

Diabetes and Insulin

by Cynthia Steffen, RPh



CE FOR TECHNICIANS ONLY



COMPLETE ARTICLE AND CE EXAM
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Diabetes is a serious disease affecting 23.6 million children and adults in the United States based on data from 2007. This accounts for 7.8% of the population. Each year 1.6 million new cases of diabetes are diagnosed in people 20 years and older. Some of the complications of diabetes include:

- heart disease and stroke
- high blood pressure
- blindness
- kidney disease
- neuropathy (nervous system disease, including nerve pain in extremities)
- amputation

The cost of diagnosed diabetes in the United States in 2007 was \$174 million.¹

Diabetes is characterized by high blood glucose levels due to insufficient levels of insulin. Insulin is produced by the beta cells of the pancreatic islets of Langerhans.² People with diabetes are either not making enough insulin or their bodies are not using the insulin properly, leading to high blood glucose levels known as hyperglycemia. Insulin is a hormone in the body that converts sugar, starch and other food into energy or the basic fuel for the cells in the body.³

TYPES OF DIABETES

There are two main types of diabetes, type 1 and type 2. Type 1 diabetes, also known as insulin dependent diabetes mellitus or IDDM, is usually diagnosed in children or young adults. It was previously known as juvenile-onset diabetes mellitus. Patients with type 1 diabetes do not produce insulin. This group makes up 5-10% of people with diabetes.¹⁻³

Type 2 diabetes is the most common type of diabetes, also known as non-insulin dependent diabetes mellitus or NIDDM, which occurs in 80-90% of cases. It was previously known as adult-onset diabetes mellitus. Type 2 diabetes patients do not produce enough insulin or the body's cells

Objectives

At the conclusion of this activity, the pharmacists should be able to:

- Describe diabetes and the proper treatment
- Describe the history of insulin
- Discuss why patients use insulin therapy
- Identify considerations in the dispensing of insulin
- Classify various types of insulin products

are resistant. Normally insulin moves the glucose from the blood into the cells. When glucose builds up in the blood, it leads to complications mentioned earlier. Type 1 or type 2 diabetes mellitus can occur at any age, therefore, age is no longer used to classify the types of diabetes.¹

One other type of diabetes to mention is gestational diabetes which occurs during pregnancy. The onset is during the second or third trimester and usually resolves after the baby is born.³

SYMPTOMS OF DIABETES

The America Diabetes Association lists the following symptoms of diabetes:

Type 1 diabetes:

- frequent urination
- unusual thirst
- extreme hunger
- unusual weight loss
- extreme fatigue and irritability

Type 2 diabetes (there are often no symptoms):

- any of the type 1 symptoms
- frequent infections
- blurred vision
- cuts/bruises that are slow to heal
- tingling/numbness in the hands/feet
- recurring skin, gum or bladder infections

TREATMENT OF DIABETES

Patients with type 1 diabetes must be treated with insulin injections. Patients with type 2 diabetes may be able to manage the disease with diet and exercise, but may need to

add an oral antidiabetic medication or even insulin injections. Some general treatment guidelines for patients with any type of diabetes are:

- attention to diet
- blood pressure control
- compliance with the medication regimen
- control of hyperlipidemia (high cholesterol)
- daily foot inspections
- increased physical activity
- learning to recognize the signs of hypoglycemia (low blood glucose)
- blood glucose monitoring at home
- monitoring hemoglobin A1C at the doctor's office (measures the person's blood glucose control over the past two to three months)
- prompt treatment of all infections³

HISTORY OF INSULIN

The pancreas was identified in the mid 19th century as the organ causing diabetes. Research at the end of the 19th Century and beginning of the 20th Century led to the discovery of insulin. Previously, diabetes was a fatal disease with no good treatment options other than starvation dieting to try to decrease blood glucose levels.

