeymoon period, a student’s insulin requirement may significantly decrease. The honeymoon period occurs because the student’s pancreas temporarily resumes some function and produces insulin. The length of time of the honeymoon period varies from student to student.

Insulin

Insulin is a hormone produced in the pancreas which is essential for survival. Insulin is responsible for promoting growth and regulating blood glucose levels in the body. Insulin is used to treat diabetes and is taken either by injection or by an insulin pump. The amount and type of insulin required is determined by the student’s health care team. There are many different types of insulin. Table 4 provides detailed information on the types of insulin. Each type of insulin has a different onset of action, peak time, and duration of action in the body. To reduce errors, always check the label to ensure use of the correct type of insulin. Figure 1 provides a graph comparing the different activities of insulin types.

Table 4: Types of Insulin

<table>
<thead>
<tr>
<th>Types of Insulin</th>
<th>Appearance</th>
<th>Onset of Action</th>
<th>Peak Time</th>
<th>Duration of Action</th>
<th>Basal/ Bolus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid-acting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lispro (Humalog)</td>
<td>Clear</td>
<td>5-15 minutes</td>
<td>1-2 hours</td>
<td>3-4 hours</td>
<td>Bolus</td>
</tr>
<tr>
<td>Aspart (Novolog)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glulisine (Apidra)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-acting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular (Humulin or Novolin)</td>
<td>Clear</td>
<td>30-60 minutes</td>
<td>2-4 hours</td>
<td>6-10 hours</td>
<td>Bolus</td>
</tr>
<tr>
<td>Intermediate-acting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH (Humulin or Novolin)</td>
<td>Cloudy</td>
<td>1-2 hours</td>
<td>4-8 hours</td>
<td>10-20 hours</td>
<td>Basal</td>
</tr>
<tr>
<td>Long-acting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>Clear</td>
<td>1-2 hours</td>
<td>Nearly flat</td>
<td>~24 hours</td>
<td>Basal</td>
</tr>
<tr>
<td>Detemir (Levemir)</td>
<td>Clear</td>
<td>1-2 hours</td>
<td>6-8 hours</td>
<td>12-24 hours</td>
<td>Basal</td>
</tr>
</tbody>
</table>

Adapted from: 2008 Wisconsin Diabetes Mellitus Essential Care Guidelines

Onset of Activity: How long it takes for insulin to begin working after injection.

Peak time: The time during which a dose of insulin is most effective in terms of lowering blood glucose levels.

Duration of Activity: How long the insulin actually works to lower blood glucose.

Basal/Bolus: The way insulin is used.
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Figure 1: Activity of Types of Insulin

Students will need to take insulin during the school day. Schools must permit the administration of insulin either by an insulin pump and/or injection. To do otherwise would effectively exclude the student from school.¹

If the student is not able to self-administer insulin during school, the school nurse or other trained school personnel must be available to administer the insulin,² including during field trips and/or other school-sponsored activities. If a student is unable to calculate the insulin required, the school must be prepared to assist the student, as accommodations indicate. These accommodations are commonly listed in a plan titled Section 504 Plan. Various plans, including the Section 504 Plan, are reviewed in Section 10: Life at School.

Basal and Bolus Insulin

- **Basal** insulin keeps blood glucose steady when no eating takes place (between meals and during the night).
- **Bolus** insulin is used before meals to mimic normal insulin levels. Bolus is the best way to reduce after-meal blood glucose levels and is used to lower blood glucose at other times.

A correction dose of insulin is used to treat high blood glucose levels for meals. This correction dose is added to the meal dose of insulin. A correction dose is determined by using a correction scale or by using a correction factor for calculating the dose. At times a student may need extra insulin during non-meal times. Certain criteria must be followed before giving extra insulin. See the Diabetes Medical Management Plan for correction insulin and extra insulin plans.

Insulin Storage

Storing unopened and unused insulin in the refrigerator is recommended. Insulin should never be frozen. Insulin is very sensitive and can become less effective when exposed to extreme temperatures.

