
Strategies for Insulin Injection Therapy in Diabetes Self-Management



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Linda Siminerio, PhD, RN, CDE
Director, University of Pittsburgh Diabetes Institute
Pittsburgh, PA

Karmeen Kulkarni, MS, RD, BC-ADM, CDE
Director, Scientific Affairs, R&D
Abbott Diabetes Care
Adjunct Faculty, University of Utah, College of Health,
Department of Nutrition
Salt Lake City, Utah

Jerry Meece, RPh, FACA, CDM, CDE
Director of Clinical Services
Plaza Pharmacy and Wellness Center
Gainesville, TX

Ann Williams, PhD, RN, CDE
Diabetes Educator
Case Western Reserve University
Cleveland, Ohio

Marjorie Cypress, PhD, C-ANP, CDE
Diabetes Nurse Practitioner
ABQ Health Partners
Albuquerque, NM

Linda Haas, PhC, RN, CDE
Endocrinology Clinical Nurse Specialist
VA Puget Sound Health Care System
Seattle, Washington

Teresa Pearson, MS, RN, CDE
Director, Diabetes Care
Fairview Health Services
Minneapolis, Minnesota

Helena Rodbard, MD, FACP, MACE
Chair, AACE Diabetes Mellitus Clinical Practice Guidelines
Past President, American College of Endocrinology
Past President, American Association of Clinical Endocrinologists
Private Practice of Endocrinology
Endocrine and Metabolic Consultants
Rockville, MD

Frank Lavernia, MD
Private Practice
Deerfield Beach, Florida

In April 2011, the American Association of Diabetes Educators (AADE) convened a multidisciplinary expert panel to propose guidelines for insulin injection therapy. The panel examined best practices and explored effective problem solving for patients who have difficulty with insulin injections. Among the topics addressed were insulin absorption, pain, injection sites, safety, barriers to insulin therapy, and teaching techniques for various populations.

Introduction

Insulin therapy is a cornerstone of treatment in type 1 diabetes and, in many cases, also critical to the management of type 2 diabetes. Despite evidence documenting the benefits of insulin therapy in achieving glycemic control and reducing risk of long-term diabetes complications,¹⁻⁴ insulin therapy remains underutilized,^{5,6} with only 29% of adults with diabetes in the United States using insulin.⁷ This underuse reflects numerous barriers to treatment initiation as well as obstacles that hinder treatment adherence. Errors in insulin injection further curtail the ability of many patients to attain glycemic goals.

According to two recent surveys, at least one third of patients fail to take their insulin as prescribed,⁸ and 20% of adults intentionally skip their doses.⁹ Furthermore, despite the essential role of insulin therapy in the management of type 1 diabetes, compromised adherence is also common among younger patients with this disease, with many failing to follow their treatment plans.¹⁰ Resistance to insulin therapy among both patients and providers is a major problem, as elucidated by the landmark Diabetes Attitudes, Wishes, and Needs (DAWN) Study.¹¹ Often the reluctance among patients is psychological and founded on myths and misconceptions.^{6,12} Providers' attitudes and beliefs are also implicated in the clinical inertia that underpins insulin underutilization. The DAWN Study revealed that insulin therapy begins later in the U.S. than in most other countries due to the belief among many clinicians that insulin therapy should be delayed until absolutely necessary.¹¹

These guidelines for diabetes educators and other health care practitioners are aimed at improving diabetes outcomes by standardizing education practice and helping patients overcome obstacles to effective administration of insulin injection therapy. Because the literature on selected insulin injection topics is limited, some recommendations presented here are based on clinical observation and expert opinion.

Insulin Absorption

Optimal absorption of insulin depends, in part, on injection into the subcutaneous tissue. Recent research allays concerns regarding shorter needle length, demonstrating that 4 to 5 mm insulin pen needles enter subcutaneous tissue with minimal risk of intramuscular injection and no additional leakage, even in obese patients.^{13,14} Glycemic control with a 4 mm needle has been shown to be equivalent to that seen with 5 mm and 8 mm needles.

