Continuous subcutaneous insulin infusion therapy: A primer on insulin pumps

Lakshmi G. Potti and Stuart T. Haines

Abstract

Objective: To summarize the role, benefits, and risks of continuous subcutaneous insulin infusion (CSII) therapy for treating diabetes.

Data sources: A literature search was conducted in Medline (1996 to July 2008) using the search terms intensive insulin therapy, insulin pump, and continuous subcutaneous insulin infusion. Reference lists from comprehensive review articles were also used to identify additional original research publications.

Study selection: Review articles and studies evaluating the role, benefits, and risks of CSII.

Data synthesis: More than 300,000 individuals use CSII to treat diabetes. Many experts believe that CSII is the best insulin delivery method for highly motivated patients with type 1 diabetes who are technologically savvy and have the means to pay for the device and infusion sets. CSII is also useful for patients with type 2 diabetes who require multiple daily injections and experience wide fluctuations in blood glucose throughout the day or who experience severe hypoglycemia. A variety of CSII systems are currently available. All CSII systems provide precise insulin delivery throughout the day and improve the accuracy of bolus dose calculations, thereby achieving improved glycemic control with less frequent and severe hypoglycemic episodes. Patients who choose CSII report improved quality of life. Potential risks associated with CSII include mechanical problems leading to diabetes ketoacidosis, infections at the infusion site, hypoglycemia, and lipodystrophy.

Conclusion: CSII is an attractive treatment option for many patients with diabetes. Given the widespread use of CSII, all health professionals should be familiar with the basic features of insulin pump technology, the potential risks and benefits of CSII, and how to troubleshoot common problems.

Keywords: Diabetes, insulin, infusion devices, pharmacotherapy.

More than 300,000 patients around the world use a continuous subcutaneous insulin infusion (CSII) system today, and the number of “pumpers” is expected to increase dramatically in the next decade. The first reported CSII system was developed by Dr. Arnold Kadish in the early 1960s. These early experimental insulin pumps were very large—as big as a backpack—and unreliable. The first commercial CSII system was the AutoSyringe (Baxter), which was affectionately called the “Big Blue Brick” by its users because of its bulky size; it generated considerable interest among medical researchers and device companies when it was introduced in 1978. However, the technology lacked important safety features, and insulin pump delivery systems were reserved for individuals who had frequent and severe episodes of hypo- and hyperglycemia. Moreover, the value of intensive insulin therapy had not yet been demonstrated; therefore, most clinicians and patients were not terribly excited about the prospect of being tethered to a cumbersome apparatus. The potential benefits of CSII became clear after the Diabetes Control and Complications Trial (DCCT) Research Group published a report in 1993. Although the basic principles remain the same, several technological improvements have occurred in the previous 15 years, making insulin pumps safer, easier, and more flexible. Although CSII systems are not suited for all patients with diabetes, some experts believe that pumps are the best method of insulin delivery for patients with type 1 diabetes who are motivated, technologically savvy, and have the means to pay for the technology. Moreover, a growing number of individuals with type 2 diabetes also use a CSII system, particularly those with wide fluctuations in blood glucose or frequent episodes of hypoglycemia despite careful dose titration on multiple daily injection (MDI). While many experts believe that patients with type 2 diabetes derive the same benefits as patients with type 1 diabetes, CSII has not been formally evaluated in a randomized controlled trial in patients with type 2 diabetes.

**Objective**

The purpose of this review is to examine the potential benefits and risks of CSII therapy, describe currently commercially available insulin pump delivery systems, and provide practical advice to clinicians and patients on how to initiate and manage insulin therapy using a CSII device.

**Intensive insulin therapy**

Intensive insulin therapy is designed to mimic physiologic insulin secretion. The beta-cells in the pancreas secrete insulin at variable rates throughout the day. In the fasting state, a relatively low rate (known as basal insulin secretion) is maintained. Basal insulin secretion regulates hepatic glucose production and other metabolic activities. In the absence of basal insulin delivery, patients with type 1 diabetes can potentially develop marked hyperglycemia and diabetic ketoacidosis (DKA), even while fasting. After consuming food, the pancreas increases the rate of insulin secretion in proportion to the amount of carbohydrates consumed in the meal. Postprandial insulin secretion occurs in different phases. The first phase is a rapid release (bolus) of stored insulin from the pancreatic beta-cells, occurring within 15 minutes of carbohydrate intake. The insulin is delivered to the liver via the portal vein, stimulating glucose to glycogen conversion which reduces postprandial blood glucose levels. The second phase of postprandial insulin secretion is gradually released over 1 to 3 hours in response to blood glucose level. Similarly, background (basal) insulin secretion varies slightly throughout the day; it is sensitive to changes in activity, blood glucose levels, and regulatory hormones (e.g., insulin, amylin, glucagon, glucagon-like peptides, gastric inhibitory polypeptide). Individuals without diabetes secrete approximately 50% of the total daily physiological insulin requirements as basal secretion, and the other 50% is secreted in response to carbohydrate intake.

Prolonged hyperglycemia increases risks for diabetes-related microvascular complications such as diabetic nephropathy, retinopathy, and neuropathy, as well as macrovascular...
complications such as myocardial infarction, stroke, and lower-extremity amputations. DCCT and the follow-up study Epidemiology of Diabetes Interventions and Complications (EDIC) conclusively demonstrated that improving glycemic control through intensive insulin therapy reduces the risk of developing diabetes-related complications in patients with type 1 diabetes. Intensive insulin therapy during DCCT was accomplished through MDI using a combination of short- and long-acting insulin or CSII using short-acting insulin. DCCT demonstrated that with every 1% reduction in glycosylated hemoglobin (A1C), the risk for developing diabetes-related complications was reduced by 25% to 32%. The mean absolute difference in the observed A1C between the conventional therapy and the intensive insulin therapy groups was approximately 2% throughout this 6.5-year study. The development of diabetic retinopathy decreased by 76%, progression of baseline retinopathy decreased by 54%, development of neuropathy decreased by 60%, microalbuminuria decreased by 39%, and macroproteinuria decreased by 54% in patients receiving intensive insulin therapy (P < 0.05 for all outcomes). Patients who received intensive insulin therapy in the DCCT had a reduction in macrovascular disease—defined as cardiovascular or peripheral vascular events—by 41%; however, given the low event rates in conventional and intensive therapy groups, this difference was not statistically significant. The EDIC study investigators followed the original DCCT participants for an additional 10 years after DCCT ended. Although the A1C gap between the intensive insulin therapy and conventional therapy groups had narrowed to less than 0.1%, the risk of microvascular and macrovascular events remained significantly lower in the intensive therapy group. Thus, patients who received intensive insulin therapy during the DCCT were 42% less likely to experience a cardiovascular event during 22 years of follow-up compared with those assigned to the conventional therapy group (P = 0.02).

MDI remains the most common method of delivering intensive insulin therapy. MDI regimens typically consists of three injections of rapid- or short-acting insulin before meals and one to two injections of either intermediate- or long-acting insulin to simulate basal insulin secretion. For bolus doses before meals, rapid-acting insulin such as aspart, lispro, or glulisine is the preferred choice because of their rapid onset and relatively short duration of activity. Rapid-acting insulin reaches peak concentrations twice as high and within half the time compared with regular insulin. A meta-analysis examining the benefits of rapid-acting insulin analogs found that they lowered A1C and modestly reduced the number of hypoglycemic episodes compared with regular insulin in patients with type 1 diabetes.

For basal insulin requirements, intermediate-acting (e.g., neutral protamine Hagedorn [NPH]) or long-acting (e.g., glargine, detemir) insulin can be used. Patients typically adjust the dose of bolus insulin to match their carbohydrate intake with each meal and use a fixed dose for basal insulin daily.

Insulin pumps are computerized devices that allow patients to preprogram, temporarily adjust, or suspend insulin infusion rates as well as deliver precise doses. CSII delivery systems attempt to mimic the pancreas as closely as technologically possible. CSII can deliver different basal insulin rates throughout the day based on changes in insulin sensitivity. Moreover, CSII allows for greater precision for bolus insulin dose delivery relative to carbohydrate intake and absorption from the gastrointestinal tract. Most insulin pumps deliver insulin through an infusion set consisting of a plastic tube connected to a small cannula that is placed in subcutaneous tissue. Rapid- or short-acting insulin is used in the pump for both bolus and basal delivery.

### Benefits and limitations of insulin pumps

#### Benefits of insulin pumps

With optimal use, insulin pump therapy allows for tighter, more precise control, which can help reduce blood glucose variations that increase the risk for micro- and macrovascular complications. One important benefit of CSII over MDI is a reduction in severe hypoglycemic events. Intensive insulin therapy is associated with a higher risk for hypoglycemia compared with conventional therapy. In early studies, severe hypoglycemia was particularly problematic with CSII. Today, however, the risk of severe hypoglycemia is significantly lower with CSII as a result of our increased knowledge of how to effectively use the technology, improved built-in warnings and alarms, and better patient education. Severe hypoglycemic episodes are defined as a state of neuroglycopenia resulting in impaired consciousness and requiring assistance to treat the episode, including IV, glucose or glucagon. Theoretically, CSII should decrease the incidence of severe hypoglycemia because it delivers small doses of subcutaneous insulin throughout the day that can be adjusted based on patient-specific requirements. Indeed, results from a recently published international study demonstrated that patients who used CSII had fewer mild hypoglycemic episodes (49.3 vs. 55.4 events/patient/year with MDI, P < 0.001) and fewer severe hypoglycemic episodes (0.2 vs. 0.5 events/patient/year with MDI, P < 0.001). CSII was also associated with a significant reduction in nocturnal hypoglycemic events compared with MDI (2.16 vs. 2.80, P = 0.0024). Fewer hypoglycemic episodes contribute to improved quality of life. Fear of experiencing severe hypoglycemia is a considerable source of stress for many patients who use insulin.