¹ See e.g., Prince George’s (MD) County Schools, Complaint No 03-02-1258, 39 IDELR 103 (OCR 2003); see also Amarillo Indep. Sch. Dist., Complaint No. 06-02-1181 (OCR 2002).
² See Wayne-Westland (MI) Community Schools, Complaint 15-00-1130, 35 IDELR 14 (OCR 2000).
Insulin should not be shaken, as shaking can affect the insulin’s ability to work effectively. When opening a new vial, check the expiration date. Do not use expired insulin. Opened vials of insulin will stay fresh for up to 28 days without refrigeration when kept at room temperature and not exposed to extreme temperatures. Refer to the manufacturer’s storage instructions for disposable insulin pens and insulin pen cartridges, as storage instructions differ between manufacturers.

**Insulin Regimens**

Students use various insulin regimens if delivery is by insulin vial and syringe. An insulin regimen depends on individual circumstances such as a student’s daily schedule, timing of meals, physical activity, age, history of hypoglycemia, frequency of blood glucose monitoring, and willingness to give more injections. Many students use an intensive insulin regimen that closely mimics normal insulin secretion. An intensive regimen requires 3-5 or more injections per day, which can allow for flexibility regarding timing of meals, content of meal, and physical activity level.

**Insulin Delivery**

The method of insulin delivery is determined by the student, family, and health care team in order to achieve the best possible blood glucose control. Three main ways to deliver insulin are:

- Vial and syringe
- Pre-filled (disposable or non-disposable) insulin pen with a disposable pen needle
- Continuous insulin pump/pod

Some students find it difficult to inject insulin (put the needle through the skin). Various products are available to make it easier for students to inject insulin without seeing the needles. These devices are called injection aids. More information on injection aids can be found at: http://forecast.diabetes.org/files/images/InjectionAidsChart.pdf.

**Insulin Vial and Syringe**

Insulin is measured in units. Figure 2 presents a picture of an insulin vial and syringe. A vial of insulin holds 1,000 units of insulin (Figure 2a). Insulin syringes have fine, short needles, allowing easy insertion through the skin (Figure 2b). Syringes are available in different sizes of needle gauge (thickness), needle length, syringe size and capacity, and measurement increments. Table 5 provides information on gauges and lengths of needles for insulin delivery. Table 6 provides information about insulin syringes. Reusing insulin syringes is not recommended. Trained school personnel may assist a student in giving insulin using a vial and syringe. Once trained to do this, school personnel may find the tip sheet called “Giving Insulin Using a Vial and Syringe,” included in Section 2: Quick Tip Sheets, helpful.

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3 In some instances, a specific type of insulin is used due to formulary restrictions; this may restrict which insulin regimen is used.
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Figure 2: Insulin Vial and Syringe

Table 5: Gauges and Lengths of Needles for Insulin Delivery

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sizes</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle Gauge (needle thickness)</td>
<td>28, 29, 30, 31, 32</td>
<td>A larger gauge means a finer (smaller) needle.</td>
</tr>
<tr>
<td>Needle Length</td>
<td>3/16 inch (6 mm) 5/16 inch (8 mm) 1/2 inch (12.7 mm)</td>
<td>Needle length can affect absorption of insulin. Shorter needles may be more comfortable.</td>
</tr>
</tbody>
</table>

Table 6: Insulin Syringe Information

<table>
<thead>
<tr>
<th>Sizes</th>
<th>Capacity for Insulin</th>
<th>Measurement Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/10 cc *</td>
<td>30 units or less</td>
<td>The 3/10 cc syringe is available with 1 unit markings.</td>
</tr>
<tr>
<td>1/2 cc</td>
<td>50 units or less</td>
<td>The 1/2 cc syringe is available with 1 unit markings.</td>
</tr>
<tr>
<td>1 cc</td>
<td>100 units or less</td>
<td>The 1 cc syringe is available with 2 unit markings.</td>
</tr>
</tbody>
</table>

* See Figure 2b.
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Insulin Pens

Insulin pens are widely used and are a convenient way to deliver insulin. Insulin pens are the size and shape of a large writing pen with insulin stored inside (Figure 3a). A fine, short, disposable needle is twisted on one end of the insulin pen before insulin is injected through the skin. The user dials the dose of insulin (Figure 3b) and then presses a plunger on the opposite end of the pen to give the insulin (Figure 3c).