Insulin type affects the rate of absorption. Rapid-acting insulin analogs and regular insulin are absorbed faster than intermediate- and long-acting insulin. The site of injection also influences absorption rate, with the fastest and most predictably consistent rate occurring in the abdomen.¹⁵ Rotation within a selected injection area is critical for optimal absorption (see “Injection Site”). Research is needed to clarify the highest single dose of various insulin types that can be optimally absorbed. Recent data show that glargine can be injected in single doses of up to 200 units with no impairment of absorption,¹⁶ but further study is needed. Many providers in clinical practice currently limit single doses to 50 units, although there is no published evidence for this practice.

Exercise increases the rate of insulin absorption,¹⁵ making the individual’s physical activity involvement an important consideration. High temperature of the injection site also accelerates absorption, necessitating that patients avoid injecting insulin immediately before or after taking a hot bath or being in a sauna. Resuspension of “cloudy” insulin is important to ensure proper absorption of injected insulin and maintenance of appropriate concentration of the remaining insulin in the vial or pen. The package insert will advise patients regarding the need to roll the vial or pen in the palms or tip it (e.g., “10 times,” “several times”). Some studies have found that most people do not adequately resuspend insulin and advocate tipping or rolling the insulin vial or pen 15 to 20 times for more accurate resuspension.¹⁷⁻¹⁹

Pain

Many factors can contribute to perception of pain with injection therapy, including needle length and diameter, injection technique, and intramuscular (IM) injection.¹⁴ Short and narrow-gauge (4 to 5-mm x 32G) insulin pen needles have been reported to reduce pain in children

and adults.^{13,14,20} Some patients anticipate that insulin injections will be painful based on their experience with other injections in the past.²¹ Very few patients who are described as “needle phobic” have true needle phobia, and psychological counseling is often needed and effective for those who do.²¹

The literature is sparse regarding the impact of using angled injection and a pinched skin fold. One investigation reported a reduction in IM injections using an angled injection and a pinched fold in prepubertal children, concluding that this combination may result in the most reliable insertion for children and lean adults.²⁰ The panel urged practitioners to exercise clinical judgment when advising patients on these two practices.

Other measures are suggested to avoid or minimize pain with injections, including: 1) injecting room temperature insulin, 2) allowing topical alcohol (if used) to evaporate before injection, 3) relaxing the muscles at the site when injecting, 4) using distraction methods, 5) quickly penetrating the skin, 6) not changing direction of the needle during insertion or withdrawal, 7) not reusing needles, and 8) using an injection device that puts pressure on the skin around the injection site. Applying pressure for 5 to 8 seconds after the injection, without rubbing, is advised if an injection seems especially painful.^{15,22}

Injection Site

Sites for subcutaneous insulin injections include the upper arms, upper thighs, abdomen, and buttocks. Absorption is fastest with injection in the abdomen, followed by the arms, thighs, and buttocks.¹⁵ The panel noted that the thigh is the preferred site for NPH insulin to ensure optimal absorption, and may also be most desirable for nighttime injections of all insulin types.

Rotation of the injection site is critical to prevent lipohypertrophy, a common consequence of inadequate rotation reported to occur in nearly 50% of individuals using insulin.²³ Lipohypertrophy has been linked to poorer glycemic control and may reduce absorption by as much as 25%.^{24,25} Rotation is typically made within the general area (e.g. arm, leg), rather than from major site to site. Injection into moles and scars and within 2 inches from the umbilicus must be avoided. At follow-up visits, diabetes educators and other practitioners need to inspect sites for signs of lipohypertrophy.

Safety Precautions

Insulin is stored according to the manufacturer's instructions. Unused vials should be refrigerated, and extreme temperatures (<36 to >86 degrees F) should be avoided to prevent loss of potency, but opened vials should be kept at room temperature.¹⁵ Prior to use, visual examination of the bottle is critical to ensure there are no changes in the insulin (e.g., clumping, frosting, altered color or clarity) that might indicate loss of potency.¹⁵ Air bubbles in the syringe must be eliminated because they reduce insulin delivery. Patients should inspect filled syringes for air bubbles, and if present, should point the needle up, tap the syringe once or twice with the forefinger, and push the plunger to allow the bubbles to escape. For insulin pens, air bubbles in the cartridge can be prevented by removing the needle between injections and priming the needle with two units of insulin prior to injection, checking to be sure there is insulin on the end of the needle and repeating the procedure if necessary to ensure no air is in the pen cartridge.¹⁵ Pen manufacturers recommend performing such air shots prior to each injection, but many patients do not always do so, and priming reduces the number of available doses. No published research was found regarding the safety of eliminating air shots. Therefore, the panel called for research to determine how much and when priming is necessary and when it can be bypassed.

Reuse of needles or syringes is usually not recommended. Nevertheless, many patients adopt this practice. Reuse is unadvisable in patients with poor personal hygiene, acute concurrent illness, open wounds on the hands or injection site, or decreased resistance to infection.¹⁵ For those patients who do reuse, recapping after each use is essential and requires adequate dexterity and hand steadiness.¹⁵ Nonvisual recapping techniques can be taught to persons with low vision and good manual dexterity.²⁶ Use of pens with safety needles may reduce the incidence of needlestick injuries.²⁷ Sharing of needles is never acceptable.

Dosing accuracy is paramount in insulin administration. Research shows that pens are more accurate than syringes when delivering doses below 5 units, but they have comparable accuracy with doses above 5 units.²⁸⁻³⁰ The literature documents various benefits of inpatient and outpatient use of insulin analogs and pens, including the potential for dosing error reduction and subsequent cost-effectiveness.^{31,32} Hypoglycemia is one of the most common side effects of insulin administration. As a precaution, all individuals on insulin therapy should be instructed on

appropriate prevention and treatment of hypoglycemia and carry with them at least 15 g carbohydrate, or more if required, to be ingested if a hypoglycemic event occurs.¹⁵ Those with type 1 diabetes and those with advanced type 2 diabetes on multiple daily injections should also carry glucagon and should be trained, along with their significant others, on its use.³³

Patients with type 2 diabetes receiving the oral medication alpha-1 glucosidase inhibitors should utilize glucose rather than standard "table sugar" (sucrose) for treatment of hypoglycemia.

Safe self-administration of insulin also requires assessment of the individual's cognitive and physical abilities to follow instructions and perform the injection technique (*see "Teaching Techniques"*).

As another safety measure, the skin at the injection site should be clean and dry. Some individuals on insulin therapy prefer the convenience of injecting through their clothing. This practice was found to be safe in adults who injected insulin through a single layer of fabric ranging from nylon to denim.³⁴ The panel urged practitioners to exercise clinical judgment before sanctioning this practice, taking into consideration the patient's personal hygiene and cleanliness of clothing.

Barriers to Insulin Therapy

Barriers to initiating and adhering to insulin injection therapy include a wide range of obstacles relating to patients, providers, and health care systems (**Table 1**).^{11,12,35,36} Identification of barriers is a critical step toward successful diabetes self-management and takes place through a careful patient assessment. By asking open-ended, nonjudgmental questions, diabetes educators can help patients address their concerns and adopt effective problem solving.^{6,37}

Many patients resist insulin therapy because of myths and misconceptions, such as the belief that the need for insulin reflects personal failure.^{5,6,12,35} Practitioners can help diminish this self-blame by explaining at the time of diagnosis that type 2 diabetes is a progressive deterioration of beta-cell function, and insulin will likely be required at some point. Concerns that insulin therapy will be complicated and inconvenient, as well as anxieties about pain and needles, are also common. Use of insulin pens, which have been found to be easier to use, more discreet, less painful, and preferred over syringes by patients and providers,³⁸ may overcome these barriers. Some strategies

for lessening fear of needles include use of a pillow for trial injections, use of a covered safety needle to conceal the needle, and the practice of desensitization, whereby the needle is placed on the patient's skin and allowed to remain there momentarily prior to injecting.

Concerns about hypoglycemia and weight gain frequently thwart willingness to undergo or prescribe insulin therapy.¹² Early in the education process, patients should be taught how to recognize, treat, and avoid hypoglycemia.⁶ Such education, including the importance of meal planning, is imperative. Slow dosage titration during treatment initiation is also essential. Patients may be reassured by explaining that although hypoglycemia may occur in up to 30% of patients receiving insulin, severe hypoglycemia is rare.³⁹ Weight gain with insulin therapy may be attributed to calories being retained, rather than excreted as glucosuria, due to improved glycemic control, fluid retention, higher food intake to prevent hypoglycemia, or for treatment of hypoglycemia.⁶ Use of insulin analogs rather than human insulin may reduce weight gain.^{40,41}

A financial barrier exists for patients who lack insurance coverage for insulin pens. However, pharmacoeconomic data reveal cost benefits for using pens versus syringes due to improved treatment adherence and reduced health care utilization.⁴²⁻⁴⁵ Additionally, in some cases the individual with coverage for insulin pens may only have one co-pay, resulting in getting more insulin per co-pay than if purchasing a vial. Moreover, there is less waste with pens because vials should be discarded after 28 days after opening. For those who use smaller doses of insulin, the disposal insulin pens with 3-ml cartridges are thus more economical.⁴⁶ Promulgation of these findings may drive changes in reimbursement policies.

Financial barriers also extend to patients with vision loss, because Medicare currently does not reimburse for nonvisual insulin drawing devices. Advocacy for creation of a medical coding number for such devices may help resolve this problem.

Lack of accessible insulin-related information is a major barrier for patients with visual impairment as well as for clinicians who hesitate to teach insulin injection without such materials. Patient information should be produced to meet Universal Design for Learning Standards,⁴⁷ and at the least, should be made available in both print and audio formats. In addition, electronic files for print formats that

are designed according to National Instructional Materials Accessibility Standard (NIMAS) guidelines can be easily transcribed into Braille or read by text-to-voice programs. Recommendations for making medical information accessible to patients with vision loss are available.^{48,49}

Low literacy/numeracy skills and learning disabilities can restrict comprehension of written information and ability to measure doses. Improved instructional design for print materials and availability in audio and video formats may help surmount this obstacle to insulin self-administration.

Resistance by physicians to prescribe insulin therapy is often based on their perceptions of patient-derived barriers (**Table 1**), such as concerns about the patient's weight, adherence behavior, and desire to prolong noninsulin therapy.³⁶ Diabetes specialists are less inclined to delay therapy than primary care physicians (PCPs).¹¹ Interestingly, an Internet survey shows that most PCPs in the U.S. report that patients feel much better after starting insulin therapy and are able to manage the demands of the regimen.⁵⁰ Conveying this finding to providers as well as patients may help encourage therapy initiation.

Limitations in health care systems also create barriers to insulin injection therapy (**Table 1**). The DAWN study found that nurses and physicians think more involvement by nurses is needed in diabetes care.⁵¹ The panel emphasized that inadequate insulin therapy education among nurses and PCPs is a significant obstacle, necessitating more training in insulin injection technique for nurses, more titration protocols for use by nonphysician practitioners, and increased support to PCPs to help them identify and utilize available resources. Concerns about time constraints often delay therapy initiation, but the panel was encouraged by data indicating that among community hospital nurses, patient instruction took less than 15 minutes for insulin pen use and 16 to 30 minutes for conventional method use.²⁷ Lack of patient follow-up is another barrier among some health care systems.

Teaching Techniques for Insulin Administration

The following recommendations reflect selected best practices for training patients to administer insulin therapy:

- A thorough patient assessment should precede therapy initiation to address barriers, including evaluation for diminished cognitive capacity or other problems

that may impair safe insulin self-administration, and assessment of health literacy and numeracy skills. Patients should be encouraged to discuss their injection-related concerns. Follow-up phone calls are advised following therapy initiation.

- During follow-up visits, treatment adherence should be assessed to identify changing barriers, adherence problems, and errors that may occur due to poor recall of instructions or other reasons. The patient's injection practice should be observed, with re-education provided as needed.
- Site rotation instruction is critical, and inspection of sites for signs of lipohypertrophy or lipoatrophy as well as reiteration of the importance of rotation should take place at all follow-up visits.
- Use of appropriate language is necessary when teaching injection technique, avoiding terms such as "throwing a dart" or "spearing." Another strategy for reducing psychological discomfort is to minimize delay in injecting.
- Use of a risk stratification table provides an effective means for identifying the patient's target blood glucose level.^{52,53}
- Dose preparation includes inspecting the insulin, following manufacturer instructions regarding rolling to resuspend the insulin, and avoiding air bubbles.
- The mixing of insulin should follow the guidelines of the American Diabetes Association.¹⁵
- Creative strategies, such as storing different insulin in separate locations or applying colored dots, rubber bands, or different colored insulin vial sleeves to vials, may help patients avoid confusing their different insulin types.
- Unused vials should be refrigerated. Recapping is essential if needles are reused. The technique involves supporting the syringe in the hand and replacing the cap with a straight motion of the thumb and forefinger, avoiding midair recapping.¹⁵ Removal of the needle is important in extreme climates.

Special Populations

The panel identified major considerations regarding insulin therapy for special populations:

Children and youth. Children and adolescents should use 4 to 6 mm needles.²² Pediatric patients experience more discomfort with injections than adults²⁰ and injection-related problems occur in adolescents as well as younger patients. Skin pinching to divert attention may minimize

pain. For younger children, strategies to allay injection fears include first injecting saline into a stuffed animal, a diaper that simulates skin, or a parent. Challenges in maintaining frequency, dosing, and timing recommendations is common among youth, who also often neglect to rotate injection sites.¹⁰ Education on site rotation is essential, and relaxation and distraction may help reduce fear of pain when rotating to a new area.¹⁰ In addition, other issues relating to insulin injection therapy among children and youth require emotional and educational support that entails a collaborative team approach.^{54,55} Educational support is also needed to ensure successful involvement of parents, caregivers, and school personnel in the administration of insulin therapy.

Pregnancy. Close monitoring and dose adjustment are especially important during the first trimester, when hypoglycemic events are often most common.⁵⁶ A raised skin fold is necessary for abdominal injections. Areas around the umbilicus should be avoided during the last trimester.²²

Elderly patients. Older patients are more likely to have impairments in dexterity, cognition, vision, and hearing. Careful assessment prior to therapy initiation and at follow-up will determine the patient's capacity for self-injection. Elderly patients may find insulin pens easier to use. Caregivers must be educated on insulin injection therapy as well as on hypoglycemia prevention and treatment. For caregivers who administer insulin using a pen device, important features include adequate length of the device, dial visibility, and ease of recapping the pen.⁵⁷

Patients with vision, hearing, or dexterity impairment. Individuals with visual impairment need accessible information and appropriate devices to facilitate insulin delivery. Nonvisual insulin measurement devices, syringe magnifiers, needle guides, and vial stabilizers help ensure accuracy and aid in insulin delivery.¹⁵ A pilot study indicates preliminary evidence of safe use of insulin pens by this population.²⁶ Prefilled syringes may be helpful, particularly for persons who have both visual and dexterity impairment.

Patients with impaired hearing may require special attention. For people with low hearing and those who use hearing aids, the educator needs to ensure that instruction takes place in a setting with very low or no background noise. The instructor should sit directly across from the

patient, with good lighting on the instructor's face to facilitate lip-reading, and speak slowly and clearly, with normal intonation. For culturally Deaf patients (i.e., persons for whom American Sign Language [ASL] is the first language), an ASL interpreter should be present during visits. To locate an ASL interpreter, refer to the Registry for Interpreters (<http://www.rid.org/>). If an ASL interpreter is not available, it may be acceptable to use a video relay service, a real-time remote ASL service using teleconferencing equipment.⁵⁸⁻⁶⁰

Patients with reduced dexterity may benefit from using insulin injection devices with preset doses and easy-handling features. Successful use of supplemental devices was observed in individuals who had difficulty grasping objects and using both hands.⁶¹ The periodic refilling of syringes by someone else may be appropriate for some individuals with reduced dexterity.¹⁵

Lean and obese populations. Research shows that needle length should not be a concern in patients who are obese or overweight, with 4- to 5-mm needles comparable to longer needles in maintaining glycemic control, without adverse effects.^{13,14} For lean patients, combined use of a raised skin fold and angled insertion has been recommended.²⁰ Problem solving strategies regarding insulin injection therapy for obese or very thin populations have been described.⁶²

Future Directions

Recognizing the paucity of studies on several aspects of insulin injection therapy, the panel identified areas for additional research (Table 2). It is hoped that an expansion of the literature will result in evidence-based practices that enhance problem solving, eliminate barriers, and lead to improved diabetes self-management through insulin injection therapy.

Table 1. Selected barriers to insulin injection therapy among patients, providers, and health care system^{11,12,35,36}

PATIENT BARRIERS	PROVIDER BARRIERS	SYSTEM BARRIERS
<p>Psychological resistance</p> <ul style="list-style-type: none"> • Myth-based fear of insulin • Fear of hypoglycemia • Concern about weight gain • Fear of needles and pain • Self-blame • Loss of control • Social stigma • Poor self-efficacy <p>Lifestyle</p> <ul style="list-style-type: none"> • Time-consuming; inconvenient • Travel issues <p>Physical/mental</p> <ul style="list-style-type: none"> • Poor recall/cognitive impairment • Visual/hearing/dexterity impairment • Learning difficulties; low literacy/numeracy skills <p>Financial</p> <ul style="list-style-type: none"> • Reimbursement issues 	<ul style="list-style-type: none"> • Perceived patient resistance • Patient's adherence behavior • Belief that patient's improved status negates need to start insulin therapy • Concerns about adverse effects (hypoglycemia; weight gain) • Provider time constraints (instruction; titration) • Lack of resources/ organizational structure to facilitate guideline adherence 	<ul style="list-style-type: none"> • Overburdened workload among providers • Access to education • Limited training of providers in injection technique • Underutilization of resources (within clinical practices, hospitals, and community) • Reimbursement issues • Poor follow-up system • Suboptimal team collaboration; poor chronic care model

Table 2. Research needs relating to insulin injection therapy

AREA	SPECIFIC FOCUS
Injection technique	<p>Dose and absorption <i>(What is the recommended largest dose for a single injection? Does it vary by insulin type?)</i></p> <p>Raised skin fold (pinch) <i>(Does a raised skin fold reduce pain? Does it affect absorption?)</i></p> <p>Angled injection <i>(Does angled injection reduce pain? Does it affect absorption?)</i></p> <p>Dose priming <i>(In what circumstances is priming necessary?)</i></p>
Treatment adherence	<p>Methods to improve adherence <i>(What strategies are effective in overcoming barriers and improving compliance with treatment?)</i></p>
Resource utilization	<p>Collaboration in teaching and improving insulin therapy <i>(How can the diabetes care team best utilize resources such as primary care office staff and community resources?)</i></p>
Special populations	<p>Inclusion of the visually impaired and other special populations in research on new insulin-related technologies</p> <p>Effective techniques for teaching individuals with impaired hearing, vision, or dexterity</p>

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