FIT Forum for **Injection Technique** Canada

Recommendations for Best Practice in Injection Technique

5th Edition 2026

Optimizing
injection technique
in diabetes

Our Objectives

- Identify the injection techniques currently being used by people with diabetes in Canada.
- Raise awareness of the impact that existing and emerging research regarding injection technique may have on health outcomes.
- Facilitate opportunities in which best practice regarding injection and infusion technique can be discussed, developed, implemented, and evaluated across Canada.

Preface

The Forum for Injection Technique (FIT) Canada provides evidence-based best practice recommendations for healthcare professionals and people with diabetes who are using injectable therapies. Originally developed in 2011, these recommendations have been disseminated broadly to ensure people with diabetes can achieve the best possible health outcomes, delivering the correct dose of medication to the correct injection site using proper technique. With subsequent editions we have added infusion techniques, updated our references, and highlighted how new research influences our practice. While much has been done and achieved, we are cognizant that gaps remain in injection/infusion technique knowledge. With the launch of this 5th edition, we will continue advocating for correct injection/infusion technique through dissemination initiatives, which will include an emphasis on education for healthcare professionals and patients, patient support, and clinical research implementation.

The Canadian FIT Board – 5th Edition

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Introduction/Background

Broad dissemination of the results of an international survey(1) led to increased awareness among healthcare professionals of the issues associated with improper injection technique. The Canadian Forum for Injection Technique (FIT) initiative was developed in response to these concerns.

Following the precedent set by the United Kingdom FIT initiative, (2) as well as other international injection technique initiatives, (3-6) the recommendations presented in the original document were designed to promote best practice in injection technique for healthcare professionals who are involved in diabetes care and their patients. (5, 6) They were also aimed at raising awareness of existing and emerging research regarding injection technique.

It was hoped that the implementation of these recommendations would have a direct impact on the health outcomes of people with diabetes who are using subcutaneous injection or infusion therapies. New editions of this document are based on new evidence and continue to be distributed to all Canadian healthcare professionals who are involved in injection therapy for people with diabetes.

At the original meeting of Canadian diabetes education experts, many unmet educational needs regarding injection technique were discussed and the top 3 educational priorities were identified:

1. Techniques to avoid intramuscular injection
2. Steps to ensure healthy injection sites
3. Provision of clear and concise direction to healthcare professionals regarding proper injection technique

Utilizing these priorities as a framework, the original best practices document was developed by the Canadian FIT Board and reviewed by an expert committee of diabetes educators. Where evidence was unavailable, expert opinion guided the recommendation. These principles have been followed in each subsequent update.

Since the writing of the 4th edition, there have been several key studies and papers that have provided new evidence, new technology, and new learnings to inform best practice recommendations.

Following up on the work done by the original FITTER (Forum for Injection Technique and Therapy Expert Recommendations) group in 2016, a new edition was published in 2025 entitled FITTER Forward. (7, 8) This evidence-based document reflects the latest technology and research. It states that although we have made some progress in generating awareness, (16-17) compelling evidence suggests that the trends for lipohypertrophy and injection errors continue to reflect unsafe practice.

Tian *et al.* support these findings in their research on lipohypertrophy. Using a new combination of diagnostic techniques, they conclude that over 50% of patients with diabetes using insulin have lipohypertrophy. (10)

In their investigations, Gentile *et al.* estimated that 37%-64% of patients have lipohypertrophy, with 79% of the older population continuing to inject into these areas. (9-10) While the effects of lipohypertrophy on insulin absorption have previously been reported as unpredictable insulin absorption leading to glycemic variability, hypoglycemia, and increased cost, Gentile *et al.* have added to this knowledge by articulating the potential impact of lipohypertrophy on cardiovascular events. (11-15) This information has been incorporated into the updated recommendations on assessment techniques, treatment, and patient education for the prevention of lipohypertrophy. (15)

With regard to patient errors in injection technique, Bari *et al.* conducted an initial study and then a follow-up study three years later looking at the injection practices of Canadian patients with diabetes. (16-17) In his first study, he found that all patients were making at least one injection error, with 93% making two or more errors. The most common mistakes were injection force, size of injection area, needle length, and injection into lipohypertrophic tissue.

In his follow-up study, Bari *et al.* continued to find similar errors in injection technique. He stresses that "education on optimal insulin injection technique continues to be an unmet medical need for the treatment of people with diabetes". (17)

With the increasing number of people using non-insulin injectable therapies, such as glucagon-like peptide-1 (GLP-1) receptor agonists, there is a further escalation in the need for education. Although these medications do not present the same risk for lipohypertrophy, they do require correct injection technique, which is reviewed in this document.

Another area drawing considerable attention is the proper disposal of the injection/infusion materials used for diabetes. To decrease the impact on the environment, products with less packaging and those that can be recycled (excluding the sharp components) are suggested in the new recommendations. (18)

This 5th edition is aimed at driving awareness of how to safely implement technological advances, especially in the areas of needle technology, insulin formulations, monitoring devices, and diagnostic tools. The recommendations also include more directive strategies to individualize education to support patients in their behaviour change. (15)

The development of FIT and the subsequent Canadian recommendations for injection and infusion techniques are supported by embecta, Canada.

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1.0
Preparing for injection therapy

1.1 Psychological challenges of injections: Adults

When considering injectable therapy, patients with diabetes can experience many psychological challenges that may delay, and at times prevent, timely interventions. These challenges may include a sense of failure, a feeling of loss of control, or guilt about not having done enough to manage their diabetes. (19-20) Many also express anxiety and fear about complications and the future. (21)

As healthcare professionals, we need to understand the patient's feelings and perceptions and address these as a first priority. Using a collaborative patient-centred approach, soliciting feedback, avoiding judgment, and supporting patient autonomy provide the best foundation to build on. (22-25)

1 Healthcare professionals should discuss with all people with type 2 diabetes, early after diagnosis, that they may require injectable therapy in the future to manage their diabetes. It is imperative to explain the natural progression of diabetes and that the initiation of insulin or other injectable therapies at any point during the course of the disease is not a personal failure but an effort to promote glycemic control. (19-21,23,25-26)

2 The conversation should be collaborative and patient-centred to elicit perceived barriers and concerns related to initiating injectable therapy (Fig. 1). Few adults have a true needle phobia (i.e., a fear of needles); however, many experience anxiety, fear, and a lack of confidence when starting an injectable therapy regimen. Healthcare professionals should explore and address any concerns or barriers to treatment, emphasizing that both parties are working together toward the mutual goal of improving treatment and quality of life. (20-21, 23, 25, 27-29)



Fig. 1. Patient-centred conversation prompts to identify perceived barriers, emotional responses, and support needs related to starting injectable therapy.

1.0
Preparing for injection therapy

1 Both the short- and long-term advantages of achieving and maintaining target blood glucose levels should be emphasized to patients with diabetes. Healthcare professionals should also explain that finding the right combination of therapies, including injectable therapy, when appropriate, is a primary treatment goal for achieving optimal glycemic targets. Patients should be assured that their concerns, including cost, access, and treatment preferences, will be addressed throughout the process. (25-26)

2 Healthcare professionals should familiarize themselves with educational strategies that have proven successful in helping patients initiate insulin. These strategies include, but are not limited to: sharing experiences of successful insulin users; providing explanations during teaching; using demonstration and teach-back methods; ensuring follow-up support; and managing expectations by setting realistic goals (Fig. 2). (15,22-25,30-31)

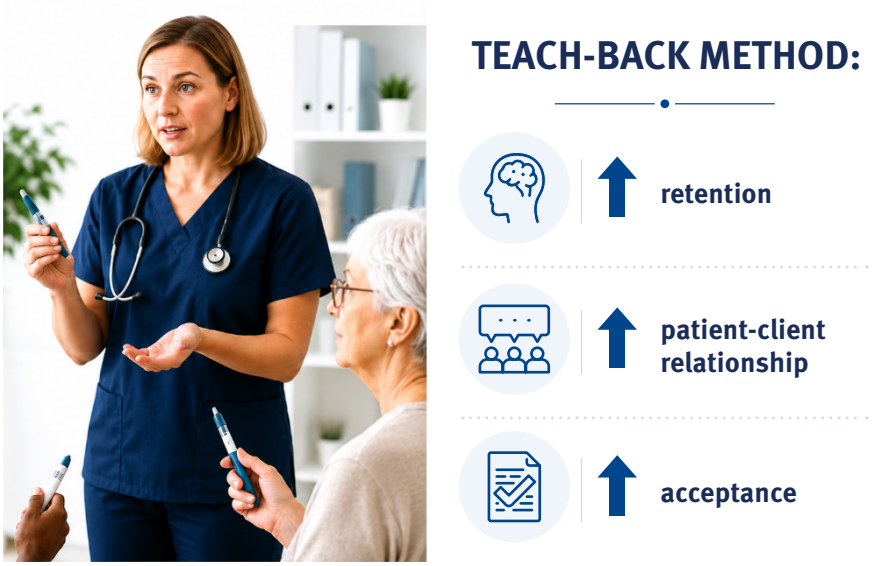


Fig. 2. The teach-back method is an effective patient education strategy in insulin initiation, enabling healthcare professionals to assess understanding while improving retention, treatment acceptance, and patient engagement.

2.0
Insulin: Use and handling

2.1 Storage of insulin

1. Unopened insulin vials and cartridges should be stored at refrigeration temperature (2 °C to 8 °C). It may be advisable to have patients check the temperature of their storage area in the fridge, as it may be outside these parameters (Fig. 3A). (32, 33)
2. Insulin should never be used past its product expiry date (Fig. 3B).
3. As per specific product monographs, once insulin is opened for use, it can be stored at ambient temperatures (15 °C to 30 °C or 59 °F to 86 °F), away from direct sunlight exposure, until the expiration date designated by the manufacturer (28-56 days) (Fig. 3C). (6,23)
4. Insulin should never be frozen or exposed to extreme heat (greater than 30 °C) for prolonged periods, as this will affect its potency and alter its action (Fig. 3D).
5. Keep the caps on insulin pens to protect the insulin from light (Fig. 3E).
6. Do not store insulin in direct sunlight (Fig. 3F).

2.2 Temperature of insulin

1. The temperature of insulin does not affect its pharmacokinetics or absorption, provided that it is stored at room or refrigeration temperature. (34)
2. Insulin administered at room temperature may reduce irritation, burning, or pain, and facilitates the re-suspension of cloudy insulin. (23, 35-38)
3. Allow refrigerated insulin to reach room temperature (30-60 minutes), as injecting cold insulin can contribute to lipodystrophy development. (39, 40)
4. Before filling an insulin pump reservoir, insulin should be allowed to reach room temperature. Filling the reservoir with cold, refrigerated insulin can lead to air bubbles forming in the reservoir, which may result in inaccurate insulin delivery and lead to hypoglycemia or hyperglycemia.



Fig. 3. Key insulin storage guidelines.

2.0
Insulin: Use and handling

2.3 Re-suspension of cloudy insulin

1 When using cloudy insulin (i.e., NPH or premixed insulin), the vial, cartridge, or pen device should first be gently rolled 10 times, then tipped (not shaken) 10 times to ensure proper re-suspension. Vigorous shaking should be avoided, as it may introduce air bubbles and affect dose accuracy. The suspension should have a uniformly milky white appearance before injection (Fig. 4). (8, 41-43)

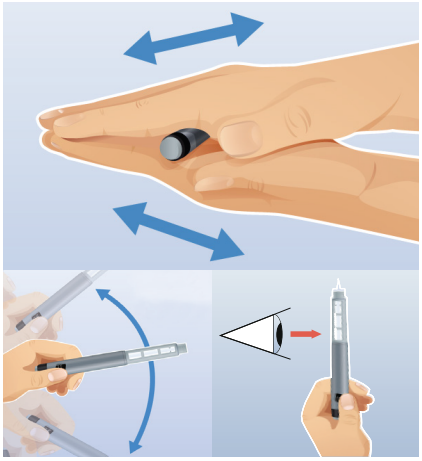


Fig. 4. Method of mixing cloudy insulin: roll 10 times, tip 10 times, then perform a visual check for milky white appearance

2.4 Effect of injection volume on insulin action (kinetics)

1 The larger the dose, the more delayed the action of NPH and short-acting (regular) human insulins. The clinical evidence regarding these human insulin formulations suggests a longer, flatter action profile with doses >50 units, which may compromise glycemic control. When injecting >50 units of short-acting (regular) or intermediate-acting (NPH) insulin per dose, it may be prudent to split the dose into 2 separate injections, depending on the desired clinical outcome. (34, 44-47)

2 The time-action profile of insulin analogues, including first-generation long-acting (insulin glargine) and rapid-acting insulin, is not affected by the volume of injection. The decision to use 2 injection sites may be a function of the device (i.e., a maximum single dose of 60-80 units) or discomfort with injection volume, rather than a requirement to achieve a better pharmacokinetic profile.

3 Insulin therapy should be individualized in accordance with the needs of the individual patient; any changes made to the dose or regimen should be done under medical supervision, and close monitoring is recommended.