Two types of insulin pens are:

- **Pre-filled disposable pens** – each pen is discarded after the insulin is used or outdated
- **Reusable (non-disposable) pens** – these pens hold insulin cartridges and each cartridge is discarded after the insulin is used or outdated

Both types of pens are packaged with five disposable pens or insulin cartridges in a box. Each disposable pen or cartridge has 300 units for a total of 1,500 units per box.

Figure 3: Insulin Pen

![Insulin Pen Diagram](Source: Media Solutions, UW School of Medicine and Public Health)

Storing an unused disposable pen or insulin pen cartridge in the refrigerator is recommended. Once the pen is used, it may be kept at room temperature. Each insulin pen and insulin pen cartridge is marked with an expiration date (pens and cartridges have different expiration dates, depending on the type of insulin). It is always best to check the insulin pen manufacturer insert for specific storage recommendations and expiration dates. To reduce errors, always check the label to ensure use of the correct type of insulin. Trained school personnel may need to assist a student in giving insulin using an insulin pen. Once trained to do this, school personnel may find the tip sheet “Giving Insulin Using an Insulin Pen,” included in Section 2: Quick Tip Sheets, helpful.

Insulin Pumps

An insulin pump (also referred to as an insulin infusion pump) is a mini-computer about the size of a cell phone that continuously delivers insulin. A picture of an insulin pump, tubing, and infusion set is provided in Figure 4. Most insulin pumps use a battery. Battery size and type varies from company to company. An insulin pump can be worn in various places (e.g., clipped or attached to a belt, attached with Velcro to a bra, slipped in a pocket). Insulin pumps are usually water-resistant, or can be waterproof by using a special cover. The insulin pump usually allows the user to disconnect the tubing and pump from the insertion site during vigorous sports, showering, or other select activities. The student’s Diabetes Medical Management Plan should indicate whether this practice is allowed.
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Insulin pump therapy is an effective and safe method of insulin delivery. Advantages of using an insulin pump include, but are not limited to:

- Pumps deliver insulin in tenths or hundreths of a unit allowing precise dosing and increased accuracy
- Improved blood glucose control through continuous flow of insulin
- Decreased number of needle sticks
- Decreased number of episodes and severity of low blood glucose (hypoglycemia)
- More flexibility and convenience with eating and physical activity
- Less insulin may be needed to control blood glucose
- Increased ability to address unique needs due to growth, lifestyle, and insulin requirements

Students who use an insulin pump require specific accommodations and may require assistance to operate the pump. Therefore, the school nurse or other trained school personnel must be able to perform or assist with basic insulin pump operations, such as changing infusion sets, changing batteries, setting temporary basal rates, administering boluses, and trouble-shooting alarms. Schools must also accommodate the securing and storing of an insulin pump if the student disconnects the pump during physical education or for another approved reason.

A “pod” is like a conventional insulin pump. One such system is called OmniPod, which is a tubing-free insulin delivery system that uses a wireless Personal Diabetes Manager program to deliver and calculate doses of insulin. This system uses a built-in FreeStyle® blood glucose meter. The Pod can be placed securely by an adhesive almost anywhere on the body. Insulin delivery by an OmniPod is approved for anyone with diabetes.

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4 See e.g., Henderson County (NC) Pub. Schools., Complaint No. 11-00-1008, 34 IDELR 43 (OCR 2000).
How an Insulin Pump Works

The insulin pump has a computer chip which acts as the pump's brain. Other important parts of an insulin pump system include the:

- Cartridge/reservoir: a small plastic vial filled with enough insulin for three days
- Infusion set: soft plastic tubing to deliver insulin from the pump to the body
- Needle or cannula: attached to the infusion set, inserted, and left under the skin

A student must change the cartridge/reservoir, infusion set, and needle/cannula every two to three days or more often if problems occur. An insulin pump is programmed for each individual student to provide insulin in two ways: basal and bolus.