Another major benefit of CSII is reduced glycemic variability. Glycemic variability is the fluctuation in blood glucose levels throughout the day and is typically characterized by postprandial hyperglycemic spikes. Although achieving near-normal glycemia, as measured by A1C, is associated with fewer complications, widely fluctuating blood glucose concentrations throughout the day can be equally detrimental, even when A1C is at or near recommended goals. Substantial fluctuations in blood glucose levels...
throughout the day increase the risk for microvascular\textsuperscript{10,19} and macrovascular\textsuperscript{18} complications. A meta-analysis of 13 randomized controlled trials that compared glycemic control on CSII versus MDI showed a reduction in A1C, a reduction in insulin requirements, and a reduction in glucose variability.\textsuperscript{20} In a study by Hoogma et al.,\textsuperscript{14} patients who used CSII had a 26% reduction in their insulin requirement (total daily dose [TDD] = 0.53 ± 0.14 vs. 0.71 ± 0.23 units/kg with MDI, \emph{P} ≤ 0.0001), a reduction in A1C (7.45% vs. 7.67% with MDI, \emph{P} ≤ 0.001), and a reduction in glucose fluctuations (70.2 vs. 77.4 mg/dL with MDI, \emph{P} < 0.001). Glycemic variability results in increased oxidative stress and an overproduction of superoxide by mitochondrial electron-transfer chain, which in turn signals a cascade of detrimental metabolic events.\textsuperscript{21} Oxidative stress is directly linked to the pathogenesis for atherosclerosis and cardiovascular disease (CVD).\textsuperscript{22} In a subsequent analysis of DCCT, patients assigned to intensive therapy, whose A1C values throughout the study were equivalent to matched pairs receiving conventional therapy, experienced a greater than 50% risk reduction in the development of retinopathy.\textsuperscript{23} This benefit may be attributable to a reduction in glycemic variability achieved with intensive insulin therapy. Optimal glycemic control not only involves achieving A1C targets but also limiting glycemic variability.\textsuperscript{24,25}

Postprandial hyperglycemia (PPHG) appears to be an independent risk factor for macrovascular complications.\textsuperscript{18} Moreover, PPHG spike, which is the difference between the postprandial blood glucose level and the premeal baseline blood glucose level, appears to predict the risk of macrovascular complications better than postprandial blood glucose concentration alone.\textsuperscript{26} The Diabetes Epidemiology: Collaborative Analysis of Diagnostic Criteria in Europe (DECODE) study found that a PPHG value more than 200 mg/dL was an independent risk factor for death from CVD.\textsuperscript{27} Patients who experienced large postprandial spikes had an increased incidence of death compared with those who had higher PPHG with smaller postprandial spikes.\textsuperscript{28} A meta-analysis confirmed that 2-hour PPHG was associated with an increased incidence of death from CVD in an Asian population.\textsuperscript{29} PPHG is also an independent risk factor for microvascular complications.\textsuperscript{18} Patients with elevated postprandial blood glucose levels are at an increased risk for diabetic retinopathy, nephropathy, and neuropathy.\textsuperscript{30,31} CSII can deliver more precise bolus and correction doses that can limit PPHG spikes and reduce glycemic fluctuations.

Patients report an improved quality of life on CSII compared with patients using MDI.\textsuperscript{32} Patients on CSII state that they feel a reduced burden due to greater flexibility regarding mealtimes, improved mental health, and fewer daily hassles in terms of carrying, storing, and administering insulin.\textsuperscript{14,17} Even patients who do not experience improvements in glycemic control after switching from MDI to CSII report increased satisfaction (Table 1).\textsuperscript{32}

### Limitations and disadvantages of insulin pumps

For many patients, being continuously attached to a foreign object is a major concern before initiating an insulin pump.\textsuperscript{17} This is a common psychosocial limitation to insulin pump therapy and especially for adolescents.\textsuperscript{32} Adolescents and younger adults often feel that wearing the pump will signify to the public that they are “diseased.” After patients become accustomed to the pump, these fears are often resolved. Other concerns are possible complications associated with insulin pump therapy, including infusion-site infections, unexplained hyperglycemia or DKA, mechanical problems, and high cost of CSII. Cost can be a considerable barrier for many patients. The cost of purchasing an insulin pump, initiating CSII therapy, and monitoring and maintaining intensive insulin therapy throughout a lifetime is a substantial burden for patients and their families (Table 1).

Infusion-site reactions include contact dermatitis and infec-

---

**Table 1. Benefits and limitations of insulin pump therapy**

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces glycemic variability</td>
<td>Cost of pump and supplies: more expensive than MDI</td>
</tr>
<tr>
<td>Reduces severe hypoglycemic episodes including nocturnal hypoglycemia</td>
<td>Infusion-site infections and risk for DKA</td>
</tr>
<tr>
<td>Improves quality of life</td>
<td>Patient fear of CSII-associated complications</td>
</tr>
<tr>
<td>Mimics physiologic secretion of insulin as closely as technologically possible</td>
<td>Does not mimic the secretion of insulin into portal circulation</td>
</tr>
<tr>
<td>Addresses “dawn phenomena”</td>
<td>Optimal use requires highly motivated and competent patient</td>
</tr>
<tr>
<td>Reduces TDD of insulin</td>
<td>Potentially negative psychosocial aspect of being “tethered” to the pump</td>
</tr>
<tr>
<td>Delivers precise doses of insulin, and basal rate can be adjusted throughout the day</td>
<td>Retinopathy may initially worsen/progress more rapidly</td>
</tr>
</tbody>
</table>

*Abbreviations used: CSII, continuous subcutaneous insulin infusion; DKA, diabetic ketoacidosis; MDI, multiple daily injection; TDD, total daily dose.*
tions. Rarely, patients develop an allergy to the adhesive or the tubing. In most situations using alternative adhesives or infusion sets will resolve the problem. Infusion-site infections are the most common complication associated with insulin pump therapy. Patients on CSII have a higher incidence of skin infections at the infusion site than those receiving MDI. Skin infections at the infusion site are most often seen within the first 5 months of therapy. Patients will present with inflammation, soreness, redness, swelling, and purulent drainage at the infusion site. Patients should be given a course of systemic antibiotic therapy to resolve the infection. Growing concerns exist about methicillin-resistant Staphylococcus aureus infections. In some cases, patients can develop large abscesses that require surgical debridement.

Unexplained highs are elevated blood glucose levels that persist for more than 2 hours. This can result from a variety of potential mechanical problems. Brief interruptions in insulin delivery can lead to DKA in as little as 3 to 4 hours if unrecognized and left untreated. Early studies showed no significant difference in the incidence of DKA in patients receiving intensive insulin therapy (MDI or CSII) versus conventional injection therapy. DKA remains a potential risk with CSII because only short-acting insulin is used and, if delivery is interrupted, glycemic control can be lost quickly. The risk of DKA has been minimized with appropriate and careful candidate selection, advances in available pump technology, and increased patient and provider experience with insulin pump therapy.

During the first year of DCCT, patients who had retinopathy at baseline and were assigned to intensive insulin therapy were significantly more likely to have worsening retinopathy than those assigned to conventional therapy. Worsening retinopathy was characterized by the development of soft exudates and intraretinal microvascular hemorrhages. This negative consequence of intensive insulin therapy was transient, and the long-term benefits emerged after only 2 years of intensive therapy. A transient progression of retinopathy has also been observed in patients who achieved improved glycemic control through CSII. In patients who have a baseline A1C greater than 9%, close monitoring with dilated retinal exams every 3 to 6 months for the first year is required to avoid this potential adverse effect.

Candidates for insulin pump therapy

Insulin pump therapy is an effective means for glycemic control for many patients living with diabetes, but it is not for everyone. Health care providers must assess each patient to determine whether he or she is an appropriate candidate for pump therapy. Health care providers should educate patients regarding the potential benefits and limitations, initiation and maintenance requirements, and considerable effort required to make this means of insulin delivery successful. Selecting appropriate candidates for insulin pump therapy should be based on professional judgment and on general guidelines.

Successful insulin pump users often possess certain characteristics that enable them to use the device safely and effectively (Table 2). These characteristics include technical ability, intellect, and motivation. Patients should possess a higher degree of technical ability to maneuver the advanced features of today's pump technologies. A patient expressing discomfort and/or an unwillingness to learn how to use the technology would not be an appropriate candidate. Patients who have a physical disability that interferes with their ability to manipulate the pump may be better served with MDI. Intellectual ability is related to the patient’s ability to make informed decisions regarding their diabetes control and their insulin requirements. To use an insulin pump most effectively, the patient is required to adjust insulin delivery based on physical activity and meals and must frequently monitor blood glucose to assess current control. The patient must also be able to understand how his or her behaviors impact disease outcomes and how to modify these behaviors. Patients should also possess a high level of knowledge about diabetes before initiating insulin pump therapy.

Lastly, patients should have the motivation and willingness to adhere to the prescribed regimen. Even if a patient has the technical and intellectual capabilities, without the appropriate motivation and desire, insulin pump therapy is no more likely to succeed than MDI. Initially, adjustments to insulin pump therapy can be quite challenging, and patients often require several weeks to incorporate the pump into their lifestyle. This adjustment period is similar to the adjustment phase often seen immediately after the initial diagnosis. Appropriate candidates often express a strong desire to improve control and gain flexibility. Patients who do not or cannot adhere to an MDI regimen are generally not good candidates for pump therapy. Patients who have not achieved excellent glycemic control with MDI but have demonstrated effective medication-taking and monitoring behaviors and have expressed the desire to learn carbohydrate counting and self-adjust insulin therapy should be encouraged to consider pump therapy.

Insulin pump therapy is generally recommended for patients 10 years of age or older. While younger children have used CSII, limited data are available regarding its use in this population. Regardless of age, the patient must possess the technical and intellectual ability to manage insulin pump therapy relatively independently. Children who are started on insulin pump therapy usually require a higher degree of involvement by parents or guardians. Therefore, the caregiver must also be supportive of and knowledgeable about insulin pump therapy.

Although patients can be started on insulin pump therapy after being on conventional injection therapy (i.e., NPH or 70/30 insulin twice daily) for a few weeks, patients with 3 to 6 months of experience with intensive insulin therapy (MDI) are generally the best candidates for insulin pump therapy. MDI and insulin pump therapy are both methods of intensive insulin therapy based on similar principles of insulin delivery, blood glucose monitoring...
requirements, meal planning, and insulin dose adjustments based on carbohydrate counting. Of course, patients who are using conventional injection therapy can be educated on all these issues, but a high degree of willingness to learn must be present.

