

Naturally sweet: Children with diabetes mellitus

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Case study

Nikki is a normally precocious four year old who was diagnosed with Type 1 diabetes last month. Today, she was found unconscious by her mother who called 9-1-1. Upon arrival, you find Nikki lying on her bedroom floor, unconscious. You conduct a primary assessment, and establish that she has a patent airway and adequate breathing. Your partner obtains a set of vital signs as you gather pertinent medical history from Nikki's mother. She informs you she gave Nikki her insulin approximately 40 minutes ago and found her unconscious when she came back to tell her breakfast was ready. Your partner reports vital signs: heart rate of 58 beats/min, respiratory rate of 18 breaths/min and a blood pressure of 96/62 mmHg.

1. What is the most likely cause of Nikki's altered mental status?
2. What should be your next step in this incident?

Introduction

Diabetes mellitus, often referred to as

“sugar diabetes,” develops when the body fails to adequately produce and/or utilize insulin, resulting in the inadequate metabolism of glucose and ultimately a shift in the metabolism of carbohydrates, fats and proteins. The end result is high levels of glucose in the blood and insufficient glucose in the cells for energy production. Diabetes mellitus is one of the most common chronic diseases in children and adolescents and is associated with serious health risks that can lead to premature death and disability. According to the Centers for Disease Control and Prevention, about 151,000 people below the age of 20 have diabetes.

Pathophysiology

Sugar, or *glucose*, is required by the cells of the body to produce energy. When the production of *insulin*, a hormone responsible for “unlocking” the cells to allow the glucose to enter, is deficient or absent, glucose is unable to enter the cells and the body turns to another avenue of energy production: the breakdown of fats and proteins. The by-product of fat metabolism is ketones. Diabetes

mellitus is divided into two classifications: insulin-dependent diabetes, referred to as Type 1 or IDDM, and non-insulin-dependent, or NIDDM/Type 2.

Type 1 diabetes mellitus

Type 1 diabetes is traditionally diagnosed during childhood and has been historically referred to as juvenile-onset diabetes. It accounts for five to 10 percent of all diagnosed cases of diabetes and is the leading cause of diabetes in children. In children under 10 years of age, Type 1 diabetes accounts for almost all diagnoses of diabetes. Type 1 diabetes is considered an autoimmune disease. For this reason, it is believed some children may be genetically predisposed, and the onset of symptoms can often be linked with a precipitating event, such as a response to a viral infection.

In Type 1 diabetes, the body's immune system destroys insulin-producing beta cells in the pancreas. The body is not able to adequately regulate blood glucose levels and glucose builds up in the blood, not entering the cells where it is needed for the production of energy. The body then breaks down fat and protein, producing ketones, that can be recognized by a "fruity" smell to the breath.

Signs and Symptoms

Development of Type 1 diabetes begins years before recognizable symptoms surface. By the time symptoms become apparent, most of the beta-cell population has been destroyed. Once this occurs, symptoms develop over a relatively short period of time. Early symptoms include those commonly associated with hyperglycemia: increased thirst and urination, constant hunger with weight loss and blurred vision. Some children may experience extreme fatigue.

Eventually, as insulin deficiency increases, ketoacids, the by-product of fat metabolism, build up in the blood and are excreted through urine and breath. Dehydration worsens and this build-up of ketoacids causes the patient to experience a feeling of shortness of breath, abdominal pain and vomiting. Diabetic ketoacidosis (DKA), a condition of elevated blood glucose and dehydration can develop

into a life-threatening diabetic coma if diabetes is not diagnosed and treated with insulin at this point. Vomiting in children is often attributed to gastroenteritis. However, new-onset diabetes can be indicated by vomiting accompanied by frequent urination, as opposed to decreased urination from dehydration caused by a GI complaint.

Children who develop Type 1 diabetes are at increased risk of other autoimmune diseases, such as celiac disease, and chronic and degenerative conditions, such as retinopathy, nephropathy, neuropathy, high cholesterol, hypertension and heart disease as they age.

Type 2 diabetes mellitus

Type 2 diabetes was commonly associated only with adults and was in fact referred to as "adult onset diabetes." It accounts for about 90 to 95 percent of all cases of diabetes and has been reported among children and adolescents in the United States with increasing frequency over the past two decades. Currently, nearly half of all new cases of diabetes mellitus in children have elements most consistent with Type 2 diabetes.

Type 2 diabetes is a condition where the body continues to produce insulin, but the cells are "resistant;" thus, Type 2 diabetes is often referred to as "insulin resistant" diabetes. It has also long been referred to as "pre-diabetes." Type 2 diabetes may be diagnosed when one or all of the following occur.

- The pancreas secretes insulin sluggishly, resulting in a change in carbohydrate metabolism.
- The body tissues require an excessive amount of insulin.
- Secreted insulin is destroyed or made inactivate in some way.