- The **basal rate** of infusion provides a tiny amount of insulin continuously throughout the day and night. The pump is programmed to deliver different basal rates to meet the student's individual insulin needs at different times throughout the day. The basal rate remains the same from day to day, except if a family member or a health care provider changes the basal rate.
- The **bolus dose** of insulin provides a larger amount of insulin to cover carbohydrate intake for meals and snacks or to decrease a blood glucose level at other times. A bolus of insulin that treats high blood glucose is called a correction or supplemental bolus.

The health care team determines the rate and amount of insulin delivered by the insulin pump. The insulin pump is programmed to include the student's:

- Target blood glucose goals (these may vary throughout the day)
- Insulin-to-carbohydrate ratio(s) (ratios may vary for meals)
- Correction insulin to meet blood glucose goals
- Active insulin time
- Maximum bolus settings and basal amounts (these are safety features)

Only rapid-acting insulin is used in an insulin pump and serves as both the basal and bolus insulin.

Calculating a Meal Bolus

The meal bolus is usually determined by using an insulin-to-carbohydrate ratio. This ratio can be different for different meals and will change as the student's insulin needs change. A feature called a "bolus calculator," which helps calculate an insulin bolus dose, is now commonly built into insulin pumps. The blood glucose reading and the amount of carbohydrates to be eaten are entered into the pump. Once this is done, the pump automatically calculates the insulin dose. Most pumps now account for "active insulin," which is insulin that may still be working in the body. Younger students may need assistance calculating bolus amounts and bolus delivery.
Special Functions of an Insulin Pump

Insulin pumps have many special functions. The available functions are either pump- or company-specific. Below are listed three common special pump functions older students may use:

**Suspend or Stop Mode**
This mode briefly stops insulin delivery. A student may use the suspend mode if he or she disconnects the pump for any reason (e.g., shower or high intensity physical activity).

**Temporary Basal Rate**
The basal rate may change to reduce the risk of high or low blood glucose during illness, physical activity (e.g., soccer game, 2 mile run), or long periods without eating. This basal rate change is called a temporary basal rate. A temporary basal rate is programmed into the pump for a specific time period. Once that specific time period has passed, the pump automatically returns to the original basal rate.

**Special Bolus Options**
Special bolus options (e.g., square, dual, multi-wave, extended) are commonly used when certain high-carbohydrate, high-fat foods are eaten (e.g., pizza, tacos), may be used when a student plans to eat for an extended time (e.g., banquet or holiday feast), or during extended snacking (e.g., reception or party).

Insulin Pump Delivery Problems
When an insulin pump stops delivery of insulin for any reason, the student’s blood glucose will rise quickly due to no delivery of insulin. High blood glucose may result in diabetic ketoacidosis (DKA), a serious complication of high blood glucose. Because the insulin pump uses only rapid-acting insulin and not long-acting insulin, the student is at risk of developing DKA if delivery of insulin stops. Blood glucose monitoring and ketone testing are required when a delivery problem is suspected. Responding quickly to any situation that interferes with the steady delivery of insulin from the insulin pump could prevent or slow the progression of DKA.

If an insulin pump stops or the pump malfunctions, school personnel must be prepared to give (or assist in giving) insulin using a syringe and vial. A written back-up plan (in the event of a pump becoming damaged, lost, or pump delivery fails) is essential.

Emergency supplies needed for an injection of insulin at school include:
- A vial (or pen and pen cartridge) of insulin
- Syringes or insulin pen needles
- Ketone testing supplies
Common Problems with Insulin Pumps

An insulin pump is a mechanical device; therefore, students may encounter problems with their pump at school. Some common insulin pump problems that school personnel may encounter are:

- Cartridge/reservoir problems: empty or bubbles present
- Infusion tubing problems: air bubbles present, blood present, or tubing kinked
- Needle/cannula problems: kinked, dislodged, or disconnected
- Site problems: red, swollen, or infected
- Pump malfunctions or alarms: low battery

Common pump problems require the attention of the student and/or school personnel. The tips included below are general considerations for addressing common insulin pump problems.

