A Continuing Education Monograph for Pharmacists, Nurses, and Dietitians.

INSULIN DELIVERY SYSTEMS

and Their Role in the Treatment of Diabetes

This continuing education activity can also be completed online at **www.MedEdToday.com.**

This activity has been supported by an educational grant from Novo Nordisk Inc.

It has been accredited by the American Association of Diabetes Educators (AADE) for pharmacists, nurses, and dietitians.

diabetes

PROGRAM GOAL

The goal of this activity is to provide healthcare professionals with information on current and investigational methods of insulin delivery to help them guide patients in selecting the most suitable method of insulin delivery.

TARGET AUDIENCE

This continuing education (CE) program is intended for pharmacists, nurses, and dietitians involved with the education and management of patients with diabetes.

EDUCATIONAL OBJECTIVES

Upon completion of this activity, participants should be able to:

- Review the epidemiology and pathophysiology of diabetes and the critical role of insulin therapy.
- Compare and contrast vial and syringe delivery with insulin pens, continuous subcutaneous insulin infusion pumps, inhaled insulin, and other delivery methods.
- State the primary advantages and disadvantages for each type of delivery system.
- Describe the use of continuous subcutaneous insulin infusion therapy in patients with diabetes.
- Identify 2 future insulin delivery systems or routes of administration currently under study.

FEE

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TABLE OF CONTENTS

INTRODUCTION

In 2005, 1.5 million new cases of diabetes were diagnosed in the United States.[1] According to the Centers for Disease Control and Prevention (CDC), 20.8 million people in the United States (7.0% of the population) had diabetes in 2005; approximately one third of these (6.2 million) were undiagnosed.[1] Nearly 28% of adult patients with diagnosed diabetes use insulin therapy—16% use insulin only and 12% use it in conjunction with oral diabetes medications (Figure 1).[1] Essentially all patients with type 1 diabetes and ~18% to 27% of patients with type 2 diabetes in the United States use daily insulin therapy.[2-3]

This rising incidence of diabetes in the United States—one that is approaching epidemic proportions, continues to drive the search for more convenient and tolerable ways of delivering insulin.[4]

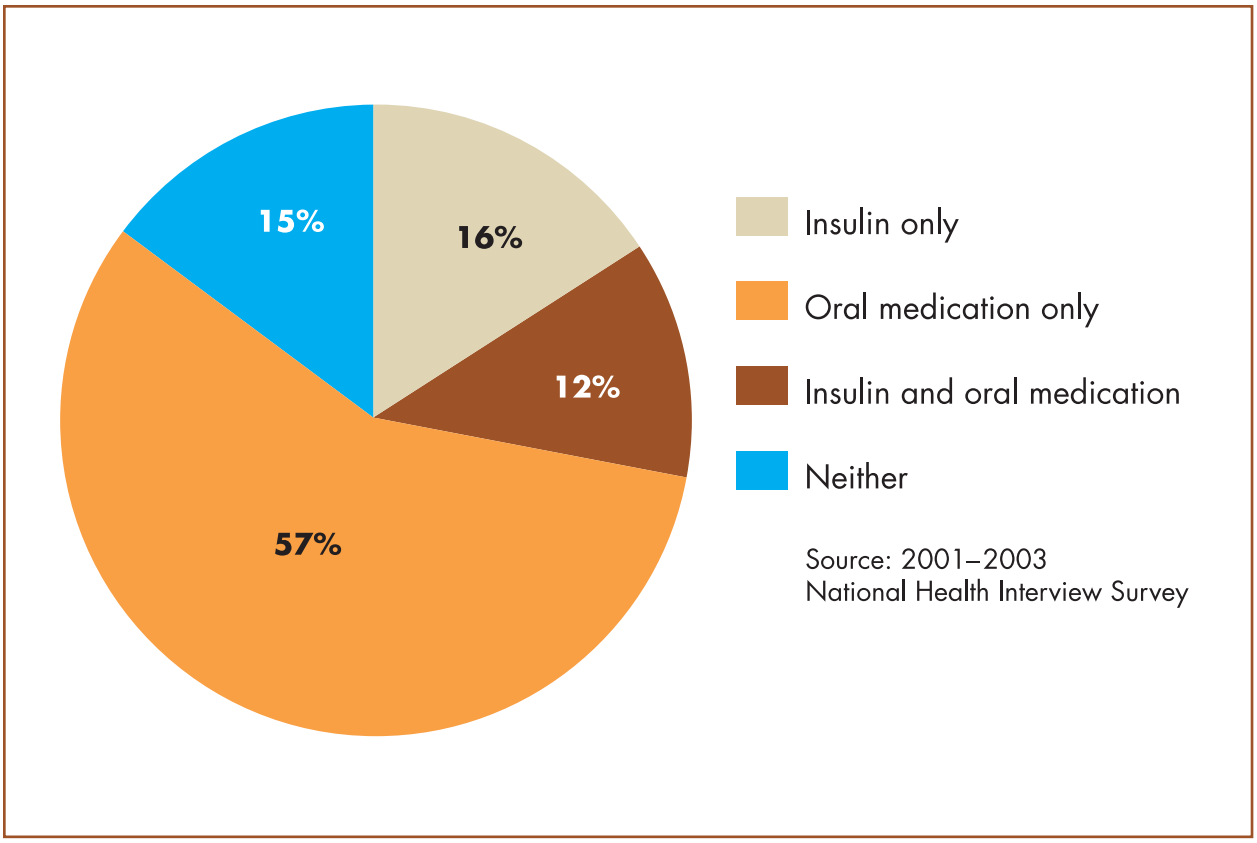

Figure 1. Treatment with insulin or oral medications among adults with diagnosed diabetes in the United States, 2001–2003.

There are now several choices of insulin delivery systems currently available. Patients who were once limited to the single option of traditional vial and syringe delivery may now select from reusable (durable) or prefilled (disposable) insulin pens, external insulin pumps, and soon, insulin that can be inhaled (Table 1). Although the availability of a variety of insulin delivery systems enhances patient convenience and flexibility, the myriad of choices can be confusing both to patients and to healthcare providers.

This monograph summarizes the currently available and investigational insulin delivery devices and methods of delivery. Its purpose is to acquaint healthcare providers with the benefits, drawbacks, and relative costs of these different systems. Nurses, pharmacists, dietitians, and other diabetes educators have frequent contact with patients and can therefore provide guidance on the various insulin delivery systems. Knowledge of the available and potential future options for insulin delivery is important for all members of the diabetes management team.