Frederick Banting and Charles Best from the University of Toronto are credited with bringing insulin to effective clinical trials.⁶ Eli Lilly and Company partnered with the University of Toronto laboratories to manufacture insulin. The work resulted in the release of Iletin in 1923.^{4,8}

Around the same time, August Krogh, a Nobel Prize winning professor at the University of Copenhagen, decided he wanted to start producing the new preparation developed at the University of Toronto to treat people with diabetes, including his wife. In 1923, he partnered with Dr. Hans Christian Hagedorn, a specialist in blood sugar regulation and pharmacist August Kangsted to found the company that would become Nordisk. In 1925, two brothers, Thorvald and Harald Pederson, who had worked for Nordisk, founded Novo. Novo and Nordisk merged in 1989 to become Novo Nordisk.⁹

In the early days of insulin therapy, patients required numerous injections because the insulin available was short-acting and the only concentration available was 40 units per milliliter. Protamine Zinc insulin was introduced in the mid-1930s and had a longer duration of action.⁸ Nordisk developed isophane insulin (NPH) in 1946. Novo launched lente insulin in 1953.⁹ Eli Lilly introduced Humulin[®] insulin in 1982 which was identical to that produced by the human body. Human insulin was created by using recombinant DNA technology.⁴ The introduction of human insulin also addressed the concern that supplies of animal-based insulin from beef and pork could not keep up with global demand.⁸

INSULIN THERAPY

Insulin is made up of two amino acid chains, A (acidic) and B (basic), joined by disulfide linkages. Insulin is a protein and is degraded in the GI tract, therefore insulin cannot be administered orally. Insulin is administered subcutaneously in most cases.³

Insulins are classified as rapid-acting, short-acting, intermediate-acting or long-acting. The differences are related to the molecular structure. Most diabetic patients require a combination of a shorter acting insulin to cover increased glucose levels after a meal and longer acting insulin to maintain a basal level. This is usually accomplished by giving twice-daily doses of intermediate-acting insulin (NPH) combined with a rapid- or short-acting insulin before breakfast and the evening meal. Alternatively, a dose of long-acting insulin is administered in the evening and doses of rapid-acting or short-acting insulin are given before each meal.² Insulin requirements change because of stress, infection, illness, emotional disturbances and pregnancy.³ Adults should keep their blood

glucose levels between 80 and 140 mg/dL before meals and at bedtime.⁵

The injection site should be rotated frequently to prevent lipodystrophy which looks like lumps or small dents in the skin surface.^{1,5} Insulin is best absorbed from the abdomen, then the arms and legs and last the buttocks.³ Rotating the injection sites within one body region for a period of time versus injecting in a different area of the body each day will decrease the variability in insulin absorption.²

Each year 1.6 million new cases are diagnosed in people 20 years and older

There is always a risk of hypoglycemia (low blood glucose) with insulin therapy. Hypoglycemia can be caused by skipping meals, increased work or exercise, vomiting, fever, diarrhea or certain medications. The signs and symptoms of hypoglycemia are:

- confusion
- double vision
- headache
- nervousness
- numbness and tingling in the mouth and lips
- fatigue
- hunger
- thirst
- sweating
- weakness
- visual disturbances
- nausea
- unconsciousness

Treatment requires sugar (orange or other fruit juice, soda containing sucrose, hard candy, sugar cubes, glucose tablets or gel or glucagon injection when a patient is not conscious).^{2,3}

DISPENSING INSULIN

All insulin products are designated as high-alert medications by the Institute for Safe Medication Practices (ISMP).⁷ It is easy to select the wrong insulin because the boxes and names look similar and all contain a volume of 10 milliliters.

Insulin is dispensed in milliliters but

ordered in USP units.

Most insulin is available as U-100 (100 units per milliliter), however, there is a product available that is U-500 (500 units per milliliter).

Regular insulin, insulin glargine, insulin detemir, insulin lispro, insulin aspart and insulin glulisine are solutions (clear). All other insulins are suspensions (cloudy).⁵

Insulin suspensions should be mixed by rolling the vial gently between the hands instead of shaking which causes foam and air bubbles.⁵

Regular insulin is often given by IV infusion in the hospital setting. The other rapid-acting insulins (insulin lispro, insulin glulisine, insulin aspart) have been used IV, but have no advantage over regular insulin IV.²

When mixing two types of insulin in one syringe, the clear (solution) insulin should be drawn up first followed by the cloudy (suspension) insulin.