**Cartridge/reservoir problems**
Consider checking:
- If cartridge/reservoir is empty
- If cartridge/reservoir is damaged
- If insulin pump is disconnected

**Infusion tubing problems**
Consider checking:
- The insertion site to determine if connection at site is loose or leaking insulin
- The tubing for kinks, bubbles, or blood

**Needle/cannula problems**
Consider checking and/or inserting a new infusing set:
- If cannula is kinked
- If insulin is leaking from insertion site
- If needle or cannula is partially out or dislodged

**Site problems**
Consider checking and/or inserting a new infusion set:
- If signs of irritation or infection occur (e.g., redness, swelling, tenderness, or drainage)
- Inappropriate placement of infusion set (e.g., placed over a scar, placed less than 2 inches from navel, or placed in a hard lumpy area)
- If a site problem is under the skin and is not visible

**Pump functions or alarms**
Note: Most pump alarms will state the problem. Consider checking:
- If pump is turned on and not in “suspend mode”
- For possible pump damage
- The pump battery status; follow the pump manual for directions on changing battery if battery is low. As a safety measure, always have student disconnect from pump when changing the battery.
- The user’s guide for directions to clear alarm and correct problem
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For help in addressing specific problems with the pump itself – or alarms that cannot be cleared – consulting the pump manual or calling the manufacturer is an option. Insulin pump manufacturers offer assistance for non-clinical questions related to pump function. Table 7 provides a list of some pump manufacturers and their contact information. More information on insulin pumps can be found at: http://www.forecast.diabetes.org/files/images/InsulinPumpChartREV.pdf.

Table 7: List of Insulin Pump Names, Manufacturers, and Contact Information

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Manufacturer Name</th>
<th>Phone and Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accu-Chek Spirit</td>
<td>Disetronic Medical Systems</td>
<td>(800) 280-7801 <a href="http://www.disetronic-usa.com">http://www.disetronic-usa.com</a></td>
</tr>
<tr>
<td>DANA Diabecare</td>
<td>Sooil Development Co.</td>
<td>(866) 747-6645 <a href="http://www.sooilusa.com/">http://www.sooilusa.com/</a></td>
</tr>
<tr>
<td>MiniMed Paradigm</td>
<td>Medtronic Diabetes</td>
<td>(866) 948-6633 <a href="http://www.medtronicdiabetes.com/">http://www.medtronicdiabetes.com/</a></td>
</tr>
<tr>
<td>OmniPod</td>
<td>Insulet Corporation</td>
<td>(800) 591-3455 <a href="http://www.myomnipod.com/">http://www.myomnipod.com/</a></td>
</tr>
<tr>
<td>One Touch Ping</td>
<td>Animas Corporation</td>
<td>(877) 937-7867 <a href="http://www.animascorp.com/">http://www.animascorp.com/</a></td>
</tr>
</tbody>
</table>


Note: Smiths Medical MD, Inc. no longer manufactures Deltec Cozmo® insulin pumps, but is continuing to provide technical assistance to those still using the pump. Contact (800) 826-9703 or http://www.cozmore.com for more information.

- Disetronic is a subsidiary of Roche, Inc.
- Animas is a subsidiary of Johnson & Johnson

The following checklist identifies critical insulin pump supplies and information needed at school for a student using an insulin pump.

Checklist for Insulin Pump Supplies and Information Needed at School

This checklist includes but is not limited to:

**Supplies**
- Extra vial of insulin and syringe
- Extra insulin pump cartridge/reservoir and infusion set
- Insertion device (if used)
- Insulin pump batteries
- Antibacterial skin cleanser, alcohol wipes, or skin prep wipes (if recommended)

**Information**
- Copy of current pump settings (e.g., basal rates)
- Pump’s serial number (likely on back of pump)
- Pump manual and alarm reference card (if available)
- Pump company’s 24-hour toll-free number (likely on back of pump)
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Sharps Disposal

State law requires the disposal of all sharps generated from insulin syringes, pen needles, infusion sets, and lancets in an approved sharps container – not in the regular trash. Schools will likely have varying policies and procedures for disposing of sharps; therefore, it is important for school personnel to be aware of their own school district’s specific policies and procedures.

Wisconsin has an active sharps collection program. This program is based on a state law that requires everyone to separate sharps from other waste. Free information and resources on sharps disposal resources and publications are available through the Wisconsin Department of Natural Resources (DNR). For additional information about sharps disposal in Wisconsin, go to the Wisconsin DNR web site: http://dnr.wi.gov/org/aw/wm/medinf/.

Blood Glucose Monitoring

Blood glucose monitoring equipment includes the monitor, test strips, lancet device, and lancets. Students must have these supplies readily available and accessible for testing during school and school-sponsored activities.

Self-monitoring of blood glucose is currently the best method for checking blood glucose levels. Blood glucose monitoring is a powerful tool that allows students the opportunity to know exactly what their blood glucose level is at any time of day. Blood glucose monitoring helps assess how insulin is working to lower blood glucose levels throughout the day and provides useful data about patterns of high and/or low blood glucose levels. Data from blood glucose monitoring can enhance a student’s self-management skills and guide additional lifestyle changes. Monitoring also assists in detecting urgent problems requiring immediate attention from school personnel.

The following circumstances may factor into the frequency of recommended blood glucose monitoring at school:

- Type of diabetes
- Blood glucose fluctuations
- Type of treatment (e.g., oral medication, insulin, diet, and physical activity)
- Adjustments of medication/insulin
- Frequency of hypoglycemia
- Hypoglycemia awareness level
- Stress
- Illness

Students with type 1 diabetes usually test their blood glucose a minimum of four times per day – before each meal and before bedtime. The student’s Diabetes Medical Management Plan (DMMP) should indicate how often the student performs blood glucose checks or whether it is necessary to check blood glucose at school.

Many different blood glucose monitors are available for testing blood glucose levels. School personnel should familiarize themselves with the monitor used by the student. A toll-free phone number is commonly listed on the back of a blood glucose monitor should school personnel need technical assistance or have questions/problems with the monitor. A listing of monitors is located at: http://www.diabeteshealth.com/media/pdfs/PRG1208/DH_Blood-Glucose-Meters_08-09.pdf. A second or backup monitor for schools to use when a student’s personal monitor fails is beneficial. A local certified diabetes educator may have a spare home glucose monitor. If not, this person could provide information on where school personnel may obtain one at low cost or possibly free.
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Blood Glucose Testing Times

In order to get a complete picture of blood glucose throughout the day, a student may check his or her blood glucose level at different times. Common testing times are listed below. Although these are common testing times, a student will test blood glucose at other times.

- **Fasting blood glucose** (before breakfast) shows how well a student’s basal insulin is working.
- **Pre-meal blood glucose** (before lunch and dinner) shows the effectiveness of a student’s breakfast and lunch insulin doses.
- **Two hours after eating** (post-prandial) shows if the insulin taken before eating was enough to cover the carbs eaten.
- **Bedtime blood glucose** (before bed) shows the effectiveness of a student’s dinner insulin dose and determines if a bedtime snack is needed.

For older students, it is important to reinforce blood glucose testing prior to driving an automobile and before, during, and after any activity, as a low blood glucose level has the ability to impair judgement.

Self-Monitoring Blood Glucose Levels

Older students are capable of testing their blood glucose levels independently, though students may require assistance on an emergency basis. School personnel may need to actually perform, assist, or supervise students with monitoring blood glucose at school if the student cannot monitor his or her own blood glucose or is incapable of doing so. Younger students typically require assistance with checking blood glucose, reading and interpreting the results, and taking appropriate steps to respond to particular blood glucose values. Trained school personnel who may assist a student in monitoring blood glucose levels may find the tip sheet “Blood Glucose Monitor Use,” found in Section 2: Quick Tip Sheets, helpful.

The accuracy of home glucose monitors has improved significantly, leading to reduced errors and improved accuracy. Good hand washing can assist with reducing false readings and inaccuracy. The student may test his or her blood glucose in the classroom or may prefer a more private setting. Every student should have a safe and clean environment in which to test his or her blood glucose. Parents/guardians can provide input regarding their child’s ability to test safely and accurately at school and during related events. Safe and appropriate lancet disposal is recommended and necessary for the safety of all students.

Alternative Site Testing

Many blood glucose monitors measure blood glucose using blood from an alternative site, such as the forearm, upper arm, base of the thumb, or thigh. Blood glucose readings from these alternative sites are not as accurate as finger stick readings. Alternative site blood glucose results differ from finger stick results when blood glucose levels are changing rapidly, such as after a meal, after taking insulin, during physical activity, or during illness/stress. Never use alternative site testing (use finger stick instead):

- If a low blood glucose is suspected
- If low blood glucose symptoms are present
- Within two hours after a meal
- After physical activity
- During illness or stress
- If alternative site test result does not match how the student is feeling
Continuous Glucose Monitors

Continuous glucose monitors (CGM), also called sensors, are a newer technology that measure glucose levels in interstitial fluid. CGM systems do not provide blood glucose readings. CGM systems are a trending device which can assist with identifying glucose patterns and fluctuations. A CGM system is used with an insulin pump or with insulin injections.

CGM technology incorporates a small electrode inserted in the fatty tissue (also called subcutaneous tissue) under the skin, similar to an insulin pump cannula or needle. Common sites for placement of a CGM system are the abdomen, upper arm (tricep), hip, or buttock area. The electrode measures glucose levels which are displayed on either the insulin pump or pager-sized device worn on a belt or in a pocket. The CGM tracks glucose levels and trends throughout the day.

CGM systems are programmed to alert for too high or too low blood glucose levels. CGM systems may not alert for all high or low blood glucose levels; therefore, reverting to blood glucose monitoring by finger stick with any symptoms is essential. **A high or low alert must always be verified by a finger stick reading. A CGM reading must not be used to determine treatment.** Only a glucose meter finger stick reading is used to determine treatment. While it may be tempting to treat a high or low blood glucose based on a CGM reading, it is not acceptable and is potentially dangerous.

The CGM is a tool to assist students and those assisting in their care to the best time to perform a finger stick reading. A number of alerts will require action as indicated in Table 8. Knowing what to do when a CGM displays an alert is important.

<table>
<thead>
<tr>
<th>Glucose alerts (high or low)</th>
<th>Action Needed</th>
<th>▪ Finger stick required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat feature (high or low)</td>
<td>Action Needed</td>
<td>▪ Finger stick required</td>
</tr>
<tr>
<td>Meter BG now</td>
<td>Action Needed</td>
<td>▪ Perform blood glucose monitoring by finger stick</td>
</tr>
<tr>
<td>Sensor end</td>
<td>Action Needed</td>
<td>▪ Revert to blood glucose monitoring by finger stick</td>
</tr>
</tbody>
</table>
| Weak signal                 | Action Needed | ▪ Move the pump closer to transmitter   
▪ Attempt to reestablish signal if possible   
▪ Revert to blood glucose monitoring by finger stick |
| Lost sensor                 | Action Needed | ▪ Attempt to reestablish signal if possible   
▪ Revert to blood glucose monitoring by finger stick |
| Cal error                   | Action Needed | ▪ Revert to blood glucose monitoring by finger stick |
| Bad sensor                  | Action Needed | ▪ Revert to blood glucose monitoring by finger stick |
| Sensor error                | Action Needed | ▪ Attempt to clear alarm if possible   
▪ Revert to blood glucose monitoring by finger stick |

*The table specifically refers to the Medtronic CGM as this is the only CGM (as of date of publication printing) that is approved for those < 18 years old. In all instances, follow Diabetes Medical Management Plan/504 Plan and CGM manufacturer guidelines and recommendations.
Section 4: Type 1 Diabetes

Calibration of a CGM is necessary. Calibration must be done when glucose levels are steady and not changing quickly. Due to these special circumstances, calibration is typically performed at home.

A considerable amount of inexperience exists with the use of CGM. School personnel must work with the student’s family, health care provider, and CGM company personnel (if possible) to become familiar with use of the CGM. Ongoing education and support for schools is needed as this technology is more frequently used.