Children diagnosed with Type 2 diabetes are commonly older than 10 years of age and/or are experiencing puberty, are overweight and may have a family member with Type 2 diabetes. Other risk factors may include a genetic predisposition, and there is a higher incidence of Type 2 diabetes in children of Native American, African American, Hispanic/Latino American and some Asian and Pacific Islander American descents. The increased risk and occurrence of Type 2 diabetes has



been directly attributed to what is being called an *obesity epidemic* and has become a serious public health problem. Diet and exercise are two of the most important lifestyle changes that can be made for children who are predisposed or already have Type 2 diabetes.

Signs and symptoms

Type 2 diabetes can have the same symptoms found in Type 1 diabetes; however, it develops more gradually in children than Type 1 diabetes. Children or teens may feel very tired, thirsty, nauseous, and experience increased urination. Additional symptoms may include blurred vision, weight loss, frequent infections and wounds or sores that are slow to heal. Some adolescents and children may present with no symptoms at the time of diagnosis, and girls may present with a vaginal yeast infection from frequent urination. Severe dehydration with extremely high blood glucose levels and coma may also occur, as with Type 1 diabetes.

Physical signs associated with Type 2 diabetes include *acanthosis nigricans*—dark, thick, velvety skin around the neck or in the armpits. Hypertension and *dyslipidemia* (high cholesterol and triglycerides) are also associated with insulin resistance and girls can develop *polycystic ovary syndrome* with absent or infrequent periods, excessive hair and acne.

Children with Type 2 diabetes have a high risk of long-term complications and conditions associated with diabetes, including hypertension, heart disease and high cholesterol. Appropriate and accurate diagnosis and management of Type 2 diabetes can prevent the onset of complications associated with diabetes. Management priorities for children with Type 2 diabetes are healthy eating, portion control and exercise. Some children may require oral medication to lower their blood glucose.

“Other” diabetes

Type 1 or Type 2 diabetes are the most commonly occurring forms of diabetes among children and adults. However, some teenagers have elements of both types. This type of diabetes is called “hybrid” or “mixed” diabetes. Individuals with “hybrid”

diabetes commonly have both insulin resistance associated with obesity and Type 2 diabetes and antibodies against pancreatic islet cells associated with autoimmunity and Type 1 diabetes. Signs and symptoms of hybrid diabetes are the same as those for Type 1 and Type 2 diabetes. Management will depend largely on which type of diabetes is present at the time of diagnosis. Treatments will likely include insulin injections (Type 1) and oral medications to improve insulin resistance (Type 2), management of healthy eating and physical activity.

Maturity-onset diabetes of the young (MODY) is a rare form of childhood diabetes that is caused by a single gene defect resulting in faulty insulin secretion. MODY can be defined by its early onset, usually occurring before the age of 25, absence of ketosis and autosomal dominant inheritance. In other words, a child whose parent has MODY has a 50 percent chance of inheriting the same type of diabetes. MODY often goes undetected and accounts for two to five percent of all cases of diabetes. Treatments vary and may include management of diet, exercise, oral anti-diabetes medications to enhance insulin secretion or insulin therapy.

Diabetes can also occur in children secondary to other diseases. Secondary diabetes is sometimes seen in children with cystic fibrosis or those using glucocorticoid (anti-inflammatory/steroid hormone) drugs. One to five percent of all diagnosed cases of diabetes may be attributed to these causes.

Management of diabetes in children and adolescents

Diabetic management of children and adolescents with Type 1 and Type 2 diabetes varies little from management of adults with

Optimal Plasma Blood Glucose Range (mg/dl)

Age	Values before meals	values at bedtime/ overnight
Toddlers and preschool (under 6 years)	100–180	110–200
School age (6–12 years)	90–180	100–180
Adolescents/young adults (13–19 years)	90–130	90–150

diabetes. However, due to body changes and metabolism demands as children grow, as well as increased levels of activities such as sports, treatment strategies should be monitored and adjusted on an ongoing basis. There is no single method to manage diabetes in all children. Treatments are individualized based on the child's type of diabetes, activity levels, age and growth and development.

The management of hyperglycemia or hypoglycemia associated with either type of diabetes is dependent on the result of blood glucose checks and ongoing monitoring. EMS practitioners should know baseline blood glucose levels appropriate for children at various ages and work with families at the time of an emergency to establish what the appropriate blood glucose level is for that child. The Plasma Blood Glucose Range table shows the optimal blood glucose level in plasma by age group.

Hypoglycemia

Children undergoing treatment for diabetes may develop hypoglycemia, a condition in which the blood glucose levels drop too low. Hypoglycemia occurs when the child has taken too much insulin, missed a meal or snack or has participated in strenuous exercise. Hypoglycemia may also occur for no apparent reason, but it often can be related to a need to change the child's insulin dose based on the child's normal growth and development. In children under six or seven years of age, hypoglycemia may result due to a form of "hypoglycemic unawareness." In other words, children at that age may lack the cognitive ability to recognize and react to the symptoms of hypoglycemia, therefore children in this age group are at a higher risk for hypoglycemia.