Insulin glargine and insulin detemir should not be mixed with any other insulin.⁵

Room temperature insulin is less painful to inject so refrigerated insulin should come to room temperature before injection.⁵

Insulin may be stored at room temperature for one month.⁵

INSULIN PRODUCTS

Rapid-acting products begin to work about 5 minutes after injection, peak in about 1 hour and continue to work for 2 to 4 hours.

- Insulin Aspart (NovoLog[®])—give within 15 minutes before a meal
- Insulin Glulisine (Apidra[®])—give within 15 minutes before a meal or within 20 minutes after starting a meal
- Insulin Lispro (Humalog[®])—give within 15 minutes before a meal

Short-acting products reach the bloodstream within about 30 minutes after injection, peak in 2 to 3 hours and work for 3 to 6 hours.

- Regular insulin (Humulin[®] R, Novolin[®] R)—give 30 to 60 minutes before a meal

Intermediate-acting products reach the bloodstream in 2 to 4 hours after injection, peak 4 to 12 hours later and work for 12 to 18 hours.

- Isophane insulin (NPH) (Humulin[®] N, Novolin[®] N)

Long-acting products reach the bloodstream in 1 hour and work for 24 to 28 hours with no real peak.

- Insulin glargine (Lantus®)—give once daily at bedtime
- Insulin detemir (Levemir®)—give once daily with the evening meal or at bedtime or, if used twice daily, space doses 12 hours apart with the second dose given with the evening meal or at bedtime^{1,5}

In addition, there are a number of insulin mixtures available including mixtures of isophane and regular insulin (Novolin® 70/30, Humulin® 70/30), insulin lispro protamine and insulin lispro (Humalog® mix 75/25, Humalog® mix 50/50), insulin aspart protamine and insulin aspart (Novolog® mix 70/30).² Eli Lilly and Company is discontinuing Humulin® 50/50 due to decreased demand. The product will be available through April 2010.⁴

CONCLUSION

Diabetes mellitus is a serious disease and the incidence is increasing. Pharmacy technicians will come in contact with many patients in their practice setting who have diabetes and

are managing with insulin therapy. Technicians need to be familiar with the disease and especially with the insulin products they assist with dispensing. ●

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ASSESSMENT QUESTIONS

Diabetes and Insulin

1. The human body produces insulin from the islets of Langerhans which are located in the
 - a. kidneys
 - b. pancreas
 - c. adrenal glands
 - d. liver
2. Insulin is classified as a (an)
 - a. antibiotic
 - b. fungicidal agent
 - c. hormone
 - d. corticosteroid
3. Prior to the discovery of insulin the only treatment for diabetes was
 - a. electro shock therapy
 - b. cold water immersion
 - c. steam purification
 - d. starvation diet
4. Insulin dependent diabetes mellitus (IDDM) is also known as _____ diabetes.
 - a. type 1
 - b. type 2

5. Which statement is true?
 - a. A deficit of insulin produces hypoglycemia
 - b. An excess of insulin produces hypoglycemia
6. The term for a high level of blood glucose is
 - a. hyperglycemia
 - b. hypoglycemia
7. Human insulin is made by recombinant DNA technology.
 - a. True
 - b. False
8. Regular insulin may be given by IV infusion.
 - a. True
 - b. False
9. Not all insulins need to be designated as high alert medications.
 - a. True
 - b. False
10. You have been instructed to draw up NPH insulin and regular insulin from vials into a syringe. Which type of insulin do you draw up into the syringe first?
 - a. NPH insulin
 - b. regular insulin



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11. Lypodystrophy is a result of rotating the injection site.
 - a. True
 - b. False

Classify the following insulin products accordingly.

- a. rapid-acting
 - b. short-acting
 - c. intermediate-acting
 - d. long-acting
12. _____ Lantus®
 13. _____ insulin lispro
 14. _____ NPH insulin
 15. _____ regular insulin
 16. How do you rate this activity?
 - a. Very good
 - b. Good
 - c. Poor
 17. Did it meet the learning objectives?
 - a. Yes
 - b. No
 18. How long did it take you to complete this activity?



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