Various types of continuous glucose monitors are available. Table 9 provides a list of types, manufacturers, and contact information of CGMs. More information on CGMs can be found at: http://www.forecast.diabetes.org/files/images/v63n01_p44v2.pdf.

Table 9: Continuous Glucose Monitors

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Manufacturer</th>
<th>Phone and Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seven Plus</td>
<td>DexCom</td>
<td>(888) 738-3646 <a href="http://www.dexcom.com">www.dexcom.com</a></td>
</tr>
<tr>
<td>Freestyle Navigator</td>
<td>Abbott Diabetes Care</td>
<td>(888) 522-5226 <a href="http://www.freestylenavigator.com">www.freestylenavigator.com</a></td>
</tr>
<tr>
<td>Guardian Real-Time</td>
<td>Medtronic Diabetes</td>
<td>(866) 948-6633 <a href="http://www.medtronic-diabetes.com">www.medtronic-diabetes.com</a></td>
</tr>
<tr>
<td>MiniMed Paradigm Real-Time</td>
<td>Medtronic Diabetes</td>
<td>(866) 948-6633 <a href="http://www.medtronic-diabetes.com">www.medtronic-diabetes.com</a></td>
</tr>
</tbody>
</table>


FDA approved for adults 18 years and older
FDA approved for children 7 years and older

Healthy Eating

Healthy eating is encouraged for all students, including those with type 1 diabetes. There are no forbidden foods. One key to good blood glucose control is regular intake of food, particularly carbohydrate foods that are spread evenly throughout the day (e.g., three meals a day).

Each student should have an established meal plan that is developed by the health care team and family. This meal plan may include time of meal or snack, type, and amount of food to balance the student’s nutritional needs. A meal plan is determined by considering the student’s current activity level, medication/insulin regimen, and weight goals. Meal plans help to ensure adequate energy for growth and development. Basic or advanced carbohydrate counting is a flexible meal approach used by students with type 1 diabetes. For more information on nutrition, refer to Section 7: Nutrition for Students with Diabetes.
Physical Activity

Physical activity is a fundamental part of a healthy lifestyle for all students, including those with type 1 diabetes. Having type 1 diabetes should not limit a student from participating in physical activity. Engaging in physical activity can reduce the amount of insulin needed to control blood glucose levels. However, physical activity also increases the risk for low blood glucose for up to 24 hours. Students participating in physical education classes and all school-sponsored sports should self-monitor their blood glucose before starting an activity to assist in prevention of low blood glucose (hypoglycemia). The result of this blood glucose test can serve as a guide for additional carbohydrate intake and/or reducing insulin needs. Knowing physical activity can cause low blood glucose, school personnel can promote strategies to reduce risk of low blood glucose episodes, such as inquiring if the student can:

- Reduce or adjust dose of insulin
- Eat additional carbohydrates prior to, during, and/or after activity
- Carry a fast-acting carbohydrate to treat low blood glucose

For more information on physical activity, refer to Section 8: Physical Activity for Students with Diabetes.

A low blood glucose level (< 70 mg/dL) can occur during or after a period of increased or unexpected physical activity. Self-monitoring of blood glucose before, during, and after participating in physical activity can assist in determining if additional carbohydrates are needed to sustain blood glucose levels. Students using an insulin pump may reduce their insulin amounts through a temporary basal reduction or by suspending the pump to stop insulin flow during high intensity sports or activities. Risk of hypoglycemia after physical activity can be reduced through frequent blood glucose monitoring, sufficient carbohydrate intake, and insulin adjustments.

Coaches and school personnel must be aware of a student’s diabetes and make sure a trained person is present to provide necessary help if the student needs to eat additional carbohydrates to treat or prevent a low blood glucose (including administration of Glucagon if the student is on insulin). Examples of quick-acting carbohydrate options include: milk, fruit juice, glucose gel, or glucose tablets.

Students engaging in physical activity with a high blood glucose level (≥ 250 mg/dL) may require testing for ketones prior to participation. Positive ketones must be taken seriously. A student with high blood glucose levels and positive ketones may not be able to participate in physical activity. For more information on high blood glucose, ketones, and physical activity, refer to the content on ketones in Section 6: Diabetes Emergencies.