Insulin pump therapy requires patients to take control of their disease and be able to make decisions on their own regarding insulin delivery. Adherence to previous treatment regimens and appointments generally indicates that a patient will continue to exhibit these behaviors while on the insulin pump. In addition to being highly motivated, patients should be aware of the limitations of therapy and have reasonable expectations. Insulin pump therapy often requires the patient to invest more time and energy than MDI, but, when used properly, the dividend is greater control and lifestyle flexibility.

**Insulin pump features**

Before initiating insulin pump therapy, each patient, with guidance from a practitioner who has experience with a variety of insulin pumps, should evaluate the available options to determine the pump best suited for his or her needs. Patients should be given an opportunity to see and handle all available pumps. The final decision should be based on ease of use, size, appearance, available features, warranty, and cost (Table 3). Images of available pumps are shown in Figure 1. The initial cost of an insulin pump ranges from $4,500 to $6,000, and annual maintenance costs range from $1,500 to $4,000. Most insurance companies, including Medicare and Medicaid, cover some of these costs.

**Bolus dosing features**

Patients using either MDI or older-generation insulin pumps need to calculate bolus doses before each meal. To do so, patients typically estimate carbohydrate intake at each meal and measure blood glucose before eating. Using this information, patients use their personal carbohydrate factor to determine the number of units of rapid-acting insulin needed for that meal, and if needed, add a correction dose based on their personal correction factor. These calculations require several steps, and most patients must use a calculator or other electronic device.

A patient’s personal correction factor is the anticipated drop in blood glucose (mg/dL) when 1 unit insulin is administered in the absence of food. This factor varies between 10 and 60 in most patients, with higher numbers indicating a greater sensitivity to insulin. The patient’s personal carbohydrate factor is the number of carbohydrates (in grams) that 1 unit insulin will “cover” or effectively blunt the anticipated blood glucose increase after consuming a meal. For the majority of patients, the carbohydrate factor is between 5 and 20. In patients who are very sensitive to insulin, 1 unit insulin will “cover” 20 g or more of carbohydrate consumed. For patients who are relatively

---

**Table 2. Candidates for insulin pump therapy**

<table>
<thead>
<tr>
<th>General guidelines for patient selection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
</tr>
<tr>
<td>≥10 years of age (younger patients can be considered but must have considerable family support)</td>
</tr>
<tr>
<td><strong>Previous intensive insulin therapy</strong></td>
</tr>
<tr>
<td>3–6 months of intensive insulin therapy with MDI</td>
</tr>
<tr>
<td>Monitors blood glucose at least four times per day</td>
</tr>
<tr>
<td>Self-administers injections and comfortable with needles</td>
</tr>
<tr>
<td>Has experience self-adjusting insulin doses between healthcare provider visits</td>
</tr>
<tr>
<td><strong>Relationship with provider</strong></td>
</tr>
<tr>
<td>Keeps routine appointments with diabetes team</td>
</tr>
<tr>
<td>Contacts the diabetes team when unusual problems or emergencies arise</td>
</tr>
<tr>
<td><strong>Psychological criteria</strong></td>
</tr>
<tr>
<td>Willing and eager to start insulin pump therapy</td>
</tr>
<tr>
<td>Aware of responsibilities to perform self-care</td>
</tr>
<tr>
<td>Understands benefits/limitations and has reasonable expectations</td>
</tr>
<tr>
<td><strong>Nutritional criteria</strong></td>
</tr>
<tr>
<td>Proficient in carbohydrate counting</td>
</tr>
<tr>
<td><strong>Medical criteria (one or more criteria may apply)</strong></td>
</tr>
<tr>
<td>Has achieved good glycemic control with intensive basal/bolus MDI regimen</td>
</tr>
<tr>
<td>Experiences episodes of severe hypoglycemia despite intensive basal/bolus MDI regimen</td>
</tr>
<tr>
<td>Wide fluctuations in blood glucose throughout the day despite intensive basal/bolus MDI regimen</td>
</tr>
</tbody>
</table>

Abbreviation used: MDI, multiple daily injection.
insensitive to insulin, 1 unit insulin might cover only 5 g or less of carbohydrate consumed.

Today, nearly all insulin pumps can calculate an appropriate bolus dose for the patient. The patient or health care provider can program the pump to store information regarding the patient’s personal correction and carbohydrate factors. Because the patient’s carbohydrate factor may be different for each meal, the pump can store more than one carbohydrate factor to accommodate changes in insulin sensitivity throughout the day. Patients can retrieve information in the pump’s database regarding the number of carbohydrates in a wide variety of foods. This feature makes it easier for patients to count carbohydrates and reduces the likelihood of an error. The patient-specific correction factor can also be input into the pump. This allows the pump to calculate and infuse an appropriate correction bolus when a blood glucose reading is above the designated target. Pumps can store the patient’s target goal glucose for each meal and at bedtime. The pump can then adjust insulin dosing to aim for this target at the desired times.

The bolus-on-board feature estimates the amount of insulin that remains in the body from the previous bolus injection. This safety feature may help prevent “stacking” of insulin doses—a phenomenon that occurs when two or more insulin injections are given in close proximity in time. The effects of each insulin dose stack on top of the previous dose(s). As an example, a patient may have taken a bolus dose for dinner and, 2 hours later, wish to give a second bolus dose for dessert. The pump is able to estimate what the patient has already received and, based on the insulin’s duration of action, calculates the second bolus dose of insulin, taking into account the previous bolus and the additional carbohydrate intake. The patient and provider must determine an estimated duration of insulin action that will work best for the patient. Solely using the pharmacokinetic information to determine how long the insulin is likely to act is not appropriate because considerable interindividual variability exists. The pharmacodynamic effects of the insulin often last longer than what is indicated by pharmacokinetic data. Not all insulin pumps have the bolus-on-board feature.

Basal dosing features

Most of today’s smart pumps come with multiple basal delivery profiles that allow the patient to select different basal infusion rates based on differences in daily or weekly schedules. As an example, many patients require a different basal rate or basal pattern on weekdays compared with weekends. This feature allows patients to preselect basal infusion rates to accommodate their lifestyles. Smart pumps also deliver basal insulin in different increments and ranges. If a patient requires a low basal infusion rate and is very sensitive to even small changes in the insulin dose, choosing a pump that allows for the deliv-
selecting an infusion set that works with the pump is important. After patients determine which pump best meets their needs, additional means (e.g., needle and syringe, pen device). Delivery rates. If the patient loses or misplaces the external data used to administer bolus doses and to adjust the basal insulin control communicates with the pump via radio waves. The PDM is an alarm reminding the user when to discard the pump. An external personal data manager (PDM) or remote connection communicates with the pump via radio waves. The PDM is used to administer bolus doses and to adjust the basal insulin delivery rates. If the patient loses or misplaces the external data manager, bolus doses of insulin must be given using more traditional means (e.g., needle and syringe, pen device).

Infusion sets
After patients determine which pump best meets their needs, selecting an infusion set that works with the pump is important. Infusion sets differ with regard to the anatomical sites where they work best, how easily they detach from the pump, whether the cannula is straight-in metal or slanted Teflon, and size. Many pumps use a standard luer-lock connection that allows the patient to choose from infusion sets made by several manufacturers. If the patient’s pump does not have this standard connection, the choice of infusion sets will be limited to single-source proprietary versions.

Initiating pump therapy
Initiating insulin pump therapy involves extensive patient education, close follow-up and monitoring, frequent dose adjustments, and, when needed, periodic troubleshooting. Most patients can initiate insulin pump therapy in an outpatient setting with frequent contact with a trained health care provider and a representative from the insulin pump company. Initiating insulin pump therapy involves several steps that require the active involvement of both the patient and health care provider(s).

Start-up training
During start-up training, the patient should be given one-on-one instruction on how to program and use the pump. In the initial training session(s), the patient should learn to input his or her personal carbohydrate factor and the correction factor, set the blood glucose targets and duration of insulin action, adjust the basal insulin delivery rate, fill and load the reservoir, connect the infusion set to the pump, and insert the cannula into the skin. Patients should be proficient in these basic pump operations before initiating insulin therapy via the pump. During the initial training period, normal saline is often used in the pump. The start-up training period may take a few days based on the patient’s comfort level with the pump technology. During this initial phase, health care providers must be readily available to address any concerns or issues that arise. Patients can also be directed to call the pump manufacturer’s 24-hour help line.

Infusion sites are areas with an adequate amount of subcutaneous fat—typically the abdomen, thighs, or buttocks. After the location is selected, the patient is instructed to prepare the infusion site. To prevent infusion-site infections, the patient should use an antiseptic product such as I.V. prep wipes, povidone–iodine solution, or chlorhexidine liquid. Isopropyl alcohol is not adequate for cleaning the site. Patients with a history of skin infections or inflammation around wounds should take particular care cleaning the infusion site because they are more likely to be carriers of S. aureus and are at increased risk for infection. After the area is cleaned, a bio-occlusive adhesive is placed on the site to prevent bacterial colonization. The infusion tubing is then inserted through the bio-occlusive adhesive into the skin. These procedures should be initially demonstrated by a health care provider. Once inserted, the infusion set is secured onto the skin with a hypoallergenic adhesive.

Pump–meter communication
Some insulin pumps can be “paired” with a meter that automatically sends blood glucose readings to the pump. This feature bypasses the need to input these data into the pump manually. The pump can then calculate the appropriate correction dose. This allows for faster administration of insulin, allows for faster correction of bolus dose calculations, and reduces the possibility of human input errors.

Wearable/disposable pumps
The Omnipod (Insulet) is a small wearable pump that attaches directly to the skin and does not use an infusion set (Figure 1F). The entire pump is discarded after 48 to 72 hours of use. The pump has an alarm reminding the user when to discard the pump. An external personal data manager (PDM) or remote control communicates with the pump via radio waves. The PDM is used to administer bolus doses and to adjust the basal insulin delivery rates. If the patient loses or misplaces the external data manager, bolus doses of insulin must be given using more traditional means (e.g., needle and syringe, pen device).

Alarms and reminders
Many pumps come with reminders that enable the patient to use the pump most effectively and alarms that alert the patient regarding a potential problem. Reminders and alarms can be set to signal the patient to test their postprandial blood glucose, to change the infusion site, to change a low battery, and to refill the insulin reservoir when a specified number is reached. Safety alarms can signal when the infusion line is clogged or when another type of mechanical problem with the pump occurs. Alarms can also be set to signal when a bolus has not been taken in the usual period of time. An auto-off feature can be set so that if the buttons have not been touched for 8 to 9 hours, the pump will deactivate to prevent further insulin delivery. The reminders and alarms can be customized on all insulin pumps.

Tracking dosing information
Having a balance between the basal and bolus administration and with correction boluses is important. The pump keeps track of the TDD of insulin, including the basal insulin delivered, mealtime boluses, and correction doses. The advantage of this feature allows the clinician and patient to observe whether correction doses are being used frequently and, if so, whether a pattern has emerged. In such cases, the prescriber and patient can analyze the data and adjust the carbohydrate ratio or basal rate to prevent the frequent use of correction boluses.
### Table 3. Available insulin pump technology, as of June 2008

<table>
<thead>
<tr>
<th></th>
<th>Accu-Chek Spirit</th>
<th>Animas 2020</th>
<th>CozMore Insulin Technology System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer</strong></td>
<td>Disetronic Medical Systems (<a href="http://www.disetronic-usa.com/dstrnc_us">www.disetronic-usa.com/dstrnc_us</a>)</td>
<td>Animas (<a href="http://www.animascorp.com">www.animascorp.com</a>)</td>
<td>Smiths Medical MD (<a href="http://www.cozmore.com">www.cozmore.com</a>)</td>
</tr>
<tr>
<td><strong>Size (in)</strong></td>
<td>3.2 × 2.2 × 0.8</td>
<td>3 × 2 × 0.86</td>
<td>3.2 × 1.8 × 0.9</td>
</tr>
<tr>
<td><strong>Weight (oz)</strong></td>
<td>4.0 with battery and full cartridge</td>
<td>3.13 with battery and full cartridge</td>
<td>3.3 with battery and full cartridge</td>
</tr>
<tr>
<td><strong>Warranty (y)</strong></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Reservoir size (units)</strong></td>
<td>315</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td><strong>Infusion set connection</strong></td>
<td>Luer-lock</td>
<td>Luer-lock</td>
<td>Luer-lock</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
<td>One AA alkaline</td>
<td>One AA lithium or alkaline</td>
<td>One AAA alkaline</td>
</tr>
<tr>
<td><strong>Basal profiles</strong></td>
<td>Store up to five profiles with up to 24 rates each</td>
<td>Store up to four profiles with up to 12 rates each</td>
<td>Store up to four profiles up to 48 rates each</td>
</tr>
<tr>
<td><strong>Basal delivery (units/h)</strong></td>
<td>Range of 0.1–25</td>
<td>Range of 0.025–25</td>
<td>Range of 0.05–35</td>
</tr>
<tr>
<td><strong>Smallest increment (units)</strong></td>
<td>0.1</td>
<td>0.025</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Temporary basal delivery</strong></td>
<td>10% increments from 0% to 200% based on baseline basal rate delivered in 15-min intervals over 15 min to 24 h</td>
<td>10% increments based on baseline basal rate delivered in 30-min intervals over 30 min to 24 h</td>
<td>% change from baseline or units/h change over a 30-min to 72-h interval</td>
</tr>
<tr>
<td><strong>Tracks bolus on board</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>Stores up to the last: 30 boluses, 30 alarms and errors, 30 TDDs, 30 temporary basal rate increases/decreases</td>
<td>Stores up to the last: 500 boluses, 120 TDDs, 30 alarms, 60 primes, 30 suspends, and 270 basal records</td>
<td>Stores up to 4,000 events</td>
</tr>
<tr>
<td><strong>Waterproof</strong></td>
<td>Up to 1 h</td>
<td>Up to 24 h at 12 ft</td>
<td>Up to 30 min at 8 ft or 3 min at 12 ft</td>
</tr>
<tr>
<td><strong>Download/available software</strong></td>
<td>Uses Accu-Chek Compass software with PDA Smartphone that comes with Bolus calculator, infrared port for wireless data transfer</td>
<td>Uses ezManager to download pump information to PC, infrared port for wireless data transfer</td>
<td>Uses CoZmanager to download pump information to PC, infrared port for wireless communication</td>
</tr>
<tr>
<td><strong>Other features</strong></td>
<td>Bright backlight display, audible or vibrating alerts, available in 12 languages, reversible display, side-mounted tactile buttons, menu navigation simplified with texts and icons, pump “skins” to personalize look of the pump, multiple safety alarms</td>
<td>Large flat panel screen with high-contrast color, has ezCarb in-pump food database that stores up to 500 food items, personalize audio notifications or vibrate for pump alarms, pump comes in multiple colors</td>
<td>Stores up to 12 custom meal boluses in food bank, hypoglycemic alarm when blood glucose drops</td>
</tr>
</tbody>
</table>

Abbreviations used: LCD, liquid crystal display; PC, personal computer; PDA, personal digital assistant; PDM, personal data manager; TDD, total daily dose.
<table>
<thead>
<tr>
<th>DANA Diabecare IIS</th>
<th>MiniMed Paradigm 522/722</th>
<th>OmniPod Insulin Management System</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.95 × 1.77 × 0.75</td>
<td>2.0 × 3.0 × 0.8 (model 522), 2.0 × 3.6 × 0.8 (model 722)</td>
<td>1.6 × 2.4 × 0.7 (OmniPod), 2.6 × 4.3 × 1.0 (PDM)</td>
</tr>
<tr>
<td>2.52 with battery and full cartridge</td>
<td>3.53 (model 522), 3.81 (model 722)</td>
<td>1.2 (Omnipod), 4.0 (PDM)</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>300</td>
<td>176 (model 522), 176 or 300 (model 722)</td>
<td>200</td>
</tr>
<tr>
<td>Proprietary</td>
<td>Proprietary</td>
<td>None required</td>
</tr>
<tr>
<td>One 3.6-V DC Lithium</td>
<td>One AAA alkaline</td>
<td>PDM powered by two AAA alkaline</td>
</tr>
<tr>
<td>Store up to 24 rates</td>
<td>Store up to three profiles with up to 48 rates each</td>
<td>Store up to seven profiles with up to 24 rates each</td>
</tr>
<tr>
<td>Range of 0.00–16</td>
<td>Range of 0.05–35</td>
<td>Range of 0.05–30</td>
</tr>
<tr>
<td>0.1</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>25% increments from 25% to 125% over an interval up to 12 h</td>
<td>% change from baseline or units/h in 30-min intervals over 30 min to 24 h</td>
<td>% change from baseline or by units/h for 30-min intervals over 30-min to 12 h</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Stores up to the last: 50 TDDs, 50 boluses, 50 primes, 12 alarms</td>
<td>Stores up to 90 days of data</td>
<td>Stores up to 90 days of data (up to 5,400 records)</td>
</tr>
<tr>
<td>Water resistant</td>
<td>Water resistant</td>
<td>Up to 30 min at 8 ft</td>
</tr>
<tr>
<td>No associated software download manager</td>
<td>Uses CareLink—a free Web-based download software</td>
<td>Uses PDM—an external data manager/controller that stores data</td>
</tr>
<tr>
<td>Large LCD screen, eight languages available, beep tone for alarm, available in four colors</td>
<td>Paradigm Real-time glucose-monitoring system measuring blood glucose every 1 min reporting an average every 5 min, large font on display, hypoglycemia prevention alarms, bolus wizard calculator, beep/vibrate alerts, four colors available</td>
<td>Two components to this system; OmniPod and PDM. OmniPod is the infusion set that has no attached tubing/cannula; features of PDM include FreeStyle glucose monitor, integrated food database storing up to 1,000 foods, bolus calculator</td>
</tr>
</tbody>
</table>

Go to www.pharmacist.com and take your test online for instant credit.
Determining the initial dose

Before initiating insulin pump therapy, the patient must discontinue MDI and the activity from intermediate- or long-acting insulin (e.g., NPH, glargine, detemir) must be given sufficient time to taper off. If the patient has been using insulin glargine, the last injection should be given 24 hours before initiating the pump. Insulin detemir or NPH injected at bedtime should be skipped the night before initiating pump therapy. Any nocturnal hyperglycemia can be corrected with a bolus of rapid- or short-acting insulin.

Pump users can typically achieve good glycemic control using a lower TDD of insulin compared with their previous insulin dose by MDI. For this reason, a conservative approach to the initial TDD via insulin pump is warranted. Most health care providers use the patient's previous TDD from MDI and the predicted weight-based TDD to estimate the TDD to be delivered via the insulin pump. To date, no validated formula exists for calculating the initial TDD. Therefore, close monitoring of blood glucose levels during the first few weeks of therapy is required to determine the patient’s optimal basal and bolus insulin requirements. For most patients, basal insulin requirements account for 40% to 60% of the TDD. Therefore, the TDD can be divided in half to determine the initial basal dose. The remaining 50% can be delivered as bolus doses throughout the day. This 50–50 method can be used to determine the initial basal and bolus doses for most patients, but clearly not all patients fit into this mold. Based on the patient’s dietary habits and physical activity, slight adjustments to this formula can and should be made to the initial dosing regimen. For example, a patient with high physical activity and high carbohydrate intake will likely require a larger proportion (55%–60%) of the TDD given as mealtime bolus doses. Alternatively, an obese, sedentary patient is likely to have some degree of insulin resistance and will require a larger proportion (55%–60%) of the TDD delivered in the basal infusion. Once the patient has initiated insulin pump therapy, the basal-to-bolus balance is monitored closely.

Determining the optimal basal rates throughout the day requires the patient to monitor blood glucose in a fasting state during an extended period of time. The optimal basal rate should prevent a rise or drop of more than 30 mg/dL during an 8- to 12-hour period with no food intake. However, optimal basal rates are often different at various times of the day. For example, most patients require a higher basal rate in the early morning hours (4:00 am–8:00 am) to mitigate the hyperglycemia caused by higher circulating levels of counterregulatory hormones (i.e., cortisol, growth hormone)—known as the dawn phenomenon. Because fasting for 24 hours is not practical or wise, optimal basal rates for various time periods (overnight, morning to early afternoon, and midafternoon to bedtime) should be determined separately. When determining the overnight basal rate, the patient is instructed to check blood glucose before bedtime (10:00 pm) and at midnight, 2:00 am, 4:00 am, 6:00 am, and 8:00 am. On separate days, the patient can then fast from the morning to early afternoon and then midafternoon to bedtime, checking the blood glucose hourly. It often requires a period of trial and error to determine the optimal basal rate for each of the three segments.

To determine optimal bolus doses, the patient and provider must determine the patient’s personal carbohydrate factor. Typically, the patient’s insulin-to-carbohydrate ratio is already known based on the patient’s previous mealtime dose requirements. However, in some cases, the patient’s insulin-to-carbohydrate ratio or personal carbohydrate factor is not known. A frequently used method to estimate the personal carbohydrate factor is to divide 500 by the TDD. If a larger percentage (60%) of the patient’s TDD is anticipated for basal delivery, dividing the TDD by 550 would yield a less aggressive bolus dose. If a smaller percentage (40%) is used toward basal delivery, a more aggressive bolus dose can be determined by dividing the TDD by 450. An insulin sensitivity factor is calculated to determine the correction bolus dose. The sensitivity factor is typically calculated by dividing the TDD by 1,500 if regular insulin is used in the pump or by 1,800 if rapid-acting insulin (insulin aspart, insulin lispro, or insulin glulisine) is used.

Initial monitoring and follow-up

The health care provider’s role in the training and identification of optimal insulin delivery is essential in the success of the patient’s insulin pump therapy. Once the patient is sent home, providing continuous care and being available for any questions, concerns, issues that arise is important. The patient is monitored very closely for the first few weeks after initiation with frequent phone calls and follow-up face-to-face visits to make dose adjustments. In most centers, patients are asked to communicate with their diabetes educator or health care provider every day for the first week following pump initiation. During this period, the patient monitors and records blood glucose at least six times a day to verify accuracy of the initial basal rates and bolus doses. Typically, patients are instructed to measure the blood glucose in the morning before breakfast, before lunch, in the mid-afternoon (or some other 2-h postprandial reading), before dinner, at bedtime, and at 2:00 am. During this time frame, the patient should keep physical activity relatively limited. After the patient has been stabilized, follow-up visits can be scheduled every 3 months.

Managing insulin pump therapy

After CSII is initiated, periodic dose adjustments are necessary to maintain optimal glycemic control and limit hypoglycemia. Routine follow-up visits are scheduled every 3 months and consist of physical exams to screen for diabetes-related complications and for obtaining A1C, lipid panel, renal function tests, and other measures to assess the patient’s control. Patients should continue to monitor blood glucose levels frequently and report any unusual
highs or lows. Unexplained highs or lows might be attributable to a miscalculation of the insulin dose or mechanical problems related to the pump technology.

**Exercise**

Patients should be evaluated before initiating an exercise program for complications that may preclude participation in excessive physical activity (i.e., coronary heart disease). An increased risk for hypo- and hyperglycemia occurs during exercise, and adjustments in insulin delivery may be needed to avoid major blood glucose deteriorations. In most circumstances following moderate-intensity exercise, the premeal bolus dose should be reduced to avoid postexercise hypoglycemia. A less physically fit individual is at greater danger of developing postexercise hypoglycemia, and a larger reduction in insulin will be required. Conversely, an increased incidence of postexercise hyperglycemia occurs in patients engaging in high-intensity exercise. The recovery time can last up to 60 minutes. During strenuous or prolonged exercise, glucose counterregulatory systems are activated by decreases in plasma insulin, increases in glucagon, and increases in epinephrine. If postexercise hyperglycemia is a consistent problem, patients should be directed to either temporarily increase the basal insulin infusion after their exercise routine or consider a less strenuous exercise program.

**Acute illness**

During acute illness, stress can induce insulin resistance, causing substantial blood glucose deteriorations. To counteract this increase in blood glucose, temporarily higher basal rates and higher bolus doses are usually required. After treatment for the acute illness is initiated, requirements may decrease and the patient will eventually return to normal insulin requirements. If blood glucose was not elevated enough to require an increase in the basal rate or bolus doses, correction doses can be administered. Illness that induces vomiting or diarrhea and reduces dietary intake may preclude the need for bolus doses. Throughout any acute illness, patients should be instructed to test their blood glucose levels more frequently and to check urine for ketones.

Patients who require hospitalization for an acute illness may or may not be continued on insulin pump therapy. Hospital protocols often dictate the insulin delivery systems that are permitted during a hospitalization. Many hospitals allow continued use of insulin pump therapy as long as the patient is capable of managing it personally. If the patient is incapacitated and the nursing staff is unfamiliar with the pump technology, therapy should be switched to standard insulin protocols used at the institution.

**Hypoglycemia and hypoglycemic unawareness**

Early reports implicated insulin pump therapy as increasing the incidence of hypoglycemia compared with MDI. More recent evidence demonstrates that CSII is associated with a lower risk of hypoglycemia. Severe hypoglycemia and hypoglycemia-induced coma are infrequent complications and seen in rates no higher than conventional injection therapy. Risk factors for severe hypoglycemia are patient specific and depend on the degree of glycemic control achieved and the sensitivity of the counterregulatory system.

Patients with lower A1C values are at higher risk for hypoglycemic unawareness. This typically presents after years of living with diabetes and results from repeated low blood glucose concentrations that reset the release of stress hormones that provoke classic hypoglycemic symptoms. Patients must develop heightened awareness of the subtle symptoms that generally occur when the blood glucose is less than 70 mg/dL to prevent severe hypoglycemic complications (i.e., seizures, coma) from occurring. To reverse hypoglycemic unawareness, the blood glucose targets are temporarily raised in an effort to strictly avoid hypoglycemia. Typically, the target fasting blood glucose targets are set at 120 to 150 mg/dL. By maintaining the blood glucose consistently above these targets during a period 1 to 2 weeks, the patient’s counterregulatory hormones are restored and the classic symptoms of hypoglycemia return.

**Mechanical problems**

Mechanical problems and interruptions in insulin delivery often cause unexplained highs and can progress to ketoadosis in 3 to 4 hours if they are not promptly addressed. Possible causes for unexplained highs include infusion-site problems, displaced or clogged infusion set, inactivated insulin because of degradation, or pump malfunction. Troubleshooting should include an investigation of the pump, infusion set, reservoir, infusion site, and battery to determine the potential causes for unexplained highs or lows. Most pumps have alarms indicating mechanical problems.

Tunneling of insulin occurs when the delivered insulin returns to the surface of the skin. Tunneling is common when the subcutaneous tissue becomes inflamed and swollen around the infusion site. Clogging of the infusion line is also a common problem. Prolonged exposure to heat can cause insulin to coagulate within the infusion set, thereby blocking delivery. Using unbuffered regular insulin increases the risk of infusion-line clogs. Rapid-acting insulin analogs like lispro, aspart, or glulisine are less likely to clog the infusion set and are the preferred insulin products to use in insulin pumps. Exogenous materials coming into contact with the reservoir or infusion line such as alcohol, lotions, and sprays can also cause clogging. Insulin leakage from the tubing or reservoir can also cause unexplainable high blood glucose levels. Although insulin leakage can be difficult to detect, patients can use observation and the distinct smell of insulin to locate the leak. If a clog, leak, or infusion-related issue is suspected, the entire infusion set should be replaced.

When the blood glucose reading is greater than 300 mg/dL or if two consecutive readings are greater than 250 mg/dL, the patient should be instructed to check for ketones in the urine.
In addition, a correction bolus dose of insulin should be administered. The blood glucose should be monitored every 2 hours, and, if ketones are present, the patient should rehydrate with an appropriate fluid until ketones have cleared and the blood glucose has stabilized.\textsuperscript{1,30} Other reasons for unexplained hyperglycemia or DKA include illness or infection, mechanical problems, degraded insulin, and incorrect bolus dosing by the patient.\textsuperscript{1} Although patients are not at an increased risk for developing DKA, it is the second most common complication seen with insulin pump therapy.\textsuperscript{34}

Back-up insulin should always be accessible in case of pump malfunction. When faced with mechanical problems, the patient may need to remove the insulin pump to troubleshoot and begin using traditional insulin injections (insulin syringes/insulin pens), covering meals with rapid- or short-acting insulin and maintaining their basal insulin requirement with a long-acting insulin.

**Infusion-site infections**

If the infusion site becomes erythematous, inflamed, or painful, the patient should be instructed to remove the infusion set, gently squeeze the site, and inspect for fluid discharge. This can indicate whether an infection or a hematoma is present. Signs of infection should be reported immediately, while a hematoma can be managed by changing the infusion site and using a new set.\textsuperscript{1} Patients are at increased risk if they are carriers of *S. aureus* or if they have recurrent skin infections.\textsuperscript{34,36} *S. aureus* species are the most common cause of site infections.\textsuperscript{33} After patients experience an infusion-site infection, they are at an increased risk for recurrent infections. Recurrent infusion-site infections may require the discontinuation of insulin pump therapy.\textsuperscript{41}

**Lipodystrophy**

Placing the infusion set frequently in the same region can lead to tissue hypertrophy and lipodystrophy. Although these lesions are benign, they can have significant cosmetic effects for patients. Patients should be instructed to frequently rotate the site of infusion set placement to avoid lipodystrophy. Patients should wait 3 to 4 weeks before using the same area to allow appropriate healing time.\textsuperscript{1}

**Conclusion**

Intensive insulin therapy is considered the standard of care of patients with type 1 diabetes. Likewise, many patients with type 2 diabetes may develop severe beta-cell failure, resulting in wide fluctuations in blood glucose throughout the day that require intensive insulin therapy. While many patients continue to use MDI, advances in insulin pump technology during the previous 15 years have made CSII therapy an attractive option for an increasing number of patients. CSII is most often initiated by specialists who have extensive experience working with the technology. However, after being initiated, “pumpers” are seen and managed in all health care settings, including primary care and family medicine clinics, hospitals, and community pharmacies. All health care practitioners should be familiar with the basic features of modern insulin pumps, able to advise patients regarding the potential benefits and limitations of this drug delivery system, and capable of troubleshooting common problems that may arise.

**References**

17. Scheidegger U, Allemann S, Scheidegger K, Diem P. Continuous subcutaneous insulin infusion therapy: effects on quality of life. Swiss

**CE Credit:**

To obtain 2.0 contact hours of continuing education credit (0.2 CEUs) for “Continuous subcutaneous insulin infusion therapy: A primer on insulin pumps,” complete the assessment exercise, fill out the CE examination form at the end of this article, and return to APhA. You can also go to www.pharmacist.com and take your test online for instant credit. CE processing is free for APhA members and $15 for nonmembers. A Statement of Credit will be awarded for a passing grade of 70% or better. Pharmacists who complete this exercise successfully before January 1, 2012, can receive credit.

The American Pharmacists Association is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. The ACPE Universal Program Number assigned to the program by the accredited provider is 202-000-09-108-H01-P.

“Continuous subcutaneous insulin infusion therapy: A primer on insulin pumps” is a home-study continuing education program for pharmacists developed by the American Pharmacists Association.
Assessment Questions

Instructions: You may take the assessment test for this program on paper or online. For each question, circle the letter on the answer sheet corresponding to the answer you select as being the correct one. There is only one correct answer to each question. Please review all your answers to be sure that you have circled the proper letters. To take the CE test for this article online, go to www.pharmacist.com and click Education. On the Education welcome page, search for this article with the search function, using “CE” and a keyword. Follow the online instructions to take and submit the assessment test. This CE will be available online at www.pharmacist.com no later than January 31, 2009. You can also find it on www.pharmacytoday.org.

1. Compared with intensive insulin therapy given as multiple daily injections (MDIs), which of the following is a potential long-term benefit of continuous subcutaneous insulin (CSII) therapy?
   a. Patients who elect to use CSII report a higher quality of life.
   b. Patients who use CSII are more likely to achieve a glycosylated hemoglobin (A1C) value less than 7%.
   c. Patients who elect to use CSII do not need to test their blood glucose as frequently.
   d. Patients who use CSII are less likely to develop renal impairment or require a kidney transplant.

2. Compared with MDI, which of the following is a short-term benefit of CSII?
   a. Blood glucose variability throughout the day is lower.
   b. The overall cost of insulin and its delivery is lower substantially.
   c. The need to monitor blood glucose concentrations throughout the day is reduced.
   d. Blood pressure, high-density lipoprotein cholesterol, and serum homocysteine concentrations are improved slightly.

3. Based on the results of the Diabetes Control and Complications Trial (DCCT) and the follow-up Epidemiology of Diabetes Interventions and Complications study, which of the following outcomes is less likely to occur in a patient with type 1 diabetes who achieves an A1C of 7% or less compared with a patient with type 1 diabetes who achieves an A1C of 8% or more?
   a. Proteinuria
   b. Cardiovascular events
   c. Proliferative diabetic retinopathy
   d. All of the above alternatives are correct.

4. A 26-year-old woman with type 1 diabetes who currently uses MDI to control her diabetes is considering a switch to CSII. However, she has had two episodes of severe hypoglycemia in the previous 3 months that required assistance. The episodes occurred without warning symptoms. Therefore, she is worried that an insulin pump might not be a good choice for her. Which of the following is an appropriate response to this patient’s concerns?
   a. “The risk of severe hypoglycemia with MDI is a bit lower than CSII. I think you should stick with MDI for now until things get straightened out.”
   b. “When it comes to risk of low blood glucose reactions, MDI and CSII are about the same. The decision to use one over the other is strictly a personal preference.”
   c. “People who have large swings in blood glucose and episodes of severe hypoglycemia may benefit from CSII with careful monitoring. I encourage you to consider switching to CSII.”
   d. “Switching to CSII would be ideal for you. Hypoglycemia is very rare, and you only need to check your blood glucose once or twice a day.”

5. The mother of a 16-year-old female patient with type 1 diabetes seeks your advice. Despite checking her glucose three or four times a day at home, the daughter’s blood glucose has been poor during the past year (last A1C = 9.8%). The mother has read about insulin pumps and would like her daughter to get one. However, the daughter refuses to even consider the idea. Which of the following might explain the daughter’s reluctance?
   a. Most female patients think insulin pumps are unattractive and bulky.
   b. Many teenagers believe wearing an insulin pump is a signal to everyone that they have a disease.
   c. Unsubstantiated rumors posted on Internet blogs suggest that using an insulin pump causes disfiguring skin lesions.
   d. Many patients with diabetes believe that when an insulin pump is required to control their blood glucose, their disease must be “really bad.”

6. According to the DECODE (Diabetes Epidemiology: Collaborative Analysis of Diagnostic Criteria in Europe) study, postprandial hyperglycemia more than 200 mg/dL is an independent risk factor for which of the following?
   a. Skin infections
   b. Hypertension
   c. Kidney transplantation
   d. Death from cardiovascular disease
7. Infusion-site reactions are a common problem among patients who use insulin pumps. Which of the following is the most commonly encountered infusion-site problem associated with insulin pump use?
   a. Pain
   b. Infection
   c. Hematoma
   d. Allergic reaction to the adhesive

8. During DCCT, which of the following complications was observed during the first month of intensive insulin therapy, particularly in patients with A1C more than 9% at baseline?
   a. Worsening retinopathy
   b. Worsening renal function
   c. New-onset coronary artery disease
   d. Worsening pain from peripheral neuropathy

9. Which of the following patients has a medical indication for insulin pump therapy?
   a. A patient with type 1 diabetes with good glycemic control on MDI
   b. A patient with type 2 diabetes who refuses to give insulin injections
   c. A patient with type 1 diabetes with macrovascular complications (e.g., stroke, myocardial infarction)
   d. A patient with type 2 diabetes with microvascular complications (e.g., proliferative retinopathy, gross proteinuria)

10. Insulin pumps today can continuously deliver relatively small amounts of insulin. Which of the following is the smallest possible increment in the infusion rate (units/h) using currently available insulin pumps?
    a. 0.025
    b. 0.05
    c. 0.5
    d. 1

11. Which of the following insulin pumps requires a remote control to administer bolus doses and adjust the basal infusion rate?
    a. Accu-Chek Spirit
    b. Animas 2020
    c. Minimed Paradigm 722
    d. OmniPod

12. Many insulin pumps have a bolus-on-board feature. The primary value of this feature is to
    a. Alert the patient when a bolus dose is being delivered.
    b. Enhance the rapid delivery of a bolus dose of insulin before meals.
    c. Improve the timing of bolus insulin delivery 10 minutes before eating.
    d. Reduce the risk of hypoglycemia due to frequent bolus dose administration.

Questions 13–20 relate to the following case:
L.P. is a 25-year-old Asian woman who would like to use an insulin pump. L.P. is currently using insulin aspart before each meal plus insulin detemir 14 units at bedtime. Her personal carbohydrate factor is 17 g carbohydrate per unit insulin and personal correction factor is 60 mg/dL per unit insulin. During the previous 2 weeks, L.P. has administered bolus doses totaling 15 units per day (average). Her weight is 50 kg, height is 5'4", and most recent A1C (2 weeks ago) is 6.7%.

13. Which of the following is not an appropriate action to take in preparing L.P. to initiate insulin pump therapy?
    a. L.P. should practice with an insulin pump for 2 or 3 days using normal saline.
    b. L.P. should be given an opportunity to see and examine all of the available pump devices.
    c. L.P. should reduce the dose on insulin detemir by 50% 3 days before initiating the insulin pump.
    d. L.P. should be instructed how to fill the insulin cartridges, insert the canula, attach the infusion set, and prime the tubing.

14. Which of the following would be the most appropriate insulin to use in L.P.'s new insulin pump?
    a. Regular insulin
    b. Insulin glargine
    c. Insulin glulisine
    d. Neutral protamine Hagedorn (NPH) insulin

15. Which of the following is the most appropriate estimate of L.P.’s initial total daily dose that should be used when making her initial dose determination?
    a. 14 units
    b. 27 units
    c. 35 units
    d. 50 units

16. Which of the following would be the most appropriate initial basal insulin infusion rate (units/h) for L.P.?
    a. 0.1
    b. 0.6
    c. 1.1
    d. 1.8
17. As instructed, L.P. skipped her evening dose of insulin detemir and started using the pump this morning at 6:00 am. She is instructed to fast and check her blood glucose every hour for the first 6 hours after starting the insulin pump. Her glucose readings are as follows: 6:00 am, 126 mg/dL; 7:00 am, 111 mg/dL; 8:00 am, 107 mg/dL; 9:00 am, 92 mg/dL; 10:00 am, 71 mg/dL; 11:00 am, 64 mg/dL. Which of the following would be the most appropriate response to this information?

a. Increase personal correction factor from 60 to 80 mg/dL per unit insulin  
b. Change personal carbohydrate factor from 17 to 15 g carbohydrate per unit insulin  
c. Encourage the patient to eat a full breakfast every morning to avoid hypoglycemia  
d. Decrease basal insulin infusion rate by 15% and check hourly fasting glucose readings tomorrow morning for 6 hours

18. At the end of the first week, L.P. faxes you information (see table below) regarding her home glucose monitoring readings, food intake, and insulin dosing. Which of the following would be the most appropriate response to this information?

a. Increase the insulin basal infusion rate by 20%  
b. Increase the insulin basal infusion from 6:00 am to 12:00 noon by 20%  
c. Increase the personal carbohydrate factor for breakfast (only) to 12 g carbohydrate per unit insulin  
d. No changes in either the basal infusion rate or bolus dosing are warranted.

<table>
<thead>
<tr>
<th></th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before breakf.</td>
<td>Blood glucose, 98 mg/dL; carbohydrates, 45 g; bolus, 2.4 units</td>
<td>Blood glucose, 89 mg/dL; carbohydrates, 60 g; bolus, 3.2 units</td>
<td>Blood glucose, 75 mg/dL; carbohydrates, 60 g; bolus, 3.2 units</td>
</tr>
<tr>
<td>After breakf.</td>
<td>Blood glucose, 234 mg/dL; correction, 2.2 units</td>
<td>Blood glucose, 271 mg/dL; correction, 2.5 units</td>
<td>Blood glucose, 220 mg/dL; correction, 2 units</td>
</tr>
<tr>
<td>Before lunch</td>
<td>Blood glucose, 98 mg/dL; carbohydrates, 60 g; bolus, 3.2 units</td>
<td>Blood glucose, 127 mg/dL; carbohydrates, 65 g; bolus, 3.4 units</td>
<td>Blood glucose, 102 mg/dL; carbohydrates, 45 g; bolus, 2.4 units</td>
</tr>
<tr>
<td>After lunch</td>
<td>Blood glucose, 182 mg/dL; correction, 1 unit</td>
<td>Blood glucose, 139 mg/dL</td>
<td>Blood glucose, 128 mg/dL</td>
</tr>
<tr>
<td>Before dinner</td>
<td>Blood glucose, 105 mg/dL; carbohydrates, 65 g; bolus, 3.42 units</td>
<td>Blood glucose, 150 mg/dL; carbohydrates, 70 g; bolus, 4.6 units</td>
<td>Blood glucose, 95 mg/dL; carbohydrates, 65 g; bolus, 3.4 units</td>
</tr>
<tr>
<td>After dinner</td>
<td>Blood glucose, 147 mg/dL</td>
<td>Blood glucose, 135 mg/dL</td>
<td>Blood glucose, 212 mg/dL; correction, 2 units</td>
</tr>
</tbody>
</table>

19. Two months later, L.P.’s personal carbohydrate factor is 19 g carbohydrate per unit insulin and her personal correction factor 75 mg/dL per unit insulin. Her target blood glucose is 110 mg/dL. Which of the following would be the most appropriate bolus dose (in units) for L.P. to administer before dinner if she plans to consume 60 g carbohydrate and her current blood glucose reading is 185 mg/dL?

a. 3.3  
b. 4.2  
c. 5.7  
d. 6.0

20. Six months later, L.P. has gained some weight and her lifestyle has been fairly sedentary. L.P. would like to start a 60-minute aerobics class on Tuesday and Thursday afternoon (4:00 pm–5:00 pm) at the local gym so she can get in better shape. She typically eats her dinner at 6:30 pm, so she plans to eat within 2 hours after exercising. In addition to checking her blood glucose more frequently during and after exercise to determine her response, which of the following would be the most appropriate initial management strategy for her insulin therapy after exercise?

a. Place the insulin pump in the “suspend mode” and hold insulin therapy, both the basal infusion and any bolus doses, for 4 hours after exercising  
b. Increase the basal insulin infusion rate by 20% from 4:00 pm to 8:00 pm on the days she exercises and give the usual bolus dose before dinner  
c. Decrease the basal insulin infusion rate by 50% from 8:00 pm to 2:00 am on the days that she exercises and give the usual bolus dose before dinner  
d. Continue the same basal insulin infusion rate but decrease the bolus dose of insulin before dinner by 50% on the days that she exercises
Continuous subcutaneous insulin infusion therapy: A primer on insulin pumps

This CE will be available online at www.pharmacist.com no later than January 31, 2009. To receive 2.0 contact hours of continuing education credit (0.2 CEU), please provide the following information:

1. Type or print your name and address in the spaces provided.
2. Mail this completed form for scoring to:
   American Pharmacists Association—CE Exam
   P.O. Box 791082
   Baltimore, MD 21279-1082
3. CE processing is free for APhA members. If you are not an APhA member, please enclose a $15 handling fee for grading the assessment instrument and issuing the Statement of Credit.

A Statement of Credit will be awarded for a passing grade of 70% or better. If you fail the exam, you may retake it once. If you do not pass the second time, you may no longer participate in this continuing pharmacy education program. Please allow 6 weeks for processing. Pharmacists who complete this exercise successfully before January 1, 2012, may receive credit.

The American Pharmacists Association is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. The ACPE Universal Program Number assigned to the program by the accredited provider is 202-000-09-108-H01-P.

PARTICIPANT INFORMATION

NAME

ADDRESS

CITY STATE ZIP

E-MAIL

WORK PHONE

HOME PHONE

How long did it take you to read the program and complete this test? ____ Hours ____ Minutes

My signature certifies that I have independently taken this CE examination:

CE ASSESSMENT QUESTIONS—ANSWERS

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>12</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>13</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>14</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>15</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>16</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>17</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>18</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>19</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>20</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

PROGRAM EVALUATION

EXEMPLARY POOR

PLEASE RATE THE FOLLOWING ITEMS.

1. Overall quality of the program 5 4 3 2 1
2. Relevance to pharmacy practice 5 4 3 2 1
3. Value of the content 5 4 3 2 1

PLEASE ANSWER EACH QUESTION, MARKING WHETHER YOU AGREE OR DISAGREE.

4. The program met the stated learning objectives: After reading this CE article, the pharmacist should be able to: Agree Disagree
   • Describe intensive insulin therapy, including the use of continuous subcutaneous insulin infusion (CSII) systems.
   • Name at least three benefits of the use of CSII.
   • Name at least three disadvantages with the use of CSII.
   • Describe the characteristics of patients with diabetes who are good candidates for CSII therapy.
   • Compare and contrast the available insulin pumps capable of delivering CSII therapy.
   • Be able to address both mechanical problems and clinical complication’s that can arise during CSII therapy.

5. The program increased my knowledge in the subject area.

6. The program did not promote a particular product or company.

IMPACT OF THE ACTIVITY

The information presented (check all that apply):

7. ❑ Reinforced my current practice/treatment habits ❑ Will improve my practice/patient outcomes
   ❑ Provided new ideas or information I expect to use ❑ Adds to my knowledge
8. Will the information presented cause you to make any changes in your practice? ❑ Yes ❑ No
9. How committed are you to making these changes? (Very committed) 5 4 3 2 1 (Not at all committed)
10. Do you feel future activities on this subject matter are necessary and/or important to your practice? ❑ Yes ❑ No

FOLLOW-UP

As part of our ongoing quality-improvement effort, we would like to be able to contact you in the event we conduct a follow-up survey to assess the impact of our educational interventions on professional practice. Are you willing to participate in such a survey?

❑ Yes ❑ No
As the nation’s largest pharmacy health care provider, CVS Caremark is transforming the delivery of health care services. We are leveraging our strengths, combining the personalized reach of the nation’s largest retail pharmacy with the innovative delivery technology of the nation’s premier pharmacy benefits management provider.

We recognize that our success as a leading health care provider, and our impact on the community, depends on our pharmacists.

We seek only the best pharmacists to join our team and advance the quest to deliver outstanding health care every day.
Stop Feeling Trapped

Let Rx relief® help your profession work for you.

Our pharmacists tell us their Rx relief® career works for them because it offers the benefits of a corporate employer, the flexibility of a small pharmacy owner, and the control they've wanted to create an independent lifestyle.

So, while employers are advertising everywhere with special offers and incentives, only Rx relief® lets you optimize your return as a pharmacist in a respectful environment while you exercise more control over your work and your working conditions.

Control Your Schedule
Change Your Scenery
Avoid Workplace Games
Control Your Income

For pharmacists who want to excel in their profession and in their lives.

PHARMACIST w/Masters or foreign equiv in Pharmaceutical Science & 1 yr exp. *Will accept Bachelors or foreign equiv & 5 yrs of progressive work exp in lieu of Masters* or foreign equiv. & 1 yr exp. Prepare and oversee prep’n & dispense prescription medications to patients & medical practitioners. Counsel patients & medical practitioners on drug indications, contraindications dosage, drug interactions & side effects. Supv 1 Clerk & 1 Technician. Must work on weekends & holidays. Must have NJ State Registered Pharmacist License. Mail res to: J&R Drug Inc., d/b/a Welcome Pharmacy, 770 W. Side Ave, Jersey City, NJ 07306. Job Loc: Jersey City, NJ

LEAD SCIENTIST R&D: With in dept. knowledge of different mass spectrometry and chromatography techniques, expertise in high resolution MS systems is a must (calibration, maintenance, impurity identification, accurate mass, structure elucidation, method development, quantification etc.). Ph.D. in Chemistry + 1 yr. rel. exp. reqd.

E-mail resumes to: Carmen Umpierre cumpierre@azopharma.com Azopharma Product Development Group, 2 Oakwood Blvd., Suite 170, Hollywood, FL

New York City Ambulatory Health Care facility has the following opportunities. NO NIGHTS OR WEEKENDS.

PHARMACY SUPERVISOR Outstanding work schedule for individuals who are NYS Registered Pharmacist with a minimum 3 years supervisory experience, strong analytical, communications and PC skills.

PHARMACIST Must be NYS Registered Pharmacist with minimum 2 years experience. Requires solid knowledge of health care delivery systems, drug utilization, strong communications and PC skills.

Both positions offer a competitive salary, outstanding benefits and a pleasant work environment. Please e-mail resume indicating position of interest to:

adopportunity@yahoo.com EOE

STAFF PHARMACIST (Boston, MA) Take all steps req’d to fill prescriptions in compliance with all laws, regulations, & company policies & procedures regarding the sale of pharmaceuticals incl: retrieving the products, count, pour, measure, or compound the required product; affixing the label to the container; & performing final auditing of the prescription. Doctor of Pharmacy Degree, 1500 hrs of board-approved internship exp, & Registered Pharmacist in Massachusetts req’d. Mail resume to Boston Pharmacy Management Company Inc., Attn: HR-SP, 24 Stevens Ln, Cohasset, MA 02025.
HELP WANTED:
APhA ADVOCACY KEY CONTACTS

With the 2008 elections over and the battle over health care reform just beginning in Congress, APhA is looking for a few good volunteers to develop relationships with their Members of Congress and advocate on behalf of the profession by participating in the APhA Advocacy Key Contact network. To become an APhA Advocacy Key Contact:

- **No experience necessary**
- Staff will train
- Learn about health care policy
- Meet interesting people
- Very rewarding experience

More Information About Becoming an APhA Advocacy Key Contact Visit: www.pharmacist.com/KeyContact

Interact with representatives from chains, hospitals, managed care organizations, federal government facilities, and pharmaceutical firms from around the country.

- Advocate Rx Solutions
- Albertsons LLC
- Banner Health
- Cameron and Co.
- Cardinal Health, Nuclear Pharmacy Services
- Cleveland Clinic
- CompleteRx
- CVS Caremark
- The Delta Companies
- Express Scripts
- HCA North Texas Division
- H-E-B
- Humana, Inc.
- IBA Molecular
- Indian Health Services
- Kaiser Permanente
- Kmart
- Kroger Co.
- Mayo Clinic
- PETNET Solutions
- Pharmstaff
- PrincetonOne
- Professional Relief Network
- Publix Super Markets
- Rite Aid Corporation
- Rx relief
- RxInsider.com
- Safeway Companies
- SUPervalu
- Texas Health Resources
- Walgreens
- Wal-Mart Stores, Inc.

Looking for a new job?

Visit the APhA Employment Exchange @ APhA Annual Meeting & Exposition • April 3–6 • San Antonio, Texas

Exposition hours: Saturday/Sunday 11:00 am – 3:00 pm, Monday 11:00 am – 2:00 pm

- Visit industry representatives
- Meet and mingle with potential employers
- Explore new opportunities
- Visit the career center at pharmacist.com for more information

JOB PLACEMENT SERVICES FOR PHARMACY PROFESSIONALS
AD INDEX

Advocacy (APhA) ................................................................. 74
AHRQ Effective Care Webinar (AHRQ) ......................... 47
APhA 2009 Advance Program (APhA) ....................... 25–36
APhA Pharmacy Law Matters 2008 CE (APhA) ....... 45
Atacand (AstraZeneca) ..................................................... 9–11
Book of the Month (APhA) ............................................. 41
BPS (APhA) ........................................................................ 44
Cold-Eeze (Quigley) ......................................................... 3
Coricidin (Schering-Plough) ............................................. C4
Corporate (HPSO Affinity Insurance Services) ........... 15
Corporate (Lexi-Comp) ...................................................... 41
Corporate (Medi-Dose) .................................................. HSE 3
Corporate (ScriptPro) ........................................................ 13
Effient (Eli Lilly, Daiichi Sankyo) ................................. 23
Employment Exchange (APhA) ...................................... 74
Handbook of Nonprescription Drugs (APhA) ............. HSE 7
Kids-Eeze (Quigley) ............................................................. 19
MTM Monograph (APhA/NACDS) ................................ C3
Pharmacy Today Subscriptions (APhA) ....................... 75
Recruitment (CVS/Caremark) .......................................... 72
Trilipix (Abbott Laboratories) .......................................... C2
Venlafaxine (UCB Pharma Inc.) ..................................... 5–7

To receive a FREE full-year subscription to Pharmacy Today, click onto www.pharmacist.com/subscription.php and complete the online subscription form.
Offer Code: PTHA-0708

And did you know, as a practicing pharmacist, you are eligible to receive a full-year subscription to Pharmacy Today, absolutely FREE?

Be in the know by joining thousands of informed pharmacists who subscribe to Pharmacy Today and receive the regularly featured MTM Tip, continuing education, Product Showcase, ISMP Error Alert, OTCs Today, Counseling Corner tip, and much more!

To receive a FREE full-year subscription to Pharmacy Today, click onto www.pharmacist.com/subscription.php and complete the online subscription form.
Offer Code: PTHA-0708
Design, distractions, and drive-up windows

Is the design of a pharmacy computer system, work area, and workflow a contributing factor in medication dispensing errors? Based on errors reported to the Institute for Safe Medication Practices (ISMP) during a recent study, nearly one-third of the pharmacy-related errors identified by the ISMP Medication Errors Reporting Program (MERP) are due to the pharmacy design and workflow. The ISMP report states, "Design considerations, such as easy access to scanned images and bar code scanning and optional pill images, can help reduce errors. Separate areas should be created for error resolution to deal with prescription filling issues such as third party rejections or prescriber authorizations. Computer systems should be designed with safe workflow considerations such as easy access to scanned images and patient history. Both data entry and quality assurance check stations should be designed to minimize distractions—a major contributor to errors. It makes sense to take a cue from the airline industry and create a “sterile cockpit” at each station with procedures and systems designed to eliminate unnecessary distractions and interruptions while controlling and minimizing others."

Study results

Results from a recent study suggest that pharmacists see a correlation among the social and technological systems of the pharmacy layout (e.g., pharmacy design, drive-through pick-up windows, and automated dispensing systems), workflow design, and increases in dispensing errors. This interaction was particularly noted in layouts with drive-through pick-up windows. Pharmacists perceive a direct relationship between concentration gaps or distractions due to pharmacy design and dispensing errors.¹

Pharmacists responding to the survey agreed that pharmacy layouts need to be more efficient and that poor design does contribute to communication and dispensing errors. They perceived that the existence of a drive-through window can contribute to delays in processing prescriptions and errors because of additional steps and time to travel to and from the window repeatedly. Most notably, pharmacists perceived that automated dispensing systems reduced errors in dispensing, errors in communication with staff, and the number of steps in prescription processing by pharmacists, and viewed these systems as more efficient in all practice settings by reducing workload effort.¹

Design for safety

While poorly designed systems and processes contribute to errors, effective design can deliver products, processes, and environments that are intuitive, easy to understand, simple to use, convenient, and comfortable, and consequently are less likely to lead to errors.²

The pharmacy should be designed to make correct actions easy to accomplish, wrong actions difficult or impossible to carry out, mistakes easy to see, and should facilitate reversing or fixing incorrect actions. Lastly, pharmacies should be designed to accommodate the needs of users and should be rooted in simplicity and ingenuity. They need not be expensive. This involves simplifying structured tasks and processes, making things visible, getting the mapping right, exploiting the powers of constraints, and designing to minimize error.³

Improving patient safety in community pharmacy involves streamlining day-to-day operations through an integrated workflow module. Consideration should be given to implementing a quality assurance check station with national drug code verification and/ or bar code scanning and optional pill images. Separate areas should be created for error resolution to deal with prescription filling issues such as third party rejections or prescriber authorizations. Computer systems should be designed with safe workflow considerations such as easy access to scanned images and patient history. Both data entry and quality assurance check stations should be designed to minimize distractions—a major contributor to errors. It makes sense to take a cue from the airline industry and create a “sterile cockpit” at each station with procedures and systems designed to eliminate unnecessary distractions and interruptions while controlling and minimizing others.

—Institute for Safe Medication Practices

References

LEARNING OBJECTIVES
After reading this monograph, the pharmacist will be able to:
1. Describe the professional role and business model of a pharmacist working as an independent medication therapy management (MTM) pharmacist practitioner.
2. Explain aspects of business planning strategies, including an analysis of a business venture’s strengths, weaknesses, opportunities, and threats.
3. Describe federal and state pharmacy laws and regulations and state and local business laws and regulations that should be reviewed when starting a new venture as an independent MTM pharmacist practitioner.
4. Describe potential liability issues pertaining to pharmacists as MTM practitioners and list safeguards to consider prior to business initiation.
5. Access tools and resources available for pharmacist practitioners to build and provide MTM services in an independent practice.

ACPE Activity Type: Application-Based

CE CREDIT
To obtain 1.5 hours of continuing education credit (0.15 CEUs) for “Medication Therapy Management Services: Developing a Practice as an Independent MTM Pharmacist,” complete the assessment exercise, fill out the CE Examination Form at the end of this publication, and return that page to APhA.

CE processing is free for APhA members. If you are not an APhA member, a $15.00 handling fee will be charged for grading the assessment instrument and issuing the Statement of Credit. A Statement of Credit will be awarded for a passing grade of 70% or better. Pharmacists who complete this exercise successfully before December 1, 2011, can receive credit.

The American Pharmacists Association is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. The ACPE Universal Program Number assigned to the program by the accredited provider is 202-000-08-235-H03-P.

“Medication Therapy Management Services: Developing a Practice as an Independent MTM Pharmacist” is a home-study continuing education program for pharmacists developed by the American Pharmacists Association.

DISCLOSURES
LeAnn Causey Boyd, PharmD, BCPS, CDE, is a consultant for Third Party Station where she is involved in the service described in this program. She declares no conflicts of interest or financial interests in any other product or service mentioned in this program, including grants, employment, gifts, stock holdings, and honoraria.

Don Thibodeau, BS Pharm, RPh, is employed by Target Pharmacy and The PillHelp Co., LLC, where he is involved in the service described in this program. He declares no conflicts of interest or financial interests in any other product or service mentioned in this program, including grants, employment, gifts, stock holdings, and honoraria.

APhA’s editorial staff declares no conflicts of interest or financial interests in any product or service mentioned in this program, including grants, employment, gifts, stock holdings, and honoraria.

This publication was prepared by Judy Crespi Lofton, MS, of JCL Communications on behalf of the American Pharmacists Association.
RECOMMEND COLD MEDICINE WITH A HEART.

TELL YOUR PATIENTS ABOUT THE ONLY COLD BRAND THAT WON’T RAISE THEIR BLOOD PRESSURE: CORICIDIN® HBP.

Like many of your patients, S. Epatha Merkerson has hypertension. Since decongestants are contraindicated for hypertensive patients, they need to be careful when they get a cold. So assure your patients that Coricidin HBP is the smart choice because it’s decongestant-free and specially made to relieve cold symptoms without raising blood pressure. Recommend the full line of products from Coricidin HBP. Powerful cold medicine with a heart.