Table 1. Summary of insulin delivery systems in the United States

Currently available insulin delivery systems

- Insulin injection
  - Vial and syringe
  - Insulin pens (reusable [durable] and prefilled [disposable] types)
  - Insulin dosers
- Insulin pumps
  - External insulin pumps for continuous subcutaneous insulin infusion
  - External insulin pumps with sensors
- Pulmonary inhalation insulin delivery

Insulin delivery systems under study

- Insulin pumps
  - Implantable open-loop pumps
  - Implantable closed-loop pumps
- Alternative routes of insulin delivery
  - Transdermal
  - Oral
  - Buccal
  - Ocular
- Pancreas and islet cell transplantation

DIABETES: AN OVERVIEW

Diabetes is a complex disorder of glucose metabolism. Type 1 diabetes accounts for 5% to 10% of all diagnosed cases and type 2 diabetes accounts for 90% to 95% of diagnosed cases of diabetes. Other types of diabetes (eg, gestational, iatrogenic) account for the remaining 1% to 5% of diagnosed cases.

DID YOU KNOW?

In 2005 in the United States, there were an estimated 20.8 million people (7.0% of the population) with diabetes; nearly one third of these (6.2 million) were unaware that they had this disease.

Diabetes is associated with substantial morbidity and mortality. In 2003, diabetes was the sixth leading cause of death.[5] The microvascular and macrovascular complications of diabetes affect nearly every body system (Table 2).[1] Microvascular complications include renal failure, retinopathy, and neuropathy. Macrovascular complications include stroke, ischemic heart disease, and peripheral vascular disease. Poorly controlled diabetes is the most common cause of nontraumatic lower extremity amputation, treated end-stage renal disease, and blindness in adults.[1] Up to 20% of patients with diabetes who are over 45 years of age have coronary heart disease. In 2002 in the United States, the direct and indirect costs of managing diabetes and its complications were estimated to be $132 billion.[1,6]

DID YOU KNOW?

In 2002, the direct and indirect costs of diabetes in the United States were estimated to be $132 billion. Direct costs include cost of medical care and services; indirect costs include costs for short-term and permanent disability and of premature death.

The importance of tight glycemic control to minimize the risks of damaging complications in patients with type 1 or type 2 diabetes is now well established. According to the results of several large landmark clinical trials (Diabetes Control and Complications Trial [DCCT], Kumamoto, United Kingdom Prospective Diabetes Study [UKPDS], and DCCT/Epidemiology of Diabetes Interventions and Complications [EDIC]), the risks of severe diabetes complications can be reduced in patients with type 1 or type 2 diabetes by tight glycemic control, which includes intensive therapy and frequent blood glucose monitoring.[7-10]

Table 2. Complications of diabetes in the United States[1]

- Heart disease and stroke
  - Account for 65% of deaths in people with diabetes
  - Adults with diabetes have heart disease death rates 2 to 4 times higher than adults without diabetes
  - Risk of stroke is 2 to 4 times higher among people with diabetes
- High blood pressure
  - ~73% of adults with diabetes have blood pressure ≥130/80 mm Hg or use prescription medications for hypertension
- Blindness
  - Diabetic retinopathy causes up to 24,000 new cases of blindness each year
- Kidney disease
  - 44% of new cases of kidney failure were due to diabetes in 2002
- Amputations
  - >60% of nontraumatic lower-limb amputations occur in people with diabetes
- Nervous system disease
  - Up to 70% of people with diabetes have mild to severe nervous system damage (which may result in impaired sensation or pain in feet or hands, slowed digestion of food, carpal tunnel syndrome, and other problems)

Optimal glycemic control is defined as maintenance of blood glucose at, or close to, normal physiologic levels.[11] Glycemic control is primarily dependent on patients' adherence with therapy. For patients using insulin, optimal control is often difficult to attain because of the complexity of insulin regimens and the discomfort associated with numerous injections and skin punctures each day. Despite the availability of new oral diabetes medications and insulin formulations, only 49.8% of patients with type 2 diabetes were in glycemic control (ie, glycosylated hemoglobin [A1C] <7%) during the 1999–2002 time period.[12] Clearly, earlier and more aggressive management of diabetes is required.

ROLE OF INSULIN IN GLYCEMIC CONTROL

The goal of insulin administration is to mimic normal, physiologic insulin secretion with peak levels following meals and low-level steady secretion between meals. Common multiple-dose regimens include an injection with either a rapid-acting insulin analog or short-acting insulin at mealtimes in combination with an intermediate- or long-acting insulin administered once or twice daily. All patients with type 1 diabetes (and many with type 2 diabetes) require multiple daily injections of insulin or continuous insulin infusion to achieve optimal glycemic control.

The results of the above-mentioned trials[7-10] have motivated healthcare professionals to encourage patients to closely monitor their blood glucose level and optimize insulin therapy to keep blood glucose and A1C concentrations as close to normal as possible.[11,13] For fasting plasma glucose, the goals of the American Diabetes Association (ADA) are between 90 to 130 mg/dL (5.0–7.2 mmol/L). The ADA's A1C goal for patients in general is <7% and the goal for the individual patient is an A1C value "as close to normal (<6%) as possible without significant hypoglycemia."[14] The American Association of Clinical Endocrinologist's A1C goal is ≤6.5%.[15]

DID YOU KNOW?

According to the American Diabetes Association *Standards of Medical Care in Diabetes—2006*, the A1C goal for patients *in general* is <7% and the A1C goal for the *individual patient* is as close to normal (<6%) as possible without significant hypoglycemia. The American Association of Clinical Endocrinologist's A1C goal is ≤6.5%.

BARRIERS TO INITIATING AND ADHERING TO INSULIN THERAPY

Patients with type 1 diabetes require insulin therapy from the time of diagnosis. Most patients with type 2 diabetes eventually require insulin therapy as the disease progresses. This fact may be surprising to many patients with type 2 diabetes, so it should be openly discussed, without overdramatization and without implying failure, at the time of diagnosis and at appointments thereafter.

Patient adherence to prescribed insulin therapy is a key component of diabetes management, yet many significant psychological barriers exist that impede initiation as well as adherence for patients with type 2 diabetes (Table 3). These barriers are sometimes called psychological insulin resistance. The newest data on misconceptions and psychological barriers to treatment adherence come from the DAWN (Diabetes Attitudes, Wishes and Needs) study, a global program initiated to improve psychosocial support of people with diabetes by raising awareness, educating, and training health professionals and patients, and by advocating for research in this area.[16,17]

Table 3. Psychological barriers to initiating and adhering to insulin therapy

- Trouble accepting the diagnosis of diabetes
- Guilty feeling that the need for insulin equates to patient failure with oral therapy
- Misconceptions about insulin and disease (symptoms not indicative of disease severity)
- Some cultural beliefs
- Apprehension/fear of injection and insulin (perception of pain/social stigma)
- Resistance to frequent monitoring of blood glucose
- Interference with daily routines and privacy
- Fear of hypoglycemia and weight gain

Many patients with newly diagnosed diabetes have trouble accepting the diagnosis or adjusting to treatment.[18] It has been reported that 5% to 10% of patients diagnosed with type 2 diabetes avoided contact with the medical care system for 10 or more years after their initial diagnosis.[18] In one study of 693 patients with newly diagnosed type 2 diabetes who were followed for 10 years (1988–1998), avoidance of any therapy and slow transitioning from failing therapies were 2 factors that compromised long-term glycemic control.[18]

DID YOU KNOW?

In one study, 5% to 10% of patients diagnosed with type 2 diabetes avoided contact with the medical care system for 10 or more years after their initial diagnosis.

Interestingly, some physicians are reluctant to initiate insulin therapy, particularly in those with type 2 diabetes. The DAWN study showed that about half of all healthcare providers use insulin therapy as a "threat" to encourage adherence to care recommendations.[17] These findings highlight the importance of educating and training patients and healthcare providers regarding diabetes management, particularly at the time of diagnosis. This training should be reinforced with frequent reminders and educational sessions.

Patients who are not prepared for future insulin therapy may feel punished for "failing" previous therapy with oral diabetes medications. In the DAWN study, American patients were among the lowest in perceived insulin efficacy and among the highest in insulin self-blame[16]—55% of people with type 2 diabetes who were not on insulin worried that starting insulin therapy means they had failed their own management of the disease.[17]

Many patients with diabetes who require insulin are concerned about using a vial and syringe, and feel overwhelmed at the prospect of giving themselves injections. Moreover, patients may become anxious about insulin therapy when it is used as a threat to encourage them to adhere to their diet and diabetes medication therapy. A study in a group of type 1 and type 2 patients with diabetes showed that 28% of patients had high scores on an anxiety level scale and more than half the patient population had avoided injections or experienced some anxiety.[19] Because it is difficult to administer insulin injections discreetly, the social stigma of syringes may be of concern.

Both patients with type 1 and type 2 diabetes can benefit from demonstrations of the numerous options available for insulin delivery and the ease with which insulin can be administered. Healthcare professionals play an important role in educating and helping patients understand the need for insulin therapy and overcoming the fear of needles and daily injections. Moreover, they can help the individual patient select an insulin delivery system that is tailored to his/her needs and lifestyle. Flexibility and convenience are 2 important factors that can enhance patient adherence with insulin therapy.

INSULIN DELIVERY SYSTEMS

A number of "patient-friendly" insulin delivery systems are currently available and more are in clinical development. The ideal insulin delivery system is one that provides:

- Accurate dosing
- Patient comfort
- Patient convenience

Additional considerations for choosing one insulin delivery system over another include patient safety, social acceptability, affordability, and environmental issues. Advantages and disadvantages of currently available insulin delivery systems are shown in Table 4. A useful summary of available diabetes products, including insulin delivery systems, is published annually in *Diabetes Forecast* by the ADA.[4]

Common methods of insulin delivery are:

- Vial and syringe
- Insulin pen or doser
- External insulin pump

Table 4. Advantages and disadvantages of currently available insulin delivery systems

	ADVANTAGES	DISADVANTAGES
Vial and syringe	• Widely available • Inexpensive • Permit mixing of insulin types	• Challenging to use for physically or visually impaired patients • Risk of inaccurate dosing • Difficult to measure small doses • Cumbersome to administer and carry for active patients • Not discreet; syringe use carries social stigma
Insulin pens and dosers	• Relatively inexpensive • Discreet • Portable and compact • Permit consistent measuring of insulin dose • Premixed insulin available • Permit flexible lifestyle • Overcomes many manual dexterity problems or impaired vision	• Somewhat more expensive than vial and syringe • Limited to available insulin formulations • Cannot mix other insulin types in pens • May require additional injections if multiple insulin types are used
CSII pumps	• Small • Discreet • Flexible programming • Permit flexible lifestyle • Accurate insulin dose delivery • Insulin delivery closely mimics physiologic secretion	• Expensive initial purchase • Require frequent blood glucose monitoring • Require high degree of patient motivation and knowledge regarding insulin dose adjustments • Potential for catheter occlusion
Inhaled insulin	• Not injected subcutaneously • Similar to subcutaneous human insulin in A1C reductions and % of patients reaching A1C <7%[20]	• Performance is intermediate between short-and rapid-acting insulins • Not recommended for smokers • Not tested in children or pregnant women • Low bioavailability means large doses need to be administered • Not discreet

CSII = continuous subcutaneous insulin infusion; A1C = glycosylated hemoglobin.

An inhaled insulin powder was approved by the US Food and Drug Administration (FDA) in February 2006 and is expected to be available in mid-2006.

VIAL AND SYRINGE

For more than 80 years, vial and syringe delivery of exogenous insulin has been the primary insulin delivery system. It remains the most popular insulin delivery system in the United States, although patients are increasingly seeking alternate methods for administering insulin.[21] In some countries, vial and syringe accounts for only 10% to 30% of the total insulin delivery.[22]

Most approved insulin products in the United States are available in vials. Patients can prepare a custom mix of insulin in 1 syringe to suit individual needs and reduce the number of injections. Currently, all approved liquid insulin preparations must be injected subcutaneously with the exception of regular human insulin and rapid-acting insulin analogs, which can also be administered intravenously in hospitalized patients requiring intensive care.

Lightweight and disposable modern insulin syringes, ranging in size from 0.3 to 1 mL, are made by many different manufacturers.[4] Easy-to-read and latex-free syringes are also available. The syringes have very fine, coated, preattached needles (28–31G) that are usually 1/2 inch or 5/16 inch long.[4] To achieve the most accurate measurement of insulin, patients match the syringe to their insulin dose. For example, a dose of ≤30 units should be drawn up in a 3/10-mL syringe. Patients should check dosage lines carefully because 1 dosage line may represent 1 or 2 units of insulin, depending on the syringe type.

Disadvantages of vial and syringe administration fall into 3 general categories:
- Potential for dosing errors
- Inconvenience of preparation
- Patient fears and social stigma associated with use of syringes and needles

Administration of insulin from a vial and syringe is a multistep process requiring cleansing of the hands and vial, injecting air into the vial, drawing insulin into the syringe, purging the syringe of air, cleansing the injection site, and, finally, giving the subcutaneous injection. An additional step is needed if insulin formulations are mixed. Errors in syringe preparation, insulin withdrawal from vial, mixing various types of insulin, and injection technique by both patients and healthcare providers are common.[23] Results from 2 studies have shown that dosing errors can range from 12%[24] to 19% of the intended dose in patients older than 40 years of age.[25]

Administration of insulin by syringe and needle is inconvenient and difficult for many patients, especially those with reduced manual dexterity or impaired eyesight, both of which are common among elderly patients. Thus, dosing errors are common in this group.[18,22] Even for patients who are not physically or visually impaired, preparing and administering insulin from a vial can be time consuming and the necessary equipment is inconvenient to carry and store. These issues can limit adherence for patients who travel or lead active lifestyles.

INSULIN PENS AND INSULIN DOSERS

The insulin pen and insulin doser systems eliminate the necessity of drawing insulin from a vial into a syringe—a challenging step for many patients and a common reason for dosing errors. Two types of insulin pens are available in the United States: reusable or (durable) insulin pens, and prefilled or (disposable) insulin pens (Table 5). The currently available insulin doser system is also a prefilled or "disposable" product.

Insulin pens are similar in appearance to writing pens containing an ink cartridge. Durable insulin pens have a disposable needle instead of a writing point and a replaceable insulin cartridge instead of an ink cartridge. Disposable insulin pens and dosers are discarded once the insulin reservoir is empty. With all these devices, the user simply dials in the required dose; some even have audible click dialers.

The technique for insulin administration is the same with reusable and disposable pens and dosers: the patient cleans the injection site; places a new needle on the device; primes the device; selects the desired insulin dose on a dial; inserts the needle under the skin; and presses a plunger to deliver the subcutaneous injection. The needle is left in place for 5 to 6 seconds to ensure the entire dose is administered and then the needle is withdrawn. After the injection, the needle should be removed from the device to prevent leakage or entry of air into the cartridge. Needles should not be reused and should be disposed of properly.

Table 5. Types of insulin pens and dosers available in the United States

MANUFACTURER	ADVANTAGES	DISADVANTAGES
Eli Lilly and Company	Humalog® Pen, Humalog® Mix75/25™ Pen, Humulin® 70/30 Pen, Humulin® N Pen	• Disposable pen • Contains 3mL of Humalog®, Humalog® Mix75/25™, Humulin® N, Humulin® 70/30 • Delivers 1–60 units of insulin • 1-unit increments; visual and audible dialing of dose • No refrigeration after first dose
Novo Nordisk A/S	NovoPen® 3	• Durable pen • Use PenFill® 3mL for NovoLog® and NovoLog® Mix 70/30 • Use Novolin® PenFill® 3mL for NPH, Regular, or 70/30 mix • Delivers 2–70 units of insulin in 1-unit increments
	NovoPen® Junior	• Durable pen • Use PenFill 3mL for NovoLog® and NovoLog® Mix 70/30 • Use Novolin® PenFill® 3mL for NPH, Regular, or 70/30 mix • Delivers 1–35 units of insulin in 0.5-unit increments
	FlexPen®	• Disposable pen • Contains 3mL of Levemir®, NovoLog®, or NovoLog® Mix 70/30 • Delivers 1–60 units of insulin in 1-unit increments • No refrigeration after first dose
	InnoLet®	• Disposable device • Contains 3mL of Novolin® NPH, Novolin® Regular, or Novolin® 70/30 mix • No refrigeration after first dose
Owen Mumford	Autopen® AN3810	• Durable pen • Use with Humalog® 3mL cartridge • Delivers 1–21 units of insulin in 1-unit increments
	Autopen® AN3800	• Durable pen • Use with Humalog® 3mL cartridge • Delivers 2–42 units of insulin in 2-unit increments
sanofi-aventis US	OptiClik®	• Durable pen • Use 3mL cartridges of Lantus® or Apidra®

Humalog® is insulin lispro [rDNA origin].
Humalog® Mix75/25™ comprises 75% insulin lispro protamine suspension and 25% insulin lispro injection [rDNA origin].
Humulin® N (NPH) is human insulin isophane suspension [rDNA origin].
Humulin® 70/30 mix is 70% human insulin isophane suspension and 30% human insulin injection [rDNA origin].
Levemir® is insulin detemir [rDNA origin].
NovoLog® is insulin aspart [rDNA origin].
NovoLog® Mix 70/30 comprises 70% insulin aspart protamine suspension and 30% insulin aspart injection [rDNA origin].
Novolin® N (NPH) is human insulin isophane suspension [rDNA origin].
Novolin® R is regular human insulin injection [rDNA origin].
Novolin® 70/30 mix is 70% human insulin isophane suspension and 30% human insulin injection [rDNA origin].
Lantus® is insulin glargine [rDNA origin].
Apidra® is insulin glulisine [rDNA origin].

DID YOU KNOW?

To ensure accuracy of dosing with an insulin pen or doser, the patient should be told to dial the dose slowly (especially important with large dosages), attach the needle just prior to injection, and leave the needle in place for 5 to 6 seconds before removing it from the skin.

Currently available durable insulin pens (Figure 2A) include the Autopen®, NovoPen® 3, NovoPen® Junior, and OptiClik®.

Figure 2A. Example of a durable insulin pen (OptiClik®).

Insulin analog formulations available in the United States in cartridges for durable pens include Apidra® (insulin glulisine), Humalog® (insulin lispro), Humalog® Mix75/25™ (75% insulin lispro protamine/25% insulin lispro injection), Lantus® (insulin glargine), NovoLog® (insulin aspart), and NovoLog® Mix 70/30 (70% insulin aspart protamine suspension and 30% insulin aspart injection). Human insulin formulations available in the United States in cartridges include Regular human insulin, NPH human insulin, and a combination of 70% NPH/30% Regular human insulin.

Prefilled pens (Figure 2B) include Humalog® Pen, Humalog® Mix75/25™ Pen, Humulin® 70/30 Pen, Humulin® N Pen, Levemir® FlexPen®, NovoLog® FlexPen®, and the NovoLog® Mix 70/30 FlexPen®. Prefilled dosers include InnoLet® N, InnoLet® R, and InnoLet® 70/30.

Figure 2B. Example of a disposable insulin pen (NovoLog® Mix 70/30 FlexPen®) containing 70% insulin aspart protamine suspension and 30% insulin aspart injection [rDNA origin].

Only an estimated 650,000 American patients were using insulin pens in 2003, a number that is expected to increase to 1.65 million by 2010.[26] In Europe, the use of insulin pens has supplanted vial and syringe use as the predominant insulin delivery method; in some countries, as much as 70% to 90% of all insulin is delivered by pen devices.[22]

DID YOU KNOW?

In Europe, insulin pens are the predominant insulin delivery method. In some countries, up to 90% of all insulin is delivered by pen devices. The United States lags behind; insulin delivery by vial and syringe is still the most common method in this country. In 2003, an estimated 650,000 American patients were using insulin pens, but this number is expected to increase to 1.65 million by 2010.

Insulin pens available in the United States are listed in Table 5. The selection of insulin pen type for an individual patient should involve consideration of:

- Insulin type and dose
- Patient's ability to change cartridges
- Patient preferences concerning size and convenience of dosing
- Cost

Currently available pen models can deliver insulin doses of up to 80 units in 0.5- to 2-unit increments. Needles for use with insulin pens range from 29G to 31G in size and from 1/2 inch to 3/16 inch in length.

Insulin formulations cannot be mixed in the pens. Patients who require insulin mixtures must either use a premixed insulin formulation or use 2 devices and administer 2 injections for each dose. Patients who have difficulty loading cartridges in the reusable pens can use a disposable pen.

The advantages of insulin pens include (see Table 4):

- Convenience
- Ability to deliver insulin discreetly
- Reduced injection site pain
- Improved accuracy of dosing

Insulin pens are compact and portable and should not be refrigerated while in use. These conveniences allow patients freedom in their daily routine and still administer their insulin doses on schedule. The portability of insulin pens facilitates discreet insulin delivery away from home and patients report that it reduces the social anxiety associated with vial and syringe use in public settings.[27]

Injecting insulin using a pen may also be less painful than with a syringe. The needle on a syringe must pass through the rubber stopper on the vial to draw up the insulin dose. During this process the needle may be blunted and/or the silicone lubricant coating the needle may be wiped away, before the needle reaches the skin. With an insulin pen, the needle remains sharp because it does not have to pass through a vial top before it is inserted into the skin.

Accurate insulin dose measurement is one of the most important concerns of both patients and healthcare providers. Incorrect techniques by individuals using a vial and syringe delivery system may cause air bubbles to be drawn into syringes, leading to inaccurate measurement of the insulin dose.[22] Patients report that they are more confident about dosing accuracy with insulin pens.[27] This may be particularly helpful for patients with impaired coordination or vision, as with elderly patients, and for patients requiring only low doses of insulin.[28]

DID YOU KNOW?

Patients report that they are more confident about dosing accuracy with insulin pens.

In the United States, some physicians are still not familiar with the use of insulin pens and thus are not able to guide patients on their use. This picture is rapidly changing. In the DCCT, pens were prescribed for 60% of patients in the intensive therapy group who received multiple daily injections of insulin; 35% of all insulin doses (ie, conventional and intensive therapy) were administered by pen in the DCCT.[29]

Many patients believe the advantages of insulin pens outweigh their disadvantages. In 2 large, multicenter surveys directly comparing vial and syringe injection with either the Novolin Prefilled™ or the NovoPen® 1.5, most patients preferred using the pens.[27] Of 507 patients who were switched from vial and syringe to the NovoPen, 98% reported that the pen was easy to use; 86% reported that pen delivery was easier than injection with vial and syringe; 73% felt that the dosing mechanism was more accurate with the pen; and 77% found that the pen made it easier to comply with their insulin regimen. In a study of patient and physician satisfaction with the Humulin®/Humalog® pen, 76% of the 315 patients were satisfied with the pen and 32 (97%) of 33 physicians felt that the pen was better overall compared with a vial and syringe; most physicians felt that less time was needed to teach patients to use the pen (88%) and to initiate insulin therapy (73%).[30] In a 12-week randomized, crossover trial with 108 patients with type 1 or type 2 diabetes, 85% reported that delivery of the NovoLog® 70/30 mix by FlexPen® was more discreet in public whereas 74% found the device easier to use compared with a vial and syringe.[31] Improved patient attitude about insulin therapy with pen devices could lead to better acceptance of, and adherence with, the insulin regimen.[27] This may improve disease management and reduce the risk for developing long-term complications.

INJECTION AIDS

The development and widespread availability of injection aids have solved many of the disadvantages of the traditional vial and syringe system. Injection aids can facilitate accurate insulin delivery and promote patient acceptance of syringe use. Available injection aids include:

- Syringe magnifiers
- Devices for nonvisual insulin measurement
- Needle guides and vial stabilizers
- Devices designed to facilitate injection delivery
- Infusion sets

Some aids can be used with any syringe brand, whereas others are designed to work only with a specific brand.[4]

Syringe magnifiers (eg, BD Magni-Guide™) enlarge the calibration scale on the barrel of the syringe up to 1.7 times. If air bubbles are present, they must be removed to prevent inaccurate dosing.

Devices for nonvisual measurement of insulin are available from a variety of manufacturers.[4] Count-a-Dose® is a syringe-filling device that produces an audible click with each unit increment of insulin drawn into the syringe.

Needle guides and vial stabilizers hold the syringe and vial together while the user fills the syringe.

Devices designed to facilitate injection delivery can be useful for individuals with needle phobias or those who have difficulty injecting hard-to-reach areas such as the buttocks or the back of the arm. These devices consist of a spring-loaded plastic or metal syringe holder that is positioned over the skin. The needle, which is hidden from view in many devices, is inserted subcutaneously by activating a spring mechanism or by pressing the device against the skin. Depending on the device, the patient either manually pushes the plunger to deliver insulin, with or without additional aid from the device, or the device automatically injects the insulin. The depth of skin penetration is adjustable in many injection aids to accommodate various skin thicknesses and increases the alternatives for injection sites.[4] The NeedleAid™ is a stabilizing guide that hides the needle, allows one-hand operation, and ensures injection at the precise angle and depth.[4] It can be used with insulin pens or syringes. The PenMate® is an attachment that conceals the needle on the NovoPen® 3 and NovoPen® Junior; this device has been shown to reduce pain perception in patients using NovoPen® 3.[32]

An option to minimize the number of skin punctures is with an infusion set. These consist of a flexible catheter that is placed subcutaneously.[4] The patient administers insulin through an external port and the catheter remains in place for 48 to 72 hours. A subcutaneous infusion set, such as Insuflon®, can be used with any syringe or insulin pen.

CONTINUOUS SUBCUTANEOUS INSULIN INFUSION PUMPS

For more than 30 years, continuous subcutaneous insulin infusion (CSII) (insulin pumps) has been an ideal method for insulin delivery for patients who require changes in the timing and dose of basal insulin that cannot be achieved with a long-acting basal insulin. They eliminate the need for daily injections, allow programming of basal insulin, and provide an easy method for the patient to deliver bolus insulin when necessary.

Today, most insulin pumps are small (2.4–3.6 inches in length) and lightweight (1.1–3.8 ounces), approximately the size of a pager. They consist of an insulin reservoir, a small battery-operated pump, and a computerized control mechanism (Figure 3).

Figure 3. Examples of insulin pumps for continuous subcutaneous insulin infusion therapy.

Insulin is delivered subcutaneously through a catheter, which is changed every 2 to 3 days. The pumps are programmed to deliver insulin at selected basal infusion rates, as well as patient-initiated bolus doses at mealtimes. Insulin pumps can be programmed to deliver different basal rates for different times of day. The amount of each bolus dose is determined by the patient based on preprandial blood glucose levels (which still have to be monitored by the patient) and by use of a carbohydrate counting technique for the meal about to be consumed.

The newest insulin pumps have many advanced features to allow users greater flexibility, more accurate dosing, and increased safety, all of which support improved blood glucose control. Computer software comes with many new pumps to allow glucose data to be downloaded to a personal computer or portable digital assistant (PDA) for storage or transmission to a healthcare professional.[4] Current models vary according to the number of programmable basal rates of infusion, range of infusion rate (0–35 units/h), and smallest bolus dose (0.05–0.1 unit). All insulin pumps have alarms to alert the user to catheter occlusion or high pressure and a low insulin reservoir. New pumps allow blood glucose results to be wirelessly transmitted to the pump; the pump software then calculates the bolus dose based on the blood glucose and grams of carbohydrate entered. Excessive insulin release (pump runaway) is prevented by built-in safeguard systems.

DID YOU KNOW?

The latest CSII pumps have many advanced features to support improved blood glucose control. Computer software is available for many models, which allows up to 1 year's worth of data to be wirelessly downloaded to a personal computer or portable digital assistant (PDA) for storage or transmission to a healthcare professional.

Since 1990, the number of patients using insulin pumps has increased exponentially in the United States.[33] In 2001, an estimated 160,000 patients in the United States were using insulin pumps; the greatest recent increase in use has been noted among adolescents.[21,33] In the DCCT, 31% of patients randomized to intensive therapy elected to use insulin pumps.[29]

DID YOU KNOW?
Six manufacturers currently market insulin pumps in the United States: Animas (Animas IR1250®), Insulet (OmniPod® Insulin Management System), Medtronic Diabetes (Medtronic MiniMed® Paradigm® 515/715), Nipro Diabetes Systems (Amigo™), Smiths Medical MD (CozMore™ Insulin Technology System), and Sooil Development (DANA Diabecare® II).

For all pumps, the patient is required to fill the insulin reservoir with up to 300 units of a rapid-acting insulin analog or short-acting insulin. All 3 currently available rapid-acting insulin analogs (Apidra®, Humalog®, and NovoLog®) have been approved by the FDA for pump use. Because insulin pumps use only rapid- or short-acting insulin formulations, any disruption in insulin delivery lasting for several hours can lead to diabetic ketoacidosis.[33]

Delivery of insulin or an insulin analog by an insulin pump has several advantages (see Table 4):
- Closely mimics the body's normal insulin release (if the pump is programmed properly)
- Constant and consistent insulin delivery
- More stable and predictable insulin absorption than with a multiple-injection regimen[34]
- Continuous delivery of basal insulin to maintain blood glucose at near-normal levels between meals and overnight
- Ease of operation (once the patient is properly trained)
- Small size
- Ability to be carried discreetly (worn on a belt or carried in a pocket)

DID YOU KNOW?
Insulin pumps accurately deliver insulin in doses as small as 0.05 unit per hour.

Insulin pumps are best suited for patients with the following characteristics:
- High level of motivation
- Willing to assume substantial responsibility for their own care
- Willing to check blood glucose levels 4 to 6 times a day
- Able to do simple mathematical calculations
- Able to make adjustments in insulin, food intake, and exercise in response to blood glucose results

Optimal glycemic control is critical in preventing growth and related disorders in children and adolescents.[35] Boland and colleagues found that adolescents could achieve optimal glycemic control with the insulin pump and maintain their quality of life.[36] Numerous observational trials and several randomized studies have shown that CSII therapy is safe and effective in pediatric populations including preschoolers and toddlers with uncontrolled type 1 diabetes.[37-44] Because newer insulin pumps are smaller, safer, and easier to use, the number of patients aged <20 years using insulin pumps has increased 20-fold since the late 1990s.[45]

Because the initial cost of an insulin pump is high, these devices may be out of reach for patients with limited financial means or inadequate health insurance. However, most insurance carriers cover the cost of these pumps, and Medicare covers pumps and supplies for people with type 1 or type 2 diabetes who meet certain requirements.[4]

Complications associated with insulin pump use include:
- Catheter occlusion by crystallized insulin
- Mechanical failure
- Infection at the site of catheter insertion
- Infusion set crimping or leakage
- Empty reservoir
- Dislodgement of the needle or cannula

Any of these complications can interrupt the infusion of insulin and thus cause hyperglycemia or even diabetic ketoacidosis. These systems must be carefully monitored for insulin supply, cleanliness, battery charge level, and mechanical function. Patients should always keep an insulin pen or vial and syringe as a backup in case of mechanical pump problems.

On the other hand, these risks are not limited to the use of insulin pumps. Hypoglycemia can occur when basal or bolus doses are miscalculated or bolus doses are not given at the appropriate time. Skin infections can result from prolonged use of an injection site or poor hygiene. Some patients may be inherently more susceptible to opportunistic skin infections.

DID YOU KNOW?
All patients using continuous subcutaneous insulin infusion should be encouraged to keep an insulin pen or vial and syringe as a backup in case of mechanical problems with the pump.

PULMONARY (INHALED) INSULIN DELIVERY

Exubera® (insulin human [rDNA origin] inhalation powder) is the first inhaled and noninjectable insulin option since the introduction of insulin in the 1920s. The large and very permeable surface area of the lungs offers a rapid and efficient means of transporting molecules, such as insulin, into the bloodstream. Exubera® was approved by the FDA in February 2006 for the treatment of adults with type 1 or type 2 diabetes in the United States. Exubera® has a time–action profile intermediate between rapid-acting and short-acting insulin preparations. In a recent clinical trial comparing Exubera® with subcutaneous insulin therapy in patients with type 2 diabetes, A1C decreased similarly in both groups.[20]

As of this writing, Exubera® had not yet reached the market. It will be available in 1- and 3-mg blisters (equivalent to 2.5–3 units of subcutaneous insulin), to be used with a special handheld inhaler.[46] Other pulmonary formulations are in development by Kos Pharmaceuticals, Eli Lilly/Alkermes, Mankind Corporation, and Novo Nordisk Inc./ Aradigm.

Potential concerns about pulmonary administration of insulin include:
- Generation of insulin antibodies (not clinically significant in short-term studies)
- Potential for interaction with pulmonary disease and tobacco use
- Possibility of insulin-induced mitogenesis[47-48]
- Long-term effect of inhaled powders on pulmonary function is unclear

FUTURE TRENDS IN INSULIN DELIVERY

Several novel routes of insulin delivery are currently in development or under study[49] including (see Table 1):
- Oral
- Buccal
- Transdermal
- Ocular
- Islet cell transplantation

Oral insulin preparations have low bioavailability and are poorly tolerated.[50] Hexyl-insulin-monoconjugate-2 is currently in Phase I and II clinical trials.[49] A buccal spray delivers liquid insulin into the mouth. The insulin is absorbed through the tongue, throat, and the inside of the cheeks.[51] Transdermal insulin delivery (insulin patch) remains in the infancy stage of development. Insulin eye drops (ocular) are being studied in animals; the amount of insulin absorbed through the eyes appears to be pH dependent.[52] Studies with nasal insulin have been problematic because of nasal irritation, variable insulin delivery, and low bioavailability.[49] Only further study and patient experience will elucidate the role and safety of these nonparenteral forms of insulin therapy.

Although successful whole-organ pancreas transplantation results in exogenous insulin independence, normal blood glucose concentrations, and normal or near-normal A1C values,[53] this procedure is invasive, requiring major abdominal surgery with attendant risks (eg, infection, thrombosis) and drawbacks (eg, lifelong immunosuppressive therapy). Transplantation of islet cells is less invasive than whole-organ pancreas transplantation. Successful islet cell transplantation means the patient no longer needs to take exogenous insulin. One group has shown 1-year insulin independence rates of 80% with islet cell transplantation.[54] Although the cost and limited supply of islet cells have restricted this method for widespread use, new immunosuppressive drugs and standardized surgical protocols are expanding the availability of the procedure.[54]

IMPLANTABLE INSULIN PUMPS

Open-loop and closed-loop implantable insulin pumps (IIPs) are inserted into the subcutaneous tissue on either side of the abdomen.[55] In the United States, implantable open-loop insulin pumps are in clinical development but they already are commercially available in Europe for patients with type 1 or type 2 diabetes.[55,56] In the open-loop system, insulin delivery is activated by the patient who determines insulin doses according to frequent blood glucose testing and anticipated food intake.

The open-loop implantable pump system comprises:

- The pump with an insulin reservoir that is refilled percutaneously
- An intraperitoneal catheter for insulin delivery
- Patient pump communicator (handheld radio controller that the patient uses to send commands to the pump)

In the closed-loop system, also called an artificial pancreas, a computer-controlled infusion pump feedback system is programmed to deliver insulin doses according to blood glucose concentrations as measured by a glucose sensor. The clinical development of closed-loop insulin pumps has been hampered somewhat by lack of a reliable sensor to directly monitor glucose levels.

DID YOU KNOW?

Closed- and open-loop implantable insulin pumps are inserted into the subcutaneous tissue on either side of the abdomen. An open-loop system is patient-activated according to frequent blood glucose testing and anticipated food intake. A closed-loop system, or artificial pancreas, is designed to deliver insulin doses according to blood glucose concentrations measured by a glucose sensor.

As with CSII pumps, the use of an implantable pump requires a high level of patient education and motivation, and, in the case of the open-loop system, frequent blood glucose monitoring. An advantage of implantable pumps is that insulin administered intraperitoneally is preferentially absorbed into the portal venous system and, thus, may resemble physiologic insulin secretion more closely than insulin administered subcutaneously.[56] Substantial improvement in clinical parameters and quality of life has been reported for patients using IIPs.[55]

Disadvantages of the implantable pumps are the cost and the need for surgical implantation. Moreover, relatively frequent surgical procedures are necessary to maintain pump function; these are typically done using a local anesthetic and are associated with minimal morbidity.[55]

APPROXIMATE COSTS OF CURRENTLY AVAILABLE METHODS OF INSULIN DELIVERY

Without question, pharmacoeconomic analyses of the DCCT and the UKPDS data have shown that the additional cost of successful intensive therapy over conventional therapy is offset by substantial reductions in the cost of treating diabetes-related complications.[57,58] From a healthcare system perspective, the cost of intensive therapy is acceptable because it is well within the range of cost-effectiveness considered to represent a good value.[57]

The cost of insulin therapy can vary widely between syringe, pen, and pump delivery systems because of varying use patterns and medical insurance coverage. Although insulin cartridges for reusable pens cost somewhat more than insulin in vials, pens offer increased comfort, convenience, and improved dosing accuracy.

The average insulin pump costs more than other options for insulin delivery, especially with the addition of required pump supplies. In the DCCT, the annual cost of intensive therapy with an insulin pump was 44% higher than that with multiple daily injections given by pen or syringe.[29]

Patient adherence with any type of therapy is integral to the overall success of that therapy. Discussion of available options between the patient and the healthcare team, especially a diabetes educator, can lead to the selection of the optimal insulin delivery device. Individualizing attention to specific patient needs and requirements can improve patient adherence, thus potentially reducing the risk of complications and thereby improving the patient's quality of life.[59]

CASE STUDIES

The following case studies illustrate typical patient concerns and benefits of alternative insulin delivery methods.

CASE 1

MP is a 57-year-old male computer programmer with type 2 diabetes of 10 years' duration. He has been adherent to his oral regimen of metformin 1000 mg twice daily and glyburide 10 mg once daily. He also has hypertension, which is well controlled by a once-daily combination of lisinopril 20 mg and hydrochlorothiazide 12.5 mg. MP is relatively sedentary, but a recent change in eating behaviors has led to a weight reduction from 192 pounds to 183 pounds over the past 6 months. Nonetheless, his most recent A1C was 8.4%, which is increased from 7.6% about 6 months ago. His physician and diabetes educator told MP that insulin therapy would be needed and provided several dosing options—add a bedtime dose of insulin glargine or add a single presupper dose of a premixed analog mixture, given that his postprandial blood glucose readings have been consistently elevated. This latter option would also permit progressing to twice-daily dosing, should it become necessary, without causing the patient to change his insulin prescription. Because MP had noted elevated fasting blood glucose as well as elevated 2-hour postmeal readings, a presupper dose of a premixed insulin analog mixture was chosen to address both issues. MP was not thrilled with having to start insulin, but he understood it was the best approach for him at this time. Several insulin delivery options were discussed and, although MP was willing to try the traditional vial and syringe delivery method, he ultimately chose the insulin pen device because it did not require refrigeration, it was easy to carry on business trips, and it was relatively discreet. After 3 months of using the insulin pen delivery method, his A1C had dropped to 7.4%. MP said that he liked the insulin pen and was finding it fairly easy to use. Another follow-up in 3 months was scheduled to assess his A1C.

CASE 2

JD is a 62-year-old insurance salesman with type 2 diabetes requiring insulin therapy. He is a basketball season ticket holder who often entertains clients for lunch and dinner; he also attends every home basketball game after work. JD routinely monitors and records his blood glucose readings in a logbook and is adherent with his bedtime injection of basal insulin and prebreakfast dose of short-acting insulin. However, JD finds it impossible to keep insulin cold and carry the vial and syringe with him all day. He refuses to carry an insulin syringe to basketball games because he doesn't want to call attention to his diabetes. Therefore, he skips his prelunch and predinner injections most days of the week. JD has noted worsening blood glucose values during the day and was not surprised to find that his A1C was 10.4%. For JD, the traditional vial and syringe insulin delivery method was clearly inconvenient. When he learned about available alternative insulin delivery devices, he embraced the insulin pen because it was easy to carry, could be kept at room temperature, and it was convenient and discreet—something he could easily use during the day and before basketball games. His logbook entries since starting the insulin pen showed a marked improvement in his blood glucose values. At his next physician visit, JD was satisfied to find that his A1C had dropped to 7.6%.

CASE 3

AJ is a 15-year-old high school freshman with type 1 diabetes. She has been using an insulin pump for 2 years. Over the past 6 months, her A1C has increased from 7.8% to 9.2% and her weight increased by 6 pounds. She states that she eats 3 meals per day and 2 snacks. AJ admits that she frequently goes low between meals if she doesn't eat and has had lows recently during the night. However, her pump data download reveals that she only has 1 basal rate set and that she is bolusing insulin less than 2 times per day, despite claims of eating 3 meals and 2 snacks daily. Further discussion reveals that AJ changed her basal rate so she wouldn't have to give a bolus during school and that she often forgets to bolus at other times because she likes to wait to give her mealtime insulin until she knows how much she is eating. She also feels uncomfortable having her pump visible to classmates, so she chooses not to use it in public. AJ and her diabetes educator first discussed her motivation to continue using the pump. AJ wants to continue using her pump as it allows her greater flexibility at school. AJ agreed to be more consistent with her basal rates and agreed to follow healthy eating habits, which includes regular meals and snacks. AJ and her diabetes educator discussed the importance of bolusing insulin before meals, and discussed ways that this could be done privately or discreetly. The diabetes educator also helped AJ feel more comfortable in discussing her insulin pump with classmates. At the next follow-up visit, AJ's weight had dropped by 5 pounds and her A1C was 8.0%.

CONCLUSIONS

Diabetes management is a life-long commitment, requiring in-depth patient education, regular physical examinations, and frequent contact with the healthcare team. Target glycemic metabolic goals are achieved through healthy eating, regular exercise, frequent glucose monitoring, psychological support, and, for most patients, the use of pharmacologic therapy, including oral diabetes medications and insulin.

The vial and syringe have been the standard insulin delivery system for more than 80 years, and improvements in syringes and injection aids have facilitated adherence for patients receiving insulin therapy.

Many of the shortcomings of vial and syringe injection have been overcome by durable insulin pens and, more recently, disposable insulin pens. These devices provide convenience as well as dosing accuracy. They are portable and allow patients to follow active and flexible schedules while complying with required insulin therapy. Insulin pens are well accepted by patients, many who prefer them to syringe and vial delivery.

Inhaled insulin is the first noninjectable insulin therapy and has a time–action profile intermediate between rapid-acting analogs and Regular human insulin. The first inhaled insulin has been approved by the FDA and there are an additional 4 products in development.

CSII pumps and, in the future, IIPs may provide the most physiologic insulin delivery. These units are expensive, however, and require that the patient be highly self-motivated to improve glycemic control.

The importance of glycemic control for patients with type 1 or type 2 diabetes is well established. Recent developments in methods to deliver insulin address some of the causes of nonadherence and should help patients accomplish the goal of better management of their diabetes. Nurses, pharmacists, dietitians, and other diabetes educators can play a key role in educating patients regarding optimal diabetes management.

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POST-TEST

1. In 2005 _____ people were estimated to have diabetes in the United States.
    a) 6.2 million
    b) 13.3 million
    c) 20.8 million
    d) No conclusive data are available

2. Which of the following is a disposable insulin delivery device?
    a) FlexPen
    b) AutoPen
    c) NovoPen3
    d) OptiClik

3. Which of the following factors is not considered to be a potential contributor to psychological resistance to insulin use?
    a) Fear
    b) Pain
    c) Cost
    d) Social stigmas

4. Insertion/injection aids for use with syringe and vial delivery include the following:
    a) Syringe magnifiers
    b) Injection aids with spring-loaded syringe holders
    c) Nonvisual insulin measuring devices
    d) All of the above

5. Patients in the Diabetes Control and Complications Trial published in 1993 were able to use insulin pens but not insulin pumps.
    a) True
    b) False

6. Approximately what percent of adult patients with diabetes use insulin?
    a) 40%
    b) 28%
    c) 16%
    d) 12%

7. Which of the following statements about insulin pens is false?
    a) They are available in durable and disposable forms.
    b) Doses can be delivered in 0.5- to 2-unit increments.
    c) Human insulin and insulin analogs can be delivered by pen devices.
    d) Various insulin formulations can be mixed by the patient in most pens.

8. Advantage(s) of insulin pens, relative to other insulin delivery systems, include all but which one of the following:

a) Convenience

b) Accuracy of insulin dose measurement

c) No need to replace needle between injections

d) Potentially less painful injections

9. Disadvantage(s) of vial and syringe delivery, relative to other insulin delivery systems, include all of the following EXCEPT:

a) Higher potential for dosing errors

b) Cumbersome/Inconvenient

c) Patient phobia

d) Cost

10. Which of the following alternative methods of insulin delivery was recently approved by the US Food and Drug Administration (FDA) in early 2006?

a) Oral

b) Pulmonary

c) Buccal

d) Transdermal

11. Patients who use a continuous subcutaneous insulin infusion (CSII) pump must:

a) have type 1 diabetes.

b) be well informed about diabetes and highly motivated to improve glycemic control.

c) be able to do simple mathematical calculations.

d) Both b and c

12. Complications such as insulin malabsorption and hypoglycemia are unique to people who have a malfunctioning insulin pump.

a) True

b) False

13. Open-loop implantable insulin pumps have been approved for use in the United States.

a) True

b) False

14. In the United States, all rapid-acting insulin analogs have been approved by the FDA for use in CSII pumps.

a) True

b) False

PROGRAM EVALUATION (069-999-06-187-H01)

This evaluation and post-test may also be completed online at:
http://mededtoday.com/ids

The participant will be offered an opportunity to print a statement of credit upon successful completion of the post-test and evaluation.

How many hours ____ and minutes ____ did it take you to complete this CE program?

Please indicate date of completion. _____

DIRECTIONS: Please rate the following on a scale of 1–5 (1 = Poor, 5 = Excellent)

EFFECTIVENESS OF TEACHING/LEARNING METHOD

(Please circle one response per line.)

How well did this program achieve the following objectives?	Poor				Excellent
• Review the epidemiology and pathophysiology of diabetes and the critical role of insulin therapy.	1	2	3	4	5
• Compare and contrast vial and syringe delivery with insulin pens, continuous subcutaneous insulin infusion pumps, inhaled insulin, and other delivery methods.	1	2	3	4	5
• State the primary advantages and disadvantages for each type of delivery system.	1	2	3	4	5
• Describe the use of continuous subcutaneous insulin infusion therapy in patients with diabetes.	1	2	3	4	5
• Identify 2 future insulin delivery systems or routes of administration currently under study.	1	2	3	4	5
• The relationship of the learning objectives to the overall purpose/goal of this independent study was effective.	1	2	3	4	5
• The teaching/learning resources were effective.	1	2	3	4	5

This home study has contributed to my professional effectiveness and improved my ability to:	Strongly Disagree				Strongly Agree
Optimize patient care	1	2	3	4	5
Communicate with patients	1	2	3	4	5
Manage my practice	1	2	3	4	5
Improve my clinical skills	1	2	3	4	5

Other: _____

_____

The overall program was: (Poor) 1 2 3 4 5 (Excellent)

Did you feel this program covered the topic adequately? Yes ____ No ____

Do you feel that the program was balanced, objective, and free of commercial bias? Yes ____ No ____

Will you change your clinical practice based on this activity? Yes ____ No ____

Suggested topics for future programs: _____

_____

General comments/suggestions: _____

_____

POST-TEST ANSWER GRID

(Enter the correct answer.)

1	2	3	4	5	6	7
8	9	10	11	12	13	14

To obtain a statement of credit, you must complete the post-test with a score of at least 75%, complete the program evaluation, and mail or fax both the evaluation form and the answer key to Program Management Services. Your statement of credit will be mailed in 4 to 6 weeks.

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