4 Second-generation long-acting basal insulins (insulin glargine U-300 and insulin degludec U-100, U-200) provide improved steady-state pharmacokinetic and pharmacodynamic profiles, with no pronounced peak and a longer duration of action than first-generation long-acting basal insulins. (95) Splitting these insulins into more than 1 injection would be a function of exceeding the maximum dose delivery of the device. There are currently no data to support dividing a large dose into a twice-daily regimen.

2.0
Insulin: Use and handling

2.5 Concentrated insulin: practical tips and special considerations

1 Concentrated insulin delivers the same dose with less volume. This concept requires further study to ascertain if there will be more, less, or no difference in rates of lipodystrophy.

2 Concentrated insulin is available in a prefilled pen device specifically designed for this type of insulin. The dosing window shows the number of units that will be delivered in a smaller volume.

3 There is no calculation required when switching or starting these insulins: 1 unit on the pen=1 unit of insulin. It is delivered in less diluent.

4 Concentrated insulins are not available in vials; therefore, it is imperative that there is NO pen-to-syringe transfer, to avoid dosing errors. It is also important that none of the concentrated insulins be removed from the prefilled pen device for use in a syringe, pump, or other delivery device, to avoid potential overdose or hypoglycemia.

2.6 Weekly insulins: practical tips and special considerations

1 Once-weekly insulin reduces the number of injections while maintaining basal coverage. It is available in some countries and holds potential to reduce treatment burden, depending on correct technique and clear education about the weekly routine.

2 Use the same evidence-based injection technique and rotation rules as for daily insulin.

3 Once-weekly insulin is supplied in a prefilled pen designed for this product and dosing interval. Use only the dedicated device and follow the manufacturer's instructions.

3.0
Injectable incretin therapies: Use and handling

The injection technique for injectable incretin therapies (e.g., GLP-1 receptor agonists) is similar to insulin. However, there are a few practical differences. While lipohypertrophy is largely associated with insulin therapy (e.g., incorrect site rotation, reuse of needles), insulin as a growth factor also contributes significantly to the development of lipohypertrophy.

Available evidence indicates that the risk of lipohypertrophy is considerably lower with non-insulin injectables, including GLP-1 receptor agonists, than with insulin. However, palpable subcutaneous nodules have been reported with once-weekly exenatide and semaglutide. (48, 49)

It is, however, still important to rotate injection sites with these agents. The results of ongoing trials will provide further information.

While no studies have been published regarding the effect of injecting an incretin therapy into an area of lipohypertrophy, it may be hypothesized that, like insulin, erratic medication absorption may occur.

Considering the time-action profile of current injectable incretin therapies, the clinical implications of these absorption distortions would have less impact than with insulin. Still, patients should be advised to avoid injecting incretin therapies into lipohypertrophic areas.

3.1 Storage of injectable incretin therapies

1. Injectable incretin therapies should be stored per the manufacturer's recommendations in a refrigerator (2 °C to 8 °C). They should not be stored directly adjacent to a refrigerator cooling element.
2. Injectable incretin therapies should not be frozen. If freezing occurs accidentally, the medication should be discarded.
3. For multi-dose reusable pen devices, once removed from the refrigerator and the initial dose has been given, the products can be stored for 30 to 56 days at room temperature (no higher than 30 °C), according to the manufacturer's recommendations, or in a refrigerator (2 °C to 8 °C).
4. Single-use devices can be stored for approximately 14 days at room temperature (no higher than 30 °C), or as per the manufacturer's recommendations.

3.2 Practical tips and special considerations

1 Injectable incretin therapies are absorbed equally from each of the usual injection sites (i.e., abdomen, arm, and thigh). (50)

2 Coformulations of premixed insulin and incretin therapies in the same pen device are also available, and their use should follow the same recommendations as insulin delivery. (51)

3 Injectable incretin therapies are available in a range of device formats, including reusable and ready-to-use, single-dose pen devices that may not require reconstitution or routine priming before each injection. Depending on the device design, an initial priming, flow check, or activation step may be required prior to the first dose only. Refer to the manufacturer's instructions for use for specific device guidance. (52-57)

4.0
Correct use of injection devices

4.1 Use of syringes with an insulin vial

1 Proper syringe selection is crucial. The decision regarding which syringe is appropriate should be based on the amount of insulin to be administered (volume: U-30, U-50, U-100, or U-500 syringes) and the length of the needle. (23) Due to the need to pierce the insulin vial stopper, the shortest available needle length of an insulin syringe is currently 6-mm.

2 Depending on the assessment of the injection site and the amount of subcutaneous tissue, the use of a 6-mm syringe needle is recommended for most adults and adolescents with diabetes. (58) For those with a BMI of 19-25 kg/m^2, ensure a skin lift and a 90° injection angle to help prevent intramuscular injection. (6) A skin lift must be used with 8-mm needles. Needle lengths greater than 8-mm are not recommended for use (Fig. 5).

3 When preparing to draw insulin, first draw air into the syringe equal to or slightly greater than the intended dose and inject it into the vial to prevent a vacuum. Then invert the vial and, keeping the needle aligned with the vial, withdraw the insulin into the syringe (Fig. 6). (6)

4 If air bubbles are seen in the syringe, hold it with the needle pointed upward, tap the barrel to bring the bubbles to the top, and then remove the bubbles by pushing the plunger to expel the air (Fig. 6).

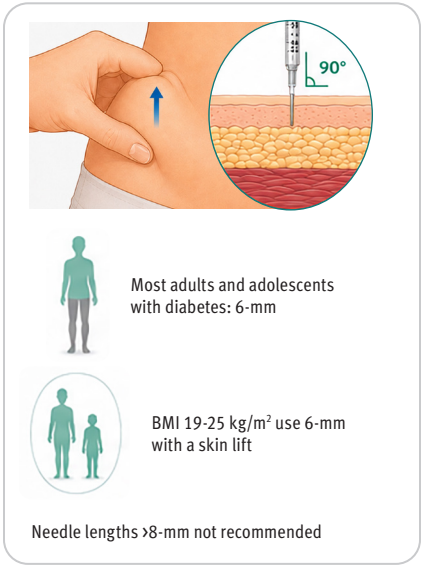


Fig. 5. Appropriate needle length is selected based on body type, with proper skin lift and 90° subcutaneous injection technique demonstrated.

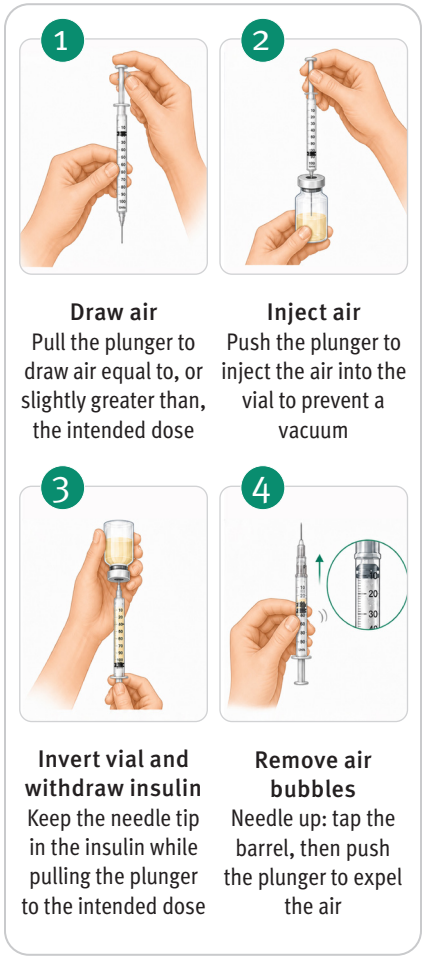


Fig. 6. Insulin syringe preparation includes air injection into the vial, insulin withdrawal, and removal of air bubbles prior to injection.

4.0
Correct use of injection devices

5 When administering injections, the following steps should be taken for a required skin lift (Fig. 7): (59, 60)

- Insert the needle completely into the skin lift.
- Depress the plunger completely.
- Remove the syringe at the same angle that it was inserted.
- Release the skin lift.

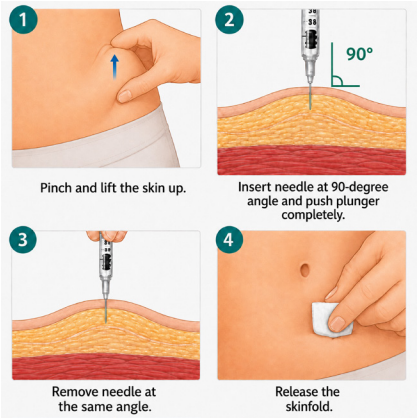


Fig. 7. The injection is administered using a proper skin lift, with the needle inserted at a 90-degree angle, followed by full depression of the plunger and needle removal.

6 Syringes should be used only once. (61-63)

7 Syringe use in those with little subcutaneous fat (BMI <19 kg/m^2) or those <6 years of age is not recommended (Fig. 8). (8)

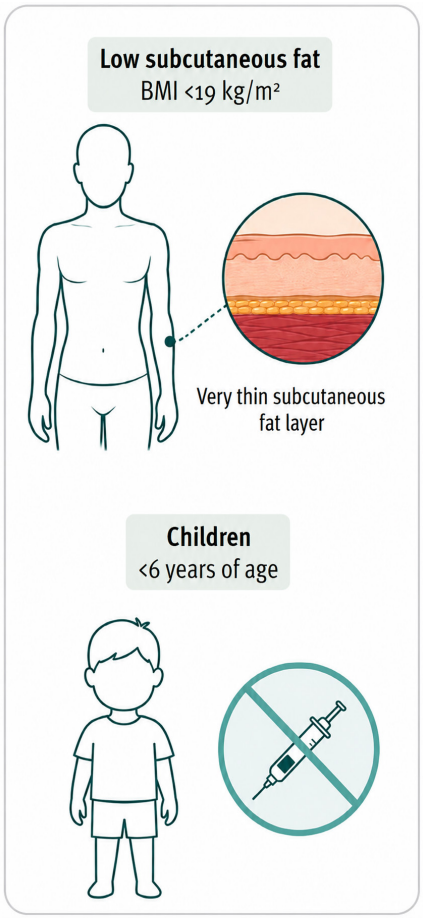


Fig. 8. Insulin syringe use may be unsuitable for individuals with low subcutaneous fat (BMI<19 kg/m²) or for children under 6 years of age.

4.0
Correct use of injection devices

4.2 Use of pen devices

When teaching patients proper pen use, healthcare professionals should consult the instruction manual for the specific device being used. Obstruction of insulin flow in a pen is rare but could lead to serious consequences. Understanding how to monitor movement of the rubber plunger within the pen is an important learning point to ensure adequate insulin delivery.

1 Insulin pen devices should always be primed (with doses as per the manufacturer's instructions) with the needle pointing upward. A flow of insulin should be observed at the needle tip before each injection. Once flow is verified, the desired dose should be dialled. Failure to remove the inner needle cover can lead to failure to deliver the intended insulin dose, followed by hyperglycemia or diabetic ketoacidosis. (64, 67)

2 Pen devices and cartridges are for single-person use only and should never be shared, due to the risk of cross-contamination. (68, 69)

3 Pen needles should be used only once. Using a new needle each time may reduce the risk of needle breakage in the skin, clogging of the needle, complications (e.g., lipohypertrophy, abscess), and inaccurate dosing. (61-63, 70, 71)

4 The insulin injection dose button should be depressed only when the pen needle is fully inserted. The injection dose button should be pushed straight down from the top, not at an angle, as this could lead to no dose being given. After pushing in the injection dose button completely, the individual should count to 10 slowly (approximately 10 seconds, or as per the manufacturer's instructions) and maintain pressure on the injection dose button before withdrawing the needle. These steps will ensure the full dose is delivered and prevent medication leakage (Fig. 9). Counting higher than 10 may be necessary for higher doses. Even waiting an additional 5-10 seconds can reduce leakage. (59, 60, 72)

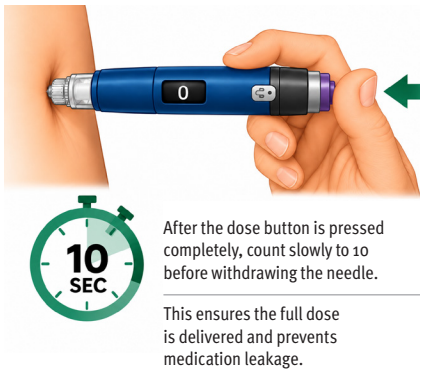


Fig. 9. Following full needle insertion, the dose button is fully depressed and maintained for approximately 10 seconds to ensure complete dose delivery and minimize leakage.

4.0
Correct use of injection devices

5 Needles should be disposed of safely in an approved sharps container immediately after use and should not remain attached to the pen. This prevents the entry of air or other contaminants into the cartridge or leakage of medication from the cartridge, both of which could affect subsequent dose accuracy (Fig. 10). (59, 70, 73)

6 Non-disposable pen devices should not be stored in the refrigerator, as the integrity of some parts (e.g., rubber) can be compromised by cold temperatures, which can in turn affect pen function.



Fig. 10. After use, the needle should be removed, disposed of in an approved sharps container, and not left attached to the pen.

7 Individuals should keep a spare syringe or a second pen at hand in case of breakage or malfunction. A syringe should never be used to remove insulin from a pen containing concentrated insulin, as the scale on insulin syringes is made for U-100 insulin only. The use of current insulin syringes with concentrated insulin could result in an overdose (Fig. 11).