Signs and symptoms

Signs and symptoms of hypoglycemia include a change in mental status, including irritability and confusion. Additional signs and symptoms include sweating, shaking, hunger, weakness, tachycardia, shallow tachypnea, dizziness and vomiting. When blood glucose levels fall very low, loss of consciousness usually occurs and the child may experience seizures.

Assessment

First assess the child's level of consciousness. If the child is unresponsive, immediately manage the airway and breathing. Obtain a SAMPLE history from the parent or caregiver and determine when the child last ate and when the last dose of insulin was administered. Additional questions should be asked to determine any change in the child's daily activities.

1. Was the insulin dose changed recently?
2. Has the child been sick with a fever, vomiting or infection?
3. Has the child been eating properly?
4. Was the child participating in rigorous activity after taking insulin or without eating?

Management

The treatment goal when addressing a child or any individual experiencing hypoglycemia is to return their blood glucose level to within normal range. Children that are awake and oriented may be given glucose orally using glucose paste or having the child drink a high concentration sugar solution or suck on a piece of candy. However, if the child has an altered mental status, nothing should be given by mouth. In those cases, an IV should be initiated and glucose administered intravenously. See the Prehospital management of diabetes mellitus table for specific prehospital management of diabetic emergencies in children.

Transportation

Children who have experienced a diabetic medical emergency should always be transported immediately to the appropriate facility, even if the child responds to interventions. An ongoing assessment should be conducted, including a reassessment of the ABCs and mental status. Blood glucose levels should be re-evaluated as allowed by local protocols. ALS intercept should be arranged if not already on scene. Children who have been diagnosed with any type of diabetes will need further evaluation for alterations in the ongoing management of their diabetes.

Prehospital management of diabetes mellitus

BLS interventions

Conduct a primary assessment, including airway, breathing and circulation, mental status; and check blood glucose level per local protocol.

- Administer oxygen as needed
 - Assist ventilations if required
- If altered mental status is present:
 - Presenting with diabetic ketoacidosis or hyperglycemia:
 - If the child is awake, alert and able to drink, give non-sweetened fluids by mouth.
 - Presenting with hypoglycemia:
 - If the child is conscious, give a sugar substance such as fruit juice, candy or oral glucose per local protocols

ALS interventions

Conduct a primary assessment, including airway, breathing, circulation and mental status:

- Check blood glucose level
- Establish an IV and infuse normal saline at 20cc/kg
- If presenting with diabetic ketoacidosis or hyperglycemia:
 - Place child on cardiac monitor and observe for arrhythmias
 - Administer one 20cc/kg bolus (only one bolus should be given unless cardiovascularly unstable or directed by medical control to give more)
- If presenting with hypoglycemia:
 - If serum glucose is <60:
 - IV dextrose 2-4 cc/kg (0.5 to 1 g/kg) D25
 - For an infant less than 30 days old: 2-4 cc/kg (0.2-0.4 g/kg) of D10
 - For an unconscious child without IV access, administer glucagon:
 - (<10 kg) 0.1 mg/kg IM
 - (>10 kg) 1.0 mg IM

These are suggestions. **Always follow local protocols** and check drug doses. Contact medical control as needed or required when administering medications to children.

Hypertonic solutions D25W and D50W are very hyperosmolar. Rapid infusion may cause extravasation resulting in swelling and tenderness at the injection site and has been known to cause tissue necrosis. Administration of D25W or D50W should be conducted through a patent IV site and slow infusion method.

Conclusion

Diabetes mellitus is a chronic disease that is being seen with increasing frequency in children. Type 1 diabetes mellitus, commonly called “juvenile diabetes,” was once the most common form of diabetes seen in children. However Type 2, historically referred to as “adult onset” diabetes, is increasing significantly among children and adolescents. EMS practitioners may be called to manage a diabetic child experiencing a hypoglycemic emergency. This emergency could be caused by alterations in insulin demands occurring through normal childhood growth and development, increased physical activity or other disease processes. The earliest signs and symptoms of diabetes can be mistakenly attributed to gastrointestinal complaints in children; a knowledgeable EMS practitioner may be the first health care provider to

recognize the differentiating symptoms that lead to an early diagnosis and appropriate management of diabetes in children.

Case study revisited

You perform a blood glucose check and obtain a reading of 30 mm/dl. You establish an IV and administer D25, slowly to avoid extravasation. As the dextrose infuses, Nikki wakes up and states she is hungry. You prepare Nikki for transport to the pediatric hospital that is familiar with her medical history. Your past experience with newly diagnosed Type 1 diabetes tells you the 40 minutes following insulin administration without breakfast had caused Nikki’s blood glucose level to drop below normal, therefore you continue to closely monitor her for any change in her level of consciousness or drop in blood glucose level en route to the hospital.

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