Fig. 11. A spare pen or syringe should be kept available, and syringes should not be used to withdraw insulin from pen devices, as this may result in inaccurate dosing and overdose.

4.0
Correct use of injection devices

4.3 Use of pen needles

1 Choose the right needle

- A shorter needle should be used at the initiation of insulin therapy. (74-76)
- The recommended needle gauge should be 32G or higher (a higher gauge represents a smaller needle diameter).
- 4-mm needles are suitable for all people with diabetes, regardless of BMI (77-78).
- Currently available research data from across a wide range of BMIs (19-65 kg/m^2) support the use of 4-mm needles to avoid the risk of intramuscular injections (Fig. 12). (79-82)
- If 4-mm needles are not available, 5-mm needles are a backup alternative. (80-82)
- 4-mm pen needles provide equivalent A1C control compared with longer needle lengths (e.g., 8-mm and 12-mm), even in individuals with higher BMI and those requiring larger doses of insulin. Needle length does not need to be increased based on body size or insulin dose. (83)

2 Injections with shorter needle lengths
Injections with shorter needle lengths (i.e., 4-mm) should be administered in adults at a 90-degree angle to the skin surface. (58, 84)

- A skin lift may be warranted to prevent an intramuscular injection in a slim limb or abdomen, even when a shorter needle is used (Fig. 12) (58, 76).
- A skin lift may not be required, particularly for patients who are using a 4-mm needle. (58, 80, 85)

3 Lean individuals
Lean individuals should administer injections into a skin lift at a 90-degree angle to prevent possible intramuscular injection. (8, 58, 76)

4 Needle length
The use of 8-12 mm needles is not recommended. (76)

5 Injection force
Use of non-posted (contoured) pen needle designs may reduce the impact of unintended user pressure across a range of injection forces and subsequent inadvertent intramuscular injections, compared to conventional posted-hub pen needle devices of equivalent lengths (Fig. 13). (86, 87)

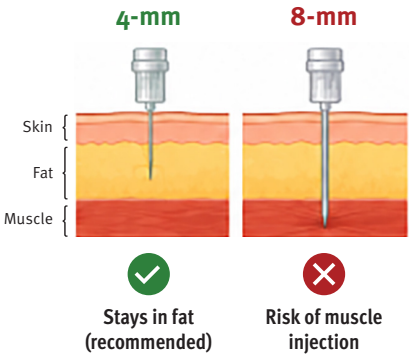


Fig. 12. Shorter needles are more likely to remain in subcutaneous tissue, while longer needles may increase the risk of intramuscular injection.

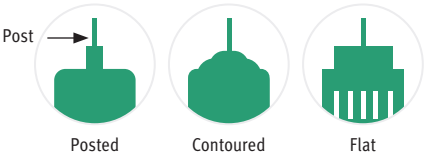


Fig. 13. Comparison of pen needle base designs.

4.0
Correct use of injection devices

4.4 Injections into subcutaneous tissue

1 To ensure proper injection technique (Fig. 14), individuals should consult with a healthcare professional who is trained in appropriate injection techniques. (8, 85)

2 Injections should never be administered through clothing as it prevents confirmation of the injection site, proper skin lift technique, and needle penetration verification. (8, 85, 88)

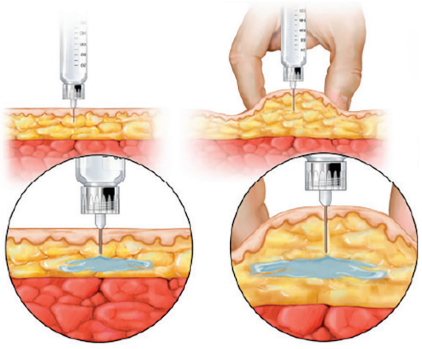


Fig. 14. Proper injection technique for subcutaneous absorption of insulin and GLP-1 receptor agonists: 4-mm pen needle with no skin lift (left); 6-mm pen needle with skin lift (right).

3 When the needle is removed, check the skin appearance for the following:
If the injection is administered correctly, the tissue beneath the skin (subcutaneous) appears normal (Fig. 15A). (85)

- A white area that appears when the needle is withdrawn may indicate that the insulin has not been injected deeply enough (intradermal injection) (Fig. 15B).
- Blood and/or bruising at the injection site may indicate that a minor capillary has been penetrated, with no resulting effect on absorption of the insulin (Fig. 15C). (8, 81, 89)

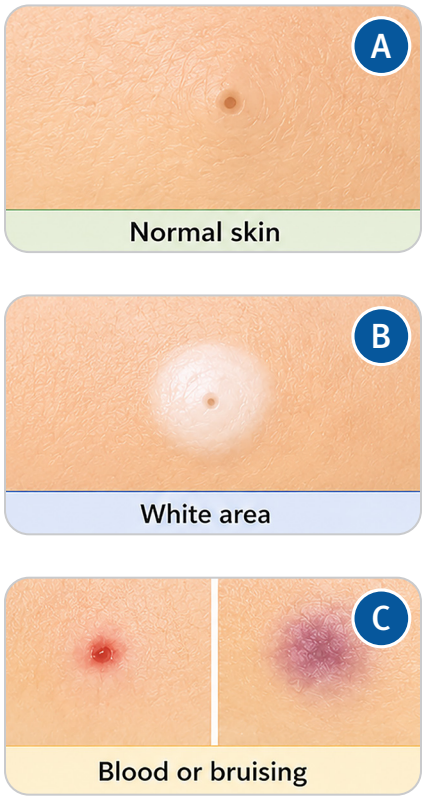


Fig. 15. Post-injection skin appearance may help assess injection depth and insulin delivery.

5.0
Injection area and site selection

5.1 Injection area selection

For the optimal effect of current insulin products, insulin should be delivered into the subcutaneous fat layer. When choosing an injection site, the thickness of the skin, which includes the dermis and epidermis, and the depth of the subcutaneous fat layer are major considerations.

Research using imaging techniques has shown that the average skin layer, including the dermis and epidermis, is relatively consistent, averaging 2.20-2.29 mm. (90)

Some studies have reflected wider variances in specific races and body sites and have suggested that skin thickness may be affected by BMI, gender, and posture at the time of injection. (90, 91) However, newer recommendations state that these differences are not of clinical significance. (9, 90, 91)

Repeated insulin injection into the same site and the presence of lipohypertrophy may result in an increase in skin thickness. (92)

There is general consensus that subcutaneous fat tissue thickness varies widely and is influenced by factors such as gender, body site, and BMI. (90) Age also plays a role, particularly with reduced subcutaneous fat in the upper arm. (90)

The buttocks have the greatest subcutaneous depth, followed by the abdomen, arms, and thighs (Fig. 16). The thickness of the subcutaneous layer increases proportionally with an increase in BMI. (79)

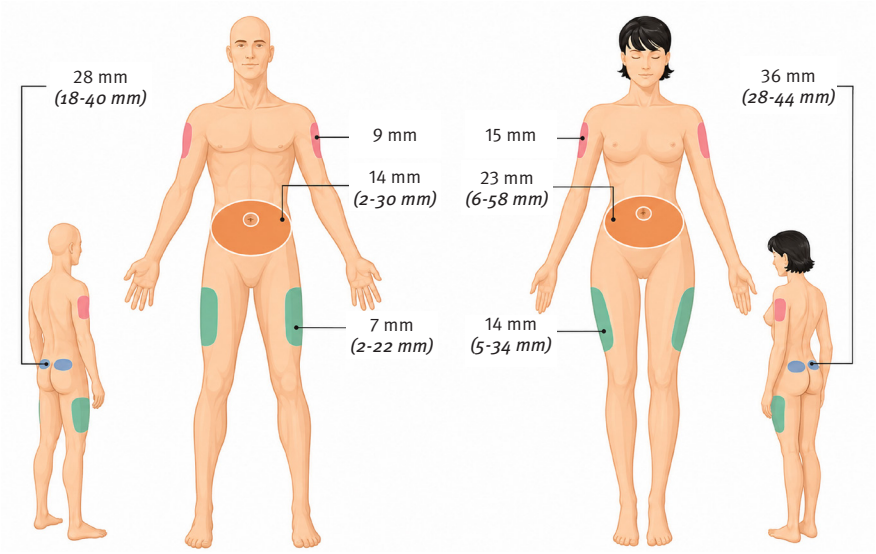


Fig. 16. Subcutaneous thickness in male and female adults. Mean values and ranges (in parentheses) are from a series of studies using ultrasound. (93)

5.0
Injection area and site selection

5.2 Reducing risk of intramuscular injection

1 To avoid intramuscular injection and, in consideration of safety and ease of self-injection, the abdomen, lateral thighs, and buttocks are the recommended self-injection areas for adults. (8)

2 Men have a higher risk of intramuscular injection at all injection sites, with the highest risk being in the thigh, followed by the arm, abdomen, and buttocks. (86)

3 The risk of an intramuscular injection is inversely proportional to BMI for both genders and is influenced by the force used during injection (Fig. 17). (86)

4 Needle depth accuracy is affected by needle design, needle length and gauge, physiology, and force used during injection. (86) Patients with diabetes have been noted to use variable injection force across different sites.

5 Due to variations in subcutaneous fat thickness, even within the same anatomical area (e.g., the abdomen), the use of a 4-mm needle helps minimize the risk of intramuscular injection and allows for a larger usable injection area (i.e., a postcard-sized area versus a postage stamp-sized area). (86)

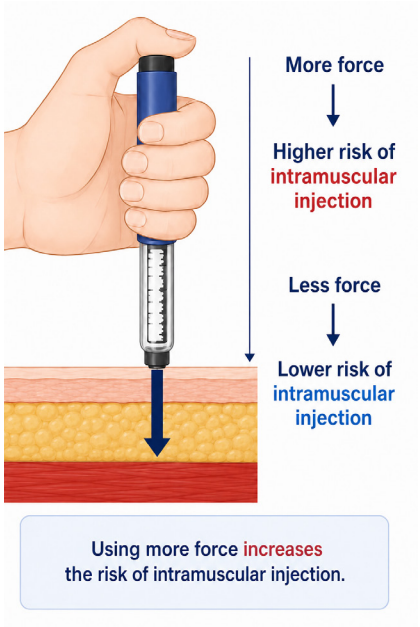


Fig. 17. Excessive injection force should be avoided, as it may increase the risk of intramuscular injection.

5.0
Injection area and site selection

5.3 Injection areas defined

1 The areas of injection are defined as (Fig. 18):
   - Abdomen boundaries: 1 cm above the symphysis, 1 cm below the lowest rib, 2-3 cm away from the umbilicus, and laterally at the flanks.
   - Thighs: upper third anterior lateral aspect of both thighs.
   - Buttocks: posterior lateral aspect of both upper buttocks and flanks.

2 The buttocks are noted to have the thickest subcutaneous fat among these areas. (4, 90, 93-95)

3 Best practices indicate that rates of unexplained hypoglycemia and increased variability are lower when the abdomen is used exclusively as the injection site.

4 The arm is not a preferred area for self-injection due to difficulty accessing the correct injection site, difficulty handling the delivery device to achieve the necessary 90-degree angle, and reduced thickness of subcutaneous fat, which could create a greater potential for intramuscular injection. (4-5, 93, 96-98)

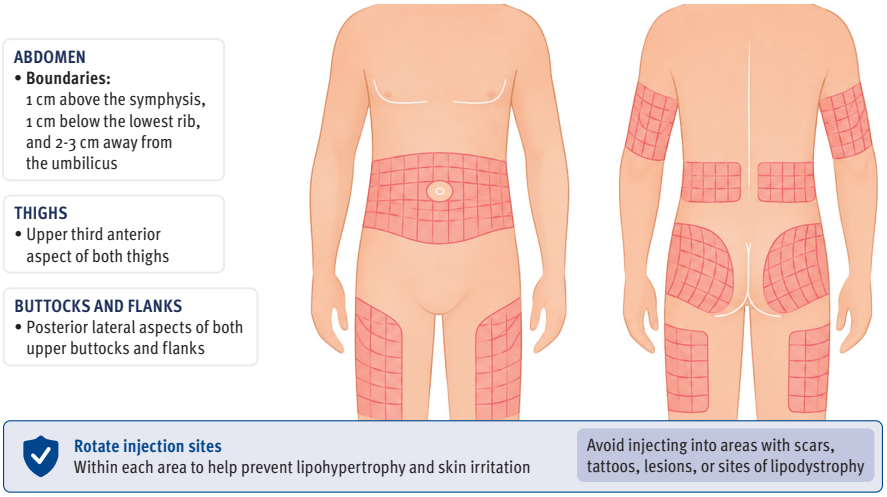


Fig. 18. Recommended injection areas. For the abdomen, injections should be given within defined boundaries, including 1 cm below the lowest rib, 1 cm above the symphysis, and at least 2-3 cm away from the umbilicus.

6.0
Injection technique

6.1 Patient preparation

1 Healthcare professionals should ensure that the patient with diabetes has a basic understanding of why injectable therapy is being initiated. Patients should indicate that their concerns have been addressed and that they are aware of the benefits of this therapy.

The prescription for insulin should clearly indicate the type of insulin to be used, the dose, and the device to be used.

If using insulin, patients should be aware of the action time of the insulin and the potential for hypoglycemia. Injection sites should be discussed and determined.

6.2 Educational strategies

There has been considerable research on the best educational strategies to use when initially engaging and instructing a patient in injectable therapy.

The following recommendations are a compilation of the most successful approaches; however, healthcare professionals must always recognize the need for personalization. (30, 39, 99)

Preparation

1 Engage the patient with diabetes in a conversation early in the course of their diabetes to discuss the possibility that insulin injections may be required. Early education supports familiarity with injection therapy and can help reduce anxiety. (20)

2 Initially address feelings, concerns, and perceived barriers to insulin use. A collaborative, patient-centred approach has the greatest influence on the patient. Sharing experiences of successful insulin users has been helpful (Fig. 19). (25, 100-102)



Fig. 19. A patient-centred framework for insulin initiation: recognizing barriers, engaging through collaborative dialogue, and assessing readiness for therapy.

6.0
Injection technique

3 Discuss the benefits, expectations, and goals of therapy. (24-25)

4 Education should emphasize the rationale behind recommended injection practices. (9, 24, 39) Answering questions and providing education throughout the decision-making process has proven results. (31, 100)

5 Considerations in the assessment for all patients initiating insulin injection therapy should include their type of diabetes and recommended therapy, the individual's ability to learn and readiness for change, the context of cultural beliefs, health beliefs, and preferences, literacy level, socioeconomic barriers, and other health challenges. (8, 12, 27, 103)

Engagement

6 Use clear language and demonstrate the stepwise process for insulin injections. (39, 104) Evidence suggests that demonstrating the injection process is the most effective way to address patients' concerns, explain the benefits of insulin therapy, and engage in collaborative communication. (24, 100) The EMOTION study found that when the insulin injection technique was demonstrated, individuals were more likely to begin insulin immediately. Those who found the "explained benefits" and "collaborative style" most helpful were less likely to discontinue their insulin. (25)

7 Visual aids, demonstration tools, apps, handouts, videos, and other educational resources should be used to reinforce understanding. Appropriate literacy levels and language should always be considered. (9, 24-25, 105)

8 Solicit questions and feedback on an ongoing basis to correct misconceptions and encourage active participation. (100)

9 Encourage hands-on skills practice using demonstration pens or syringes during training. This helps reduce patients' fears and instill confidence in the learner. (24, 31, 100)

10 Brief, structured teach-back should be incorporated following the initial instruction. Ask patients to demonstrate and explain the correct injection technique. Return demonstration is the most effective teaching method to ensure correct technique and demonstrates user autonomy. (24-25)

6.0 Injection technique

Follow-up

11 Ongoing education and reinforcement are essential. Regular reassessment of injection technique, access to refresher education, and supportive follow-up can positively influence treatment adherence and patient confidence. Planned, scheduled follow-ups also help alleviate anxiety. (9, 30-31, 106)

12 Patients should be informed of common warning signs or symptoms related to injecting their medication, including unusual pain, leaking, bleeding, bruising, redness, swelling, or lumps at injection sites. These should be brought to the attention of their healthcare professionals and addressed promptly. (9, 100)

13 Healthcare professionals should remain up to date with advances in insulin delivery technologies and patient education strategies to ensure consistent, evidence-based guidance for patients. (9, 31)

6.3 Skin preparation

1 The skin surface of the injection site should be inspected prior to injection to ensure that it is clean and intact (Fig. 20A). (9, 107-108)

2 Healthcare professionals and patients must wash their hands with soap and water or an antiseptic (Fig. 20B), then dry them thoroughly. (108-109)

3 Clean the injection site using a circular, outward motion, starting at the injection site and working outward. Allow the area to dry on its own (Fig. 20C).

4 Disinfection is particularly important in group care settings, such as hospitals and nursing homes. If alcohol is used to clean the site, the skin must dry completely before the injection is administered. (88, 110-111)



Fig. 20. Key steps in skin preparation prior to injection: inspection of the site, hand hygiene, and proper cleaning technique.

6.0
Injection technique

6.4 Injection

1 Inspect the injection device for dose and flow. If using a pen, follow the manufacturer's instructions for needle attachment and priming (Fig. 21).



Fig. 21. Inspect the device.

2 Prepare the device as directed for injection. If using a pen, dial to the correct dose (Fig. 22).

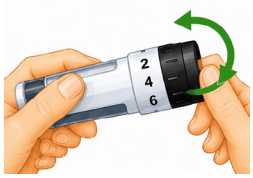


Fig. 22. Prepare the device.

3 Select an appropriate injection site. Recommended injection areas include the abdomen, thighs, upper outer arms, and upper outer buttocks. Ensure you rotate injection sites regularly. Avoid injecting into scars, bruises, irritated skin, or areas of lipohypertrophy.

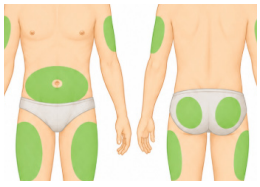


Fig. 23. Recommended insulin injection sites.

4 Inject into the selected site using a 90-degree angle (Fig. 24). (Refer to the relevant section for skin lift if necessary.)



Fig. 24. Insert the device.

5 The needle should enter the skin gently with firm, consistent pressure. The skin should not dent under the pressure. Increased application force on the pen needle may increase the risk of indentation, bruising, or unintended intramuscular injection (Fig. 25). (86-87)

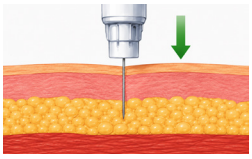


Fig. 25. Avoid excess force.

6 The needle should be held in the skin for up to 10 seconds to ensure proper flow into the injection site (Fig. 26).

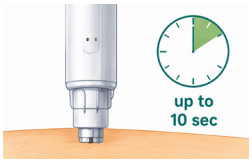


Fig. 26. Hold the needle in the skin for up to 10 seconds.

7 Inject slowly and observe device-specific cues that the injection has been delivered successfully. For example, on devices with a dose window, the number selected after each injection should disappear when the desired dose has been injected. If a number other than zero is showing, then the correct insulin dose has not been administered. In this event, replace the cartridge, attach a new pen needle, prime the pen (per the manufacturer's instructions), and administer the remainder of the dose (Fig. 27). (72)



Fig. 27. Check the dose window.

8 Withdraw the needle at the same angle at which it was inserted (Fig. 28).

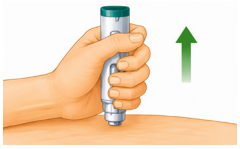


Fig. 28. Withdraw the needle.

9 Dispose of the needle/syringe in an appropriate container (Fig. 29).



Fig. 29. Properly dispose of used needles/syringes.

6.0
Injection technique

6.5 Tips for making injections more comfortable

1 Inspect and palpate the injection site prior to each injection. Any area with signs of lipodystrophy, edema, inflammation, ulceration, or infection should be avoided. (5, 82, 88)

2 Avoid injecting into hair roots, scars, moles, stretch marks, tattoos, or other skin abnormalities. (70)

3 Insulin should be at room temperature prior to injection. (35, 112)

4 It is recommended to use a higher-gauge needle with a sharp, multi-bevel tip and contoured base. (35, 113-117)

5 Use a new needle for each injection. (70)

6 Insert the needle through the skin using a quick, smooth movement without excessive force. (86, 115)

7 Inject medication slowly and evenly. Ensure that the plunger (syringe) or injection dose button (pen) has been fully depressed. (49)

8 If using alcohol swabs, inject only when the alcohol has dried fully.

9 In some cases, the insulin dose should be distributed between two injection sites, as discomfort at the injection site may decrease at doses <50 units for insulin with 100 units/mL concentration. (118)

10 Higher-concentration basal and mealtime insulins are now available in Canada, which may permit higher doses to be administered in smaller volumes than was previously the case.

11 If needed, apply ice or analgesic cream to the site before administering an injection.

12 If needed, use such devices as Inject-Ease®, Insuflon®, iport®, or needle-free jet injectors.

7.0
Handling of sharps and disposal

7.1 Risk reduction

Despite the introduction of safety-engineered devices (SEDs), there remains a high risk of needlestick injury (NSI) to healthcare professionals from subcutaneous injections, lancing devices, and infusion sets used in diabetes care. (119-121)

NSIs are also prevalent when unofficial plastic bottles or breakable glass bottles are used for sharps disposal. (122) Establishing simple, reliable routines for handling and discarding sharps prevents injuries and promotes safe injection practices. This includes using the correct designated containers for sharps. (122)

Environmental concerns regarding the volume of packaging used in diabetes injection/infusion products have been well documented. (32) When choosing products, consider the effect on the environment for disposal of these products. (123)

Most provinces may now have sharps disposal programs in place, where proper sharps containers are provided and no-cost recycling is provided to patients.

This section outlines best practices for sharps handling, container use, and safe disposal according to local guidelines.

1. SEDs (syringes, pen needles, or lancets) should be used by all healthcare professionals for all injections (Fig. 30). (122, 124)
2. The use of SEDs by third-party care providers should be considered in high-risk patients (i.e., those positive for HIV, HBV, or HCV) when injecting in the home or communal setting. (125)
3. Needles should never be recapped, resheathed, or modified prior to disposal. (8, 122)
4. Used needles should never be left attached to a pen device for safety purposes and due to the potential leakage of air into the cartridge, affecting the accuracy of future dosing. (73, 122)



Fig. 30. Examples of SEDs designed to help prevent needlestick injuries.

7.0
Handling of sharps and disposal

7.2 Sharps container

1 Immediately after use, sharps should be placed directly into an approved, clearly labelled, puncture-resistant sharps container (Fig. 31). Under no circumstances should sharps be disposed of in household garbage. (122, 126)

2 Sharps containers should be mounted at eye level and in clear line of sight prior to the use of the sharp.

3 Safe placement of the sharps container in the client's home or mobile clinic must be a priority, in consideration of children, pets, confused adults, and drug users.

4 Sharps containers must have tight-fitting lids and be used exactly as directed by the manufacturer to prevent accidental exposure.



Fig. 31. All needles should be disposed of in an approved sharps container after use.

5 Sharps containers should be replaced when they are three-quarters full to reduce the risk of accidental injury or spillage. (122)

6 Containers should be disposed of according to local or provincial waste management requirements, which may include returning them to a pharmacy, a community sharps collection program, or a household hazardous waste facility. (126-127)

7 Sharps should be disposed of at the point of use. When sharps containers are transported (i.e., during home care or travel), they should be stored upright in a stable location with the opening covered.

8 Healthcare professionals should be aware of programs in their area that supply sharps containers and offer safe disposal (i.e., pharmacies, MD offices, community centres). (127)

7.3 Education

1 Proper sharps disposal should be demonstrated at the initiation of injection therapy and reviewed at subsequent healthcare visits to ensure ongoing safe practice. (128-129)

2 All healthcare professionals, individuals with diabetes, and caregivers should be aware of local regulations for sharps disposal and understand the consequences of improper disposal, such as NSIs to waste handlers. (116, 126-127, 130)

3 Education should stress the importance of the use of SEDs, never recapping or resheathing needles, and adhering to community guidelines for the disposal of sharps containers. (8, 119, 131)

4 All those involved in the selection of injection/infusion devices should opt for minimal packaging and the potential for recycling of non-sharps materials in consideration of the environmental impact of disposal. (123, 126)

8.0
Site rotation

Site rotation is essential to avoid lipohypertrophy and to facilitate consistent insulin absorption, thereby contributing to a decrease in glycemic variability and unexplained hypoglycemia. (12, 13, 37, 132-138)

1 Healthcare professionals should reassess their patients' injection-site rotation at least annually, or sooner if signs of suboptimal injection technique are observed. (139)

2 To prevent lipohypertrophy and maintain consistent insulin absorption, patients should be assisted in the development of a personalized, structured rotation regimen for injection and insertion sites. (140-143)

3 For insulin injections, structured rotation is recommended in the same anatomical area (e.g., abdomen or thigh) at the same time of day, with injections administered at least 1-2 cm apart (i.e., the width of a finger) across the entire area (Fig. 32). (13, 140, 144-145)

4 A study of coloured pen needle caps accompanied by education information within the packaging demonstrated a statistically significant improvement in injection-site rotation. (146)

5 The abdomen remains the preferred injection/infusion area; however, patient preference remains an important consideration. (68) Care should be taken to avoid injecting or inserting within 2-3 cm of the umbilicus (Fig. 32).

6 The flanks, located lateral to the umbilicus and above the hips, are considered part of the abdominal injection area and provide an additional suitable site for rotation (Fig. 32).

7 Injection or insertion site rotation should be discussed with, and demonstrated by, patients at every visit. (1, 4, 143) Site documentation by healthcare professionals is recommended to assist and verify regular rotation. (12)

8 Injection-site map handouts or rotation apps can reinforce regular rotation between and within sites, and help maintain sufficient distance from previous injection spots. (9)

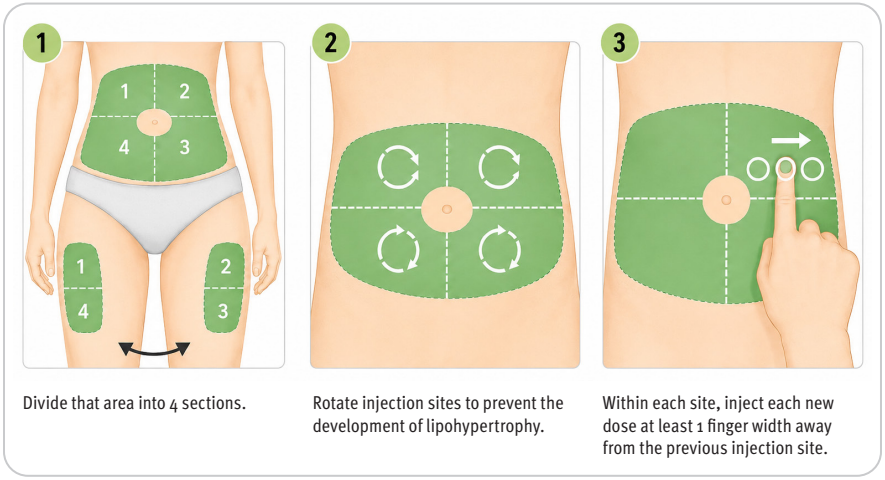


Fig. 32. Overview of insulin injection-site rotation, demonstrating anatomical site selection, division into quadrants, and systematic rotation with proper spacing between injections.

9.0 Factors affecting insulin absorption

Factors that affect the temperature and the integrity of the skin at the injection site will impact insulin absorption rates, thus contributing to glycemic variability. If blood flow is increased to the area, such as during exercise, there will be more rapid absorption of insulin, whereas injecting cold insulin will have a delayed effect. (147-148) The injection site selected, the type of insulin being injected, and the physiology of the insulin depot also affect the rate of absorption. (147)

9.1 Intradermal injections

1 Intradermal injections should be avoided with current insulin formulations and injection devices, as they may lead to unpredictable insulin absorption, increased immune reactions, injection site pain, and leakage (Fig. 33). (147-148)

9.2 Intramuscular injections

1 Intramuscular and intradermal injection of all human insulin, and rapid- and long-acting analogues, should be avoided due to the risks of erratic blood glucose control and severe hypoglycemia. (33, 150)

2 Accidental intramuscular injection into an arm, leg, or the buttocks prior to or during exercise may increase insulin absorption and result in faster action and a more rapid decrease in blood glucose levels. (62)

3 Excessive injection force can increase the risk of intramuscular injection. (86)

4 The risk of unintentional intramuscular injection is higher in individuals with low BMI (<19 kg/m^2), low or lean body mass, and in children aged ≤6 years, due to a shorter distance between the skin and muscle. In these groups, the use of a 4-mm non-posted pen needle is recommended to reduce this risk. Injections should be administered at a 90-degree angle into a lifted skinfold (skin lift). (86, 151)

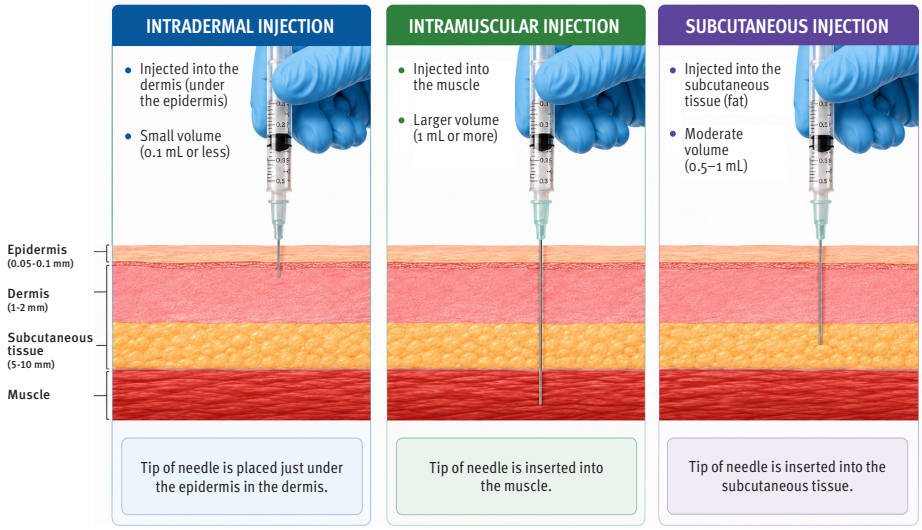


Fig. 33. Comparison of intradermal, intramuscular, and subcutaneous injections, showing the relative needle insertion depths within tissue layers.

9.0
Factors affecting insulin absorption

9.3 Injection site–related factors

1 Massaging the injection site immediately before or after an injection is not recommended, as it increases absorption and results in an unpredictable time-action profile. (34, 152)

2 Avoid damaged skin (e.g., from surgical scars, tattoos, areas of inflammation, and lipodystrophy) when injecting insulin and incretins (Fig. 34). (5, 34, 147)

3 Injecting into an area that has an increased skin temperature (e.g., after a sauna or hot bath) can increase the absorption rate of insulin. (44)

4 Insulin is absorbed most consistently from the abdominal area. (144, 153-156)

5 The upper arm and the lateral side of the thigh (not proximal to the knee) have moderate insulin absorption rates. (67, 155-157)

6 The slowest absorption of insulin occurs when it is injected into the buttocks; thus, this may be the preferred injection site if slow absorption is desired. (67)

7 Rapid- and long-acting insulin analogues may be administered at any injection site, as absorption rates do not appear to be site-specific. (156, 158-162)

8 The abdomen is the preferred site for soluble human insulin (regular), as absorption of this insulin is fastest in this area. (67, 140, 149, 153-154, 163)

9 For the fastest absorption rate and to reduce postprandial glycemic excursions, premixed regular/NPH insulin should be injected into the abdominal site. (149)

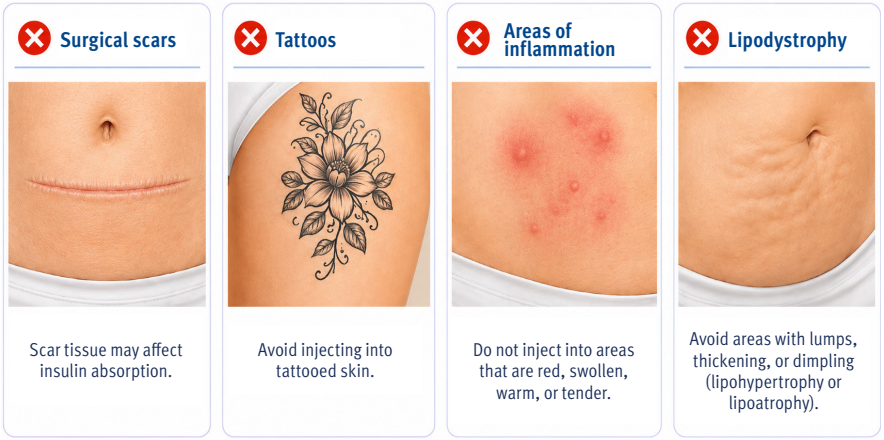


Fig. 34. Areas to avoid when administering insulin and incretin injections, including scar tissue, tattoos, inflamed skin, and regions affected by lipodystrophy.

9.0
Factors affecting insulin absorption

9.4 Leakage considerations

1 Larger doses of insulin are associated with more leakage and potentially more discomfort. (45, 118, 164)

2 In patients with obesity, there is no difference in glycemic control, safety, leakage rates, or patient ratings between 4-mm, 5-mm, and 8-mm needles. (80, 83, 165-166) In one study, the amount of leakage appeared to increase related to a coinciding increase in BMI. (80)

3 The volume of leakage is generally <0.1 IU (or <1.0% of total insulin) for most patients and is therefore almost always clinically insignificant. (164, 167-168)

4 Inject slowly and observe cues for successful injection tailored to the injection device. For example, pen devices with a dose window should be checked after each injection; the number 0 should be displayed when the desired dose has been injected. Delaying needle tip withdrawal for 10 seconds may reduce the chance of insulin leakage. Recommendations may vary regarding how long to delay withdrawal, but even an additional 3-10 seconds can help reduce leakage (Fig. 35). (72)

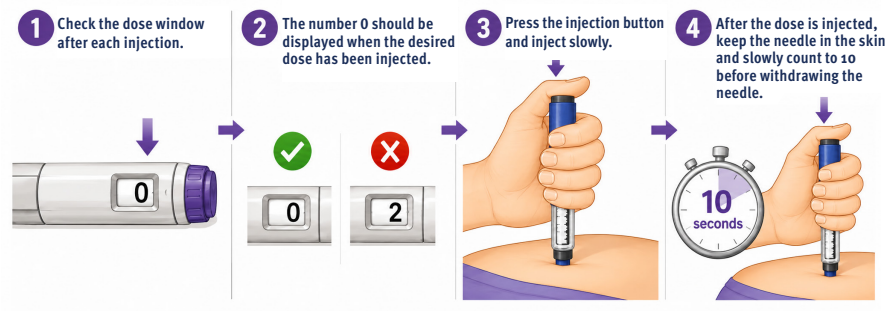


Fig. 35. Key steps to reduce insulin leakage, including confirming dose delivery, injecting slowly, and maintaining needle hold time before withdrawal.

9.0
Factors affecting insulin absorption

9.5 Bruising and bleeding

Local bruising and/or bleeding may occasionally occur at an injection site and may be more common in patients taking antiplatelet therapy or those with bleeding disorders (Fig. 36). (87) Patients with type 2 diabetes, women, and those with a higher BMI are also more likely to experience bruising. (169)

Ongoing research examining how far bleeding spreads from the dermis into the subcutaneous layer suggests that bruising is linked to poor metabolic control, but it does not affect the pharmacokinetics or pharmacodynamics of insulin. Unlike lipohypertrophy, bruising is not associated with glycemic variability or the frequency of hypoglycemic events. (87, 169)



Fig. 36. Abdominal bruising associated with excessive injection force.

Excessive pressure at the injection site is a primary contributor to bruising and bleeding. This is often related to unconscious fear of injections or the misconception that greater force is required when administering larger doses. (8, 16-17, 48, 74, 87, 90, 142, 169-170) A recent Canadian study reported that 76% of individuals used excessive force during injections, which may also increase the risk of intramuscular injection. (16-17, 87, 169) The use of shorter, thinner-gauge needles (e.g., 33G or 34G) may result in less bruising and have positive psychological implications for adherence.

Since bruising may be an early indicator of lipohypertrophy, structured educational strategies should be implemented to reinforce proper injection technique. (169)

1. Patients should be reassured that occasional bruising or bleeding at an injection site does not affect medication efficacy. (113, 171)
2. Patients should be instructed to avoid excessive force that causes skin indentation when inserting the needle. The needle should be inserted gently while maintaining visibility of the needle hub (Fig. 37). (86, 142)

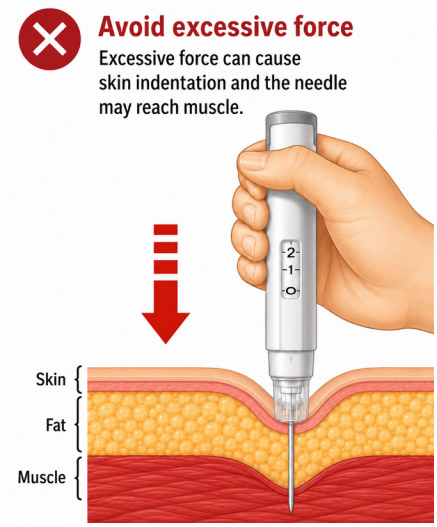


Fig. 37. Excessive injection force causing skin indentation and increased risk of unintended intramuscular injection.

9.0
Factors affecting insulin absorption

3 To reduce the likelihood of bruising or bleeding, consistent rotation of injection sites should be encouraged. (48, 172)

4 Patients should be advised to avoid massaging the injection site.

5 The use of shorter, thinner needles with a contoured hub may help reduce tissue trauma. (87, 90, 173-174)

6 Frequent or unexplained bruising or bleeding should prompt a review of injection technique. Healthcare professionals should assess needle length and gauge, needle manufacturer or product, injection angle, insertion force, site rotation, and device handling to identify potential causes and reinforce correct practice. (87, 169)

10.0 Lipodystrophy

Lipodystrophy is a disorder of the adipose tissue that is frequently related to repeated insulin injections into the same skin site. It is the most common complication of subcutaneous injections and includes both lipoatrophy, the loss of adipocytes resulting in crater formation, and lipohypertrophy, the enlargement of adipocytes creating swelling and nodules. (8, 14, 41, 48, 149, 163)

10.1 Lipoatrophy

Initially seen with the use of animal insulins, lipoatrophy is described as a depression of the skin, frequently deep but varying in size (Fig. 38). (10)

The cause is attributed to an immunological reaction to injected insulin resulting in damage and disappearance of the subcutaneous fat layer. It is more commonly seen in women with type 1 diabetes who experience autoimmune disorders. By switching to recombinant human insulin/insulin analogs and rotating through new injection sites, lipoatrophy can be averted. (10)

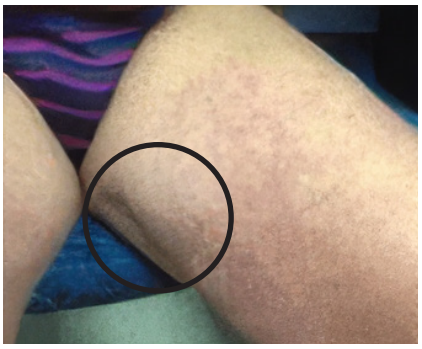


Fig. 38. An example of lipoatrophy.

10.2 Lipohypertrophy

1. Lipohypertrophy is the most common form of lipodystrophy found at injection sites, with an estimated occurrence rate of 37% to 64% among insulin users. (106, 175-178)
2. The accumulation of fatty tissue at the injection site is thought to result from the stimulation of insulin on adipose tissue, causing excessive growth (hypertrophy) and excessive proliferation (hyperplasia) of lipid cells. (179-181)
3. Described as a thickened or rubbery lesion, lipohypertrophic areas vary in size, shape, and depth (Fig. 39). Some may be visually apparent while others are only detected through palpation and ultrasound. (182)



Fig. 39. Lipohypertrophic lesions.

10.0 Lipodystrophy

4 Due to the fact that these sites are usually painless and hypalgesic, (176) patients with diabetes repeatedly inject into these areas, resulting in an increase in glycemic variability, increased risk for complications, and an increasing economic burden. (9-10,183-184)

5 Lipohypertrophy is significantly underreported, with many healthcare professionals unaware of its severe impact on glycemic management. (10)

10.3 Identifying lipohypertrophy

1 Visual examination of injection sites may show areas of nodules or swelling.

2 However, many lesions are first identified only through palpation. Gentile and others have developed systematic palpation techniques to be used by trained professionals to locate and classify stages of lipohypertrophy. (177, 185) When palpated with the fingertips, lipohypertrophic areas may feel dense and hard (Fig. 40). These lesions can also be identified by pinching the skin; while healthy skin can be pinched together tightly, lipohypertrophic lesions cannot. (10)

3 Ultrasound can detect deeper-lying lesions and ascertain structural changes in the skin and subcutaneous tissue. (176, 186) Although not available universally, ultrasound is considered the "gold standard" for identification and classification of lipohypertrophy. (187)

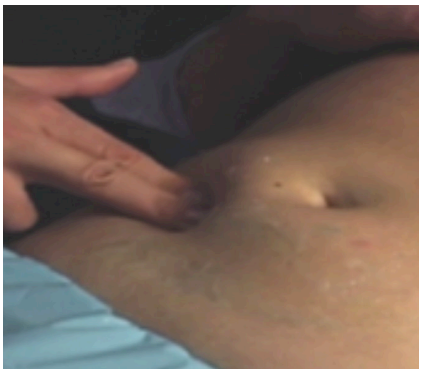


Fig. 40. Proper palpation technique for detection of lipohypertrophy.

10.4 Pathology of lipohypertrophy

1 Unlike other injectable agents (e.g., GLP-1 receptor agonists, heparin), insulin has a growth factor effect on adipose tissue, contributing to the enlargement and proliferation of adipocytes when injected repeatedly into a small subcutaneous space. (177, 188-189).

2 The lipohypertrophic nodules which develop can become fibrotic, with decreased vascularity leading to decreased insulin absorption. (14, 147, 177-178)

3 The lipogenic effect of insulin contributes to the thickening of the subcutaneous layer, which expands toward the dermal layer. (92, 188) With this thickening, the structural differentiation of the skin and fat layers becomes blurred. (177-178) The skin layer also thickens, showing a high density of collagen fibres. (92)

4 Other histological examinations of lipohypertrophic lesions in the subcutaneous tissue have shown dense plaques of tissue composed of macrophages. This suggests there may be an inflammatory response from insulin exposure and the trauma from repeated needle penetration. (177, 179)

10.0 Lipodystrophy

10.5 Contributing factors to the development of lipohypertrophy

1 The strongest correlating factor in the development of lipohypertrophy is the repeated injection or infusion of insulin into a small area (i.e., smaller than the size of a postage stamp). (10, 106, 148, 176, 190)

2 Other factors strongly associated with increased areas of lipohypertrophy include (Fig. 41): (10, 12, 13, 37, 106, 134-135, 176, 178, 190-194)

- Longer duration of insulin use
- More frequent injections
- Higher doses of insulin
- Reuse of needles
- Injection of ice-cold insulin
- Failure to inspect injection/ infusion sites on a regular basis allowing for repeated use

3 An international survey found that 28% of participants could not remember ever having their injection sites checked by a healthcare professional. This clearly indicates the need for heightened awareness among both healthcare professionals and patients with diabetes to check injection sites daily and rotate sites to avoid lipohypertrophy. (195)

4 It has been noted that patients with diabetes repeatedly choose lipohypertrophic sites for injections/ infusions, as these areas have limited nerve innervation and result in relatively painless injections. (71, 196-197) This behaviour further increases the negative impact of lipohypertrophy.

5 Recent studies have reported that certain social/economic issues contribute to patterns of behaviour that increase the likelihood of the development of lipohypertrophy. These conditions include living alone, low socioeconomic status, and lack of access to diabetes care. (10, 148, 176)

6 The additives to some insulin preparations may introduce foreign elements that may trigger an immune response. (10) Conversely, the use of rapid-acting analogues may reduce the risk of lipohypertrophy due to the reduced time they are in contact with adipocytes. (8, 198)

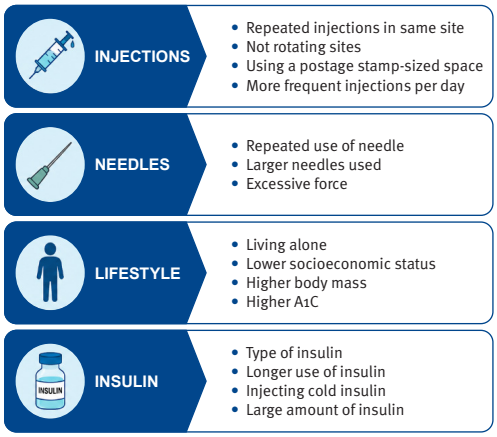


Fig. 41. Key risk factors associated with insulin injection-related lipohypertrophy, grouped by injection practices, needle use, lifestyle characteristics, and insulin-related factors.

10.0 Lipodystrophy

10.6 Impact of lipohypertrophy

1 Injecting insulin into a lipohypertrophic site affects the pharmacodynamics, pharmacokinetics, and pharmacoadherence of the drug. (10)

2 The effects of injecting/infusing into a lipohypertrophic site have been documented as a decrease in the rate of insulin absorption, as well as a variable rate of insulin absorption. This results in an unpredictable and varied glycemic response, increased rates of hypoglycemia, and an increase in A1C (Fig. 42). (14, 141-142, 192) Pozzuoli determined that the presence of lipohypertrophy was associated with a 2.7-times higher risk of severe hypoglycemia. Glycemic variability has been linked to an increase in macro- and microvascular complications. (10, 14)

3 Studies have also shown that when insulin is injected into a lipohypertrophic area, higher doses of insulin are required to achieve glycemic targets, resulting in increased cost for patients with diabetes. (179) When switching to an unaffected site, a significant reduction in insulin may be necessary in order to avoid hypoglycemia.

4 Quality of life has been affected by the development of disfiguring anatomical lesions at the site of lipohypertrophy. Patients with diabetes have reportedly decreased, and in some cases discontinued, their insulin injections for this reason. (148, 175)

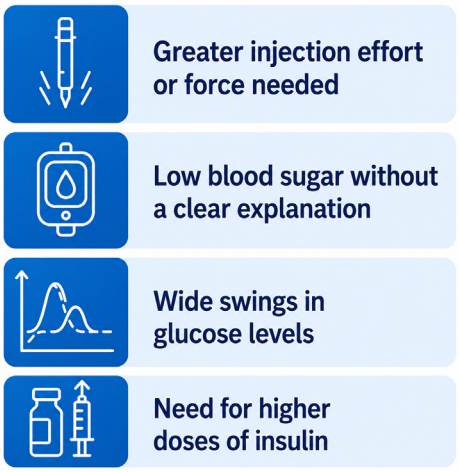


Fig. 42. Common indicators of lipohypertrophy and its impact on insulin administration and glycemic control.

10.0 Lipodystrophy

10.7 Prevention of lipohypertrophy through assessment, treatment, and education

In order to effectively deal with the real problem of lipohypertrophy, we must recognize the warning symptoms.

Warning Symptoms of Lipohypertrophy: (9)

1. Increased glycemic variability with unidentified cause
2. Unexplained recurring hypoglycemia
3. Increased insulin requirements
4. Increased force needed for injections

To drive awareness regarding lipohypertrophy, structured education programs have been developed, trialled, and evaluated. These programs have included the introduction of appropriate palpation techniques to identify lipohypertrophic lesions, discussion of the risk factors and impact of lipohypertrophy on diabetes management, and outlining the treatment and prevention of lipohypertrophy. Patients with diabetes participating in these programs have shown improvements in their A1C, less glycemic variability, and fewer episodes of unexplained hypoglycemia. (180, 189)

Another important factor to consider in any educational interventions is pharmacoadherence. As discussed previously, the effect of a drug is determined by its pharmacokinetic and pharmacodynamic properties, as well as its pharmacoadherence.

Patients with diabetes need to have knowledge about insulin, including knowing why they are being prescribed the drug, what benefits they can expect, (9) and how to properly inject the drug. These are important education points to include in any discussion in order to increase the value of treatment and encourage adherence. (9, 139)

As we have learned in all aspects of diabetes management, education needs to be reinforced and supported. (180) A recent study done in Canada showed that all 230 patients surveyed were making at least one injection technique error in these areas: applied injection force (76%), size of injection site (64%), duration of pen needle in skin (61%), pen needle reuse (39%), performing a skin lift with a 4-mm or 5-mm needle (38%), using a longer pen needle than required (34%), and injection of insulin into lipohypertrophic tissue (37%). (16)

"Increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatments".
— World Health Organization (199)

10.0 Lipodystrophy

Annual examinations by healthcare professionals and interventions providing education and re-education for patients with diabetes on proper injection technique, emphasizing appropriate site rotation, have resulted in improved glycemic control, (39, 142, 200) reduced episodes of hypoglycemia, (201) reduced total daily insulin dosage, (200) decreased needle reuse, (71) shrinkage of lipohypertrophy lesions, (142) and higher patient satisfaction (Fig. 43). (39, 114)

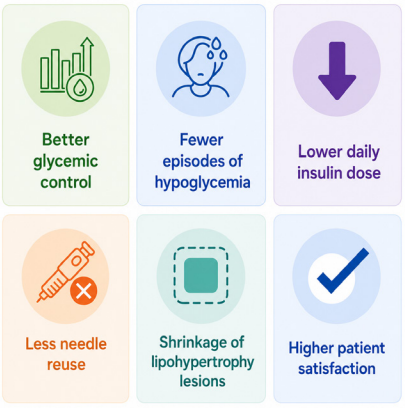


Fig. 43. Key clinical benefits associated with proper injection technique and ongoing patient education.

10.8 Recommendations: Key strategies for intervention

1 Structured education regarding lipohypertrophy should be included during all insulin initiations and reinforced during all discussions with insulin-using patients (Fig. 44): (175, 180, 195)

- Individual needs and preferences regarding what and how to learn should be identified.
- Multiple media tools, including surveys, videos, simulation tools, and apps, should be incorporated in all education programs.
- Learning should be assessed through teach-back and discussion.
- Updates in research findings and technology should be shared.

2 Injection/infusion sites should be inspected and palpated by a healthcare professional at each visit (Fig. 44): (106)

- The inspection should be performed while the patient with diabetes is in a standing or supine position.
- Adequate lighting should be ensured.
- The injection area should be palpated in a circular, sweeping motion using the fingertips.
- Assessment is enhanced with the use of examination gel or lotion.

3 Patients with diabetes should be taught the warning signs of lipohypertrophy and to manually inspect and palpate their injection sites to detect lipohypertrophy (Fig. 44).

4 Patients with diabetes should be informed that rotation of their injection sites is the strongest protective action to prevent lipohypertrophy. They should be asked to demonstrate their rotation pattern at each visit (Fig. 44). (183, 190)

5 Patients with diabetes should be instructed to never use lipohypertrophic sites when injecting insulin.

10.0 Lipodystrophy

6 In order to reduce the risk of hypoglycemia when changing from a lipohypertrophic injection site to a healthy site, patients with diabetes should be cautioned to reduce their insulin dose initially and monitor their blood glucose levels more frequently (Fig. 44).

7 Patients with diabetes should be instructed to have their insulin at room temperature before injecting to avoid cryotrauma to the area. (106)

8 By avoiding injections into lipohypertrophic sites over a 3-6 month period, these lesions may decrease by up to 50% in diameter or, in some instances, resolve completely.

"Insulin injection technique is suboptimal in many patients, highlighting the need for improved patient education. Increasing the awareness of the importance of preventing lipohypertrophy and insulin injection errors represents an important tool to reduce the clinical, social, and economic burden of diabetes."
— Pozzuoli (190)



Fig. 44. Simplified framework outlining key considerations for preventing lipohypertrophy.

11.0
Considerations during pregnancy

11.1 Special considerations

During pregnancy, anatomical changes, fetal proximity, and shifting insulin needs can influence injection technique and patient confidence. (201) Questions arise as to why, where, and how insulin can be safely administered.

This section offers guidance on needle choice, site selection, and trimester-specific considerations to support safe and comfortable injections during pregnancy.

1. Education regarding insulin use during pregnancy is essential for all pregestational and gestational patients with diabetes who require insulin. Education should address psychological adjustment to insulin therapy, expected changes in insulin requirements during pregnancy, site selection and rotation, and prevention of hypoglycemia. (201-202)
2. The abdomen is the preferred site for injection during pregnancy. The lateral aspect of the thigh is an alternative site. (90, 109, 203-204)
3. Shorter needles (4-mm or 5-mm) should be used to decrease the risk of an intramuscular injection. (90, 109) A skin lift is not usually necessary with a 4-mm needle.
4. Avoid injecting into areas where the skin is taut or where there is evidence of scars, moles, or stretch marks. Injections should not be done within 3-4 cm of the umbilicus. (202)
5. Injection site changes across trimesters (Fig. 45): (109, 202)
   - First trimester: no change in injection technique required.
   - Second trimester: consider using the lateral sides of the abdomen as the skin becomes more taut across the abdomen.
   - Third trimester: the lateral sides of the abdomen are the recommended areas for injection. A skin lift may be utilized for patient comfort.

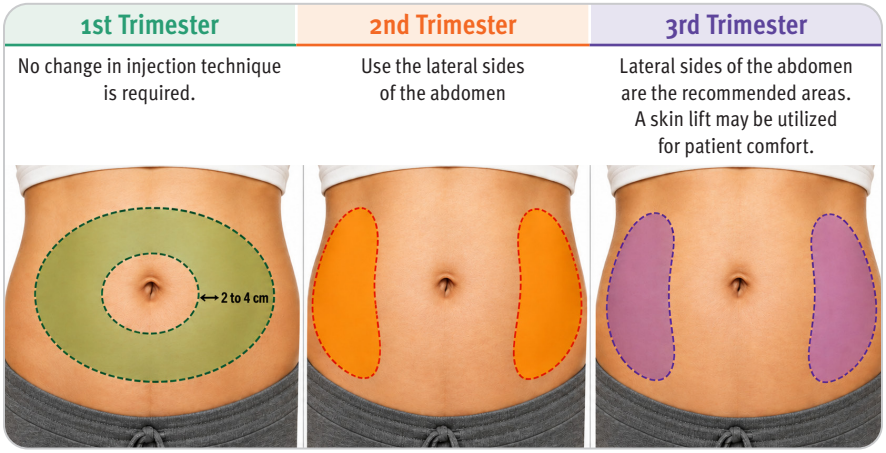


Fig. 45. Recommended injection sites across pregnancy trimesters.

11.0
Considerations during pregnancy

6 Continuous glucose monitor use is now recommended for pregestational (205-206) and gestational patients with diabetes using insulin (Fig. 46). (207) With the stretching of the skin and the fluid changes in pregnancy, sensor placement can be challenging. There is an increased potential for skin irritation and overuse of injection sites. (205, 207-208) It is recommended that patients follow professional advice to use alternate sites of the arm or thigh for continuous glucose monitoring if necessary.



Fig. 46. Pregnant woman using a CGM system to support glycemic management during pregnancy.

12.0
Considerations in pediatrics

12.1 Thickness of subcutaneous fat

Many children and adolescents are emaciated at the time of diabetes diagnosis. As well, children aged 2 to 6 years, those who are slim, and very lean teenagers have minimal subcutaneous fat tissue. All these factors render the administration of insulin into subcutaneous fatty tissue very challenging. Appropriate injection techniques are key to achieving optimal blood glucose control.

1 The healthcare professional should conduct an individualized assessment to determine the amount of subcutaneous fat thickness at each injection site. This assessment will guide the choice of needle length and administration technique. Professionals should inspect injection sites and provide targeted, individualized instruction on a regular basis. (209-211)

2 Insulin pens are the injection devices of choice due to their small needle lengths (4-mm, 5-mm). (211) 4-mm needles are the safest needle length currently available. (6, 57, 118, 130, 212)

- A 4-mm needle can be inserted at a 90-degree angle without a skin lift in adolescents and children older than 6 years of age.
- Children aged 2-6 years require a skin lift in order to avoid intramuscular injection.
- Currently available research supports the use of a 32-gauge needle, which provides reduced injection pain without compromising structural integrity.

3 Syringe use in very young children (<6 years) is not recommended, since the risk of intramuscular injection remains. If using a syringe for children 6 years and older, injections should always be given into a skin lift. (6)

12.2 Injection sites

Small children have less surface area at injection sites. As well, since many children and adolescents do not adhere to an adequate site rotation plan, lipohypertrophy is a common occurrence. Barriers to the use of multiple sites include fear that a new site will be painful to inject into and comfort with an existing routine. (213-214)

1 The healthcare professional should educate parents, children, and adolescents regarding the need for injection site rotation. Indeed, parents must reinforce the consequences of injecting into "favourite spots."

2 Injection sites should be rotated diligently, both between sites and within each site. Within a given site, each injection should be placed approximately 1 cm, or one finger width, from the previous injection, following a predetermined pattern to avoid repeated injections in the same location.

3 For children and adolescents who self-inject, supervision may be required to ensure adequate site rotation.

12.0
Considerations in pediatrics

12.3 Needle anxiety and pain

Needle anxiety is common in children and adolescents, as well as their parents; younger children report greater fear and pain. Parents' attitudes are important for their child's acceptance of injections. (215-217)

1 The healthcare professional should ask patients about needle fear and pain, as many do not report it voluntarily.

2 At diagnosis of diabetes, healthcare professionals should consider intervention strategies for the child's parents, as follows:

- Inform them that displayed distress and negative attitudes can influence their child's cooperation with insulin administration.
- Have parents experience the injection regimen by performing a saline injection with a syringe or pen needle attached to an empty insulin pen.

3 Younger children may be helped by: (209)

Distraction therapy (provided it does not involve trickery), e.g., injecting while watching a favourite television show, blowing bubbles, or looking for hidden objects in picture books (Fig. 47).

- Play therapy (e.g., injecting a favorite stuffed toy).

4 Older children and adolescents experiencing needle anxiety may be helped by cognitive behavioural therapy, if available, including: (209)

- Relaxation training
- Guided imagery
- Graded exposure
- Active behavioural rehearsal
- Modelling and reinforcement
- Incentive scheduling



Fig. 47. Play therapy can familiarize young children with injections and reduce anxiety.

12.4 Preparing children for injections

Anticipatory fear is often worse than the actual experience of injection. Parents who are well prepared beforehand will transmit less anxiety to a child. In fact, the presence of a calm and reassuring parent is the most effective support for a distressed child. (68-69)

12.0
Considerations in pediatrics

12.5 Self-injection

The age at which children can self-inject is related to their developmental maturity rather than chronological age. Most children >10 years of age can either administer their own injections or help with them. (218)

If self-injecting, young children should do so under supervision and share responsibility with their parents. (209, 218)

12.6 Insulin under- and overdosing

Intentional under- or overdosing of insulin is common in children and adolescents and can lead to severe hypoglycemia or diabetic ketoacidosis. (219-222)

1. If insulin dose manipulation is suspected or confirmed, the healthcare professional should instruct parents to be more involved in insulin administration. (223)
2. If omission or overdosing remains an issue, parents should be instructed to assume responsibility for injecting insulin.
3. Supervision of injections by parents or caregivers should include checking the dose prior to injection and ensuring the injection has penetrated the skin.

12.7 Adolescence

Adolescence is defined as puberty through 18 years of age. During this stage of life, insulin resistance is more common, and higher doses of insulin are often required to achieve near-normal glucose control. Studies have demonstrated that insulin levels are higher during puberty than they are during adulthood or the years preceding puberty (224).

Although the majority of adolescents with type 1 diabetes adapt well to the difficult challenges of puberty, it must be recognized that their health and emotional needs are distinct from those of younger children or older adults. Adolescence involves training to become an independent adult and may result in failures and mistakes, as well as successes. Many adolescents have a greater tendency to skip insulin due to peer pressure, rebellion, pain, depression, or diabetes burnout. As well, some adolescents associate insulin with weight gain and therefore choose to skip insulin doses. (224)

13.0
Considerations for the older person

Education and treatment approaches for injection therapy in the older population are challenged by age-related physical, cognitive, social, and psychological changes (Fig. 48). (11)

Structural and functional changes in the skin, including the thinning of the epidermis and vascular tissue, can lead to an increase in fragility, a decrease in skin elasticity and integrity, and a decrease in healing potential. (11, 203, 225) There is a decline and redistribution of subcutaneous fat, as well as a loss of muscle mass. When excess pressure is applied during the injection, these changes can contribute to more bruising and an increased potential for intramuscular injections. (11, 86-87)

Changes in cognition can initially be exhibited by memory loss and further exacerbated by decreases in hearing and sight. Impaired counterregulatory hormones reduce the recognition of hypoglycemia, leading to glycemic variability and creating a greater potential for falls and fractures. (226)

Insulin injection technique is also affected by impaired neuroperception and dexterity difficulties due to conditions such as arthritis and Parkinson's disease. In a recent study, the older population was found to have a higher percentage of lipohypertrophy compared to the younger population (79% versus 48%). The cause of lipohypertrophy was primarily due to needle reuse and non-rotation of sites, with the older versus younger (>65 years of age versus ≤65) population repeatedly injecting into the less painful lipohypertrophy nodules. (11)

Considerations of frailty are more important than age when dealing with this population. (227) The approach must be highly individualized and take into account all aspects of their lives (i.e., physical, social, and spiritual realms). Educational interventions need to be directive and regularly reinforced. (227-228)

Our primary concern is evaluating safety in injection technique in the older population. Tailored assessment, simplified regimens, and supportive device selection can enhance safety and independence. (230)

This section highlights key considerations for ensuring effective and practical injection techniques in older adults.



Fig. 48. Healthcare professional providing individualized education and support to an older adult receiving injection therapy.

13.0
Considerations for the older person

13.1 Special considerations

1 Assessment for cognitive and functional ability should be done using standardized tests. The clock-drawing test is a validated test for cognitive function in the older population (Fig. 49). (230) Depression screening is mandatory to identify barriers to self-management. (227, 231)

2 A structured, individualized diabetes management and injection technique plan should be developed considering physical dexterity and limitations, memory, vision, strength, and psychosocial context. Simplified regimens, including the use of basal insulins, are preferred for safety. (229, 232-233)

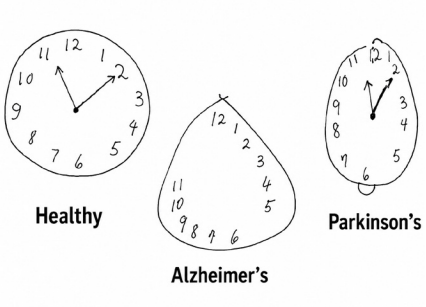


Fig. 49. Clock drawing test illustrating differences in visuospatial and cognitive function in healthy individuals compared with Alzheimer's disease and Parkinson's disease.

3 Pen devices are recommended over syringes due to easier handling, clearer dose markings, and the potential for dosing errors to be reduced. Disposable prefilled pens, memory pens, and pens with assistive devices can help support more accurate and safer dosing. Technology-assisted injection devices are helpful for adherence and tracking purposes. (227, 234-235)

4 The abdomen is the recommended site for self-injection due to easier access and greater visibility of the site. (230) The use of a pen device with a 4-mm needle with a contoured tip is encouraged to avoid the need for a skin lift. (9) The outer aspect of the arm is an alternate site for trained caregivers. (230) Safety-engineered devices are recommended for third-party caregivers.

5 Family members, friends, and caregivers should be incorporated into education, management plans, and follow-up for optimal outcomes. (11, 227) They can offer support for safety, adherence, and monitoring. Telephone follow-up has been shown to be effective and is recommended. (228, 236)

6 All injection-related training should include a teach-back demonstration to ensure competency. (24)

7 All education and treatment plans should be reinforced and updated on a regular basis. (227, 237)

14.0 Insulin infusions

14.1 Selecting an infusion set

An insulin pump is a small computerized device programmed to mimic the human pancreas (Fig. 50). It delivers small continuous doses of insulin for basal needs and variable amounts of bolus insulin, as needed, for food or corrections. Insulin is delivered into the subcutaneous space by either an infusion set with a cannula and tubing, or a cannula within a pod that attaches directly onto the skin.

Insulin infusion sets are available in a variety of lengths, diameters, connector materials, and designs to meet individual needs and preferences.

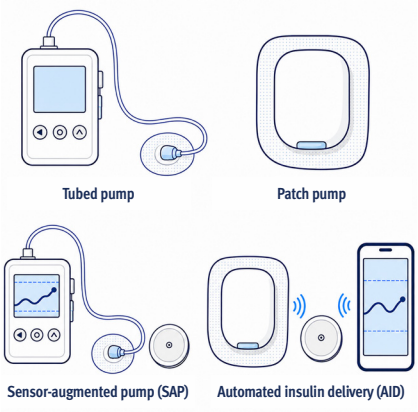


Fig. 50. Different types of insulin pumps and infusion sets.

Conventional (tubed) pumps deliver insulin through a fine tube connected to a subcutaneous cannula. Traditional infusion sets are changed every 2-3 days, and newer extended-wear sets can last up to 7 days. (201, 238-239)

Patch pumps adhere directly to the skin and do not use external tubing. Some are mechanical without electronics and deliver fixed doses via button presses, while programmable models allow electronic control of basal rates and boluses. Designs may be fully or semi-disposable. (201, 238-239)

Sensor-augmented pumps (SAP) combine an insulin pump, a CGM system, and an algorithm that can suspend insulin when glucose is low or predicted to drop within the next 30 minutes. This is called open-loop control. (201, 238-239)

Automated insulin delivery (AID) systems are increasingly being used and adjust insulin based on CGM readings to mimic physiologic delivery. They consist of a pump, a CGM system, and a dosing algorithm. This is called closed-loop control. (201, 238-239)

When selecting an appropriate infusion set, the following factors should be considered:

- Cannula length
- Cannula composition (steel or Teflon)
- Pump type (conventional vs. AID)
- Insulin formulation
- Extended-wear compatibility
- Patient or caregiver preference
- Patient's ability to self-insert the device
- Patient's lifestyle and physical activity level

14.0 Insulin infusions

1 Choosing the appropriate cannula length depends on the thickness of the patient's subcutaneous tissue and the preference of the insertion angle (Table 1). (3)

- The criteria for choosing cannula length are similar to choosing insulin pen needle length. (12) Skin thickness studies suggest that shorter cannulae may reduce the risk of intramuscular insertion. (85)
- The angle of insertion depends on the type of infusion set used: Steel cannulae require a straight insertion, whereas Teflon cannulae can be inserted straight or at an angle (20°-45°), depending on the patient.
- A review of known patient sensitivities is important when considering the choice of cannula. Patients sensitive to Teflon should use a steel cannula. In some cases, the risk of local inflammation may be reduced with a steel cannula due to better biocompatibility. (240)

2 When choosing tubing length, consider the distance between the infusion set and the pump location on the body. Tubing should be long enough to allow the user to interact easily with the pump while avoiding tension that could dislodge the infusion set. Lateral movement of the cannula may increase the risk of tubing kinking or detachment of a Teflon cannula. (241)

14.2 Inserting an infusion set

An infusion set may be inserted manually or with an automatic insertion device (which can be either reusable or disposable). The technique depends on the device used and the amount of subcutaneous tissue at the insertion site. With Teflon sets, a rapid single motion insertion lowers the risk of needle-angle kinking and may reduce insulin leakage. (164, 241-242)

Automatic insertion devices should be considered for patients with:

- Needle phobia
- Dexterity limitations
- Low vision
- Difficulty inserting into hard-to-reach areas
- Low confidence with manual insertion

Composition	Length	Angle of insertion
Steel	6-mm, 8-mm, 10-mm	Straight
Teflon	6-mm, 9-mm, 13-mm, 17-mm	Straight or angled
Pod/patch pumps	Automatic insertion of 50 degrees to a depth of 6.5-mm	

Table 1. Examples of cannulae and insertion.

14.0 Insulin infusions

14.3 Site selection and rotation

All patients should be instructed to perform manual insertion of an infusion set if an automatic insertion device is unavailable.

Insertion of a steel cannula offers more reliable infusion when inserted manually, as the risk of kinking is eliminated and insertion failure is reduced compared with Teflon cannula devices.

Site selection should be individualized. Many patients prefer to insert infusion sets in the abdomen or upper buttocks/thigh, as these areas are easily visible.

The same criteria used to select insulin injection sites should apply to infusion-set site selection. Proper infusion site selection minimizes the risk of insertion site reactions, lipodystrophy, and scar tissue formation, and promotes better insulin absorption.

1. The principles of insulin injection site rotation should also be applied to infusion sites.
2. All infusion set components (insulin reservoir and tubing) should be changed every 2-3 days (manufacturer recommendation), or sooner if glycemic control deteriorates.
3. Extended-wear infusion sets may be used for up to 7 days with compatible pumps and reservoirs and should be replaced sooner if hyperglycemia, site pain, leakage, or adhesion failure occurs.
4. Patch pumps can be placed in the same sites as infusion sets and may be appropriate for patients who have difficulty accessing harder-to-reach areas. Consideration should be given to proximity to skinfolds, where the patch may detach when users are in a bending or sleeping position or are performing regular daily activities. Refer to manufacturer recommendations regarding horizontal or vertical placement of the patch pump in relation to the body part.
5. Insulin infusion set changes prior to bedtime should be avoided. If needed, set an alarm 1-2 hours after a site change to check glucose levels.

14.0 Insulin infusions

14.4 Skin preparation

1 Skin hygiene education is a priority during pump training and should be reinforced at regular intervals. The risk of local bacterial infection is higher with pump therapy because the infusion set remains in place for 2-3 days. During this time, the insertion site can become warm and humid, encouraging bacterial growth. To aid in the prevention of skin infections, it is important that patients clean the infusion site prior to insertion of the insulin infusion set. Skin maintenance should also include proper adhesive removal, as residual adhesive that accumulates over time can be very harsh on the skin. (243)

2 The risk of infection and skin irritation from adhesive materials can be reduced with the use of antiseptic agents and protection of the site with a layer of protective material (e.g. bio-occlusive barrier, spray, or cream). (243) The material should be applied around the area of skin where the cannula is inserted, to prevent occlusion.

3 Insertion through barriers (such as adhesive dressings) remains controversial because the small amount of dressing material may increase the risk of occlusion; as such, this practice is not recommended.

4 To reduce infection risk, patients should inspect insertion sites daily. Signs of infection include pain, swelling, itching, redness, warmth, drainage (clear, cloudy, white, yellow, or bloody), unpleasant odour, and unexplained hyperglycemia.

5 Applications of lotions or cosmetics should be avoided near infusion sites because they can increase skin irritation. (243)

6 Products such as a transparent adhesive dressing may be used to improve adhesion. Patients who use protective barrier products may find their application helpful both prior to insertion and during removal of the insulin infusion set.

7 Frequent infusion set and cartridge changes may be required for patients who are prone to site irritation or infection, or those who require large volumes of insulin.

8 For patients with known skin sensitivities, adhesive patch trials are recommended prior to initiation of pump therapy.

9 Proactive skin care is essential for patch-pump users, as adhesive reactions to infusion sets and patch pumps are reported in roughly one-to two-thirds of users. If an adhesive reaction occurs, try changing the application site, switching to a different adhesive, using skin-barrier wipes or sprays to form a protective film that reduces irritation, and applying a topical corticosteroid as directed by a healthcare professional (if needed).

14.0
Insulin infusions

14.5 Insertion

1 Patients should wash their hands thoroughly with soap and water before inserting an infusion set and clean the insertion site with an antiseptic solution or soap and water. (133)

2 Patients should allow skin to air dry prior to inserting the infusion set or applying the patch pump.

3 Infusion sets must be inserted through healthy subcutaneous tissue.

4 Proper pump site rotation, along with avoiding sites affected by lipohypertrophy, helps maintain consistent insulin absorption and skin health.

5 When inserting Teflon infusion sets manually, a rapid, smooth motion should be used to reduce the risk of kinking.

6 When inserting sets into the torso, patients should be taught to stand and lean against something supportive like a wall during insertion and secure tubing with tape to help prevent accidental pull-outs.

7 There is presently a paucity of evidence regarding the stability of the infusion cannula of a patch pump and how well it adheres to the skin. Considerations regarding variability include the height and weight of the patch. (243)

8 To reduce redness, irritation, leakage, and localized bumps at the point of insertion (known colloquially as "pump bumps") from this movement, the tubing on an angled insulin infusion set can be anchored to the body with tape.

9 When priming the tubing of the pump, patients should ensure that the cannula is disconnected from the set to avoid an unintentional insulin bolus, which increases the risk of hypoglycemia.

10 Pain and discomfort at the insertion site may result from poor insertion technique, potential infection, the type of cannula material used, skin-related issues or site location.

14.0 Insulin infusions

14.6 Troubleshooting

1 **Unexplained Hyperglycemia**
Sudden unexplained hyperglycemia, particularly when accompanied by nausea or vomiting, should prompt assessment and insulin administration via an alternate source (e.g., insulin pen or syringe) (244-245) followed by an assessment of the infusion set, tubing, and insulin reservoir, with changes made if required.

Possible causes of unexplained hyperglycemia include leakage, air bubbles, blockage, or occlusion at the infusion site, missed bolus, incorrect time of infusion, empty reservoir, dislodged infusion site, or ignored alarms.

Insulin pumps infuse rapid-acting insulin only; therefore, diabetic ketoacidosis (DKA) can develop quickly (within hours) after infusion interruption. Patients and caregivers must understand the signs and symptoms of DKA and know how to respond.

2 **Silent Occlusion**
Silent occlusion is defined as an interruption in insulin flow that does not trigger a pump alarm and, therefore, remains unknown to the user. Silent occlusions are thought to occur before full occlusions do and are believed to be a cause of unexplained hyperglycemia. (245-246)

Factors that increase occlusion risk include:

- poor insertion technique
- incorrect infusion set selection
- incorrect insertion angle
- improper cannula placement
- insertion near fascia
- cannula degradation
- crystallization of insulin
- blockages from blood or tissue debris

Bubble formation is another potential cause of occlusion. Removing air bubbles from the reservoir should be a key step during infusion-set preparation. Insulin should be allowed to reach room temperature before filling the reservoir, as filling with cold, refrigerated insulin can contribute to bubble formation and may affect insulin delivery. (247)

3 **Lipohypertrophy**
Lipohypertrophy is the most common complication associated with insulin infusion sets. Prevalence estimates in children range from 26%-42% among insulin pump users. (245, 248) A recent study of adults with type 1 diabetes reported lipohypertrophy in 34% of pump users. (248)

In the presence of repeated and persistent unexplained hyperglycemia, patients should be counselled to perform self-monitoring of blood glucose more frequently and a review of their insertion habits should be completed at the next opportunity.

14.0 Insulin infusions

14.7 Special considerations

1 **Pediatrics**
When choosing an appropriate insulin infusion set and infusion site for infants and children, consider the amount of subcutaneous tissue available in the buttocks and abdomen.

Infants have a higher BMI and more subcutaneous tissue than preschool children (i.e., those between 2 and 6 years of age). School-aged children slowly gain subcutaneous tissue until they reach puberty. (247, 249-250) Hence, using the buttocks for infusion sets may be a more suitable infusion site than the abdomen in preschool children. Indeed, a recent study reported significantly lower glycemic variability with this method of insulin infusion versus infusion in the abdomen. (251)

2 **Pregnancy**
In the first trimester of pregnancy, a woman's normal infusion set and infusion sites are often adequate to maintain blood glucose control. In the second and third trimesters, as the abdominal tissue stretches, it may be necessary to move the infusion site to the lateral sides of the abdomen and adjust the angle of insertion. (252)

3 During pregnancy, the use of stainless-steel insulin infusion sets is advised, as they reduce the risk of hyperglycemia due to kinking. The angle of insertion may need to be adjusted to ensure that the set is secure and infusing into healthy tissue.

4 **Physical activity**
Active people who are at risk of infusion set dislodgement may consider a longer angled infusion set for increased security. (243)

If cannula kinking occurs in patients who have high muscle mass and low body fat, a steel cannula may be considered. (246, 254)

The infusion set should be secured firmly. Use adhesive-enhancing products and/or overlays as needed to minimize movement, prevent dislodgement, and reduce patient discomfort.

14.8 Education

1 Education and training for infusion-set users should be reinforced regularly, with routine assessment of infusion sites and insertion technique by both patients and healthcare providers.

2 Patients should be encouraged to try different infusion-set types to determine the most suitable option. Different body sites may be used to optimize comfort and performance.

3 Ongoing education is required for new technologies, insulin delivery systems, and devices.

4 Patients should be educated on site assessment and self-inspection, including lipohypertrophy prevention and skin care strategies.

15.0 Institutions

The safety of patients and healthcare professionals in our healthcare facilities can be ensured by promoting standardized procedures for injection and infusion therapy. (119)

Needlestick injuries are largely preventable with appropriate training and the use of safety equipment.

Consideration must also be given to the safe disposal of all injection and infusion devices to prevent downstream injuries to other healthcare providers. (122)

Administration is encouraged to develop a "safety culture" through reinforcement of staff training and increased awareness of best practices. (122, 131)

This section outlines institutional responsibilities for device use, sharps handling, and best-practice implementation.

15.1 Protecting healthcare professionals

1. Use safety-engineered devices (e.g., syringes or pen needles with automatic shielding mechanisms) for all injections to eliminate the need for recapping and significantly reduce needlestick injuries. Ensure staff input when choosing these devices and that training has been completed prior to their use. (117, 122, 255)
2. Ensure clear visibility and access to a sharps disposal unit before injection begins. Providers should never need to step away while holding an exposed needle. (121, 256)
3. The hub of the needle should be visible during the injection to observe that the device has discharged. (256)
4. Institutions should maintain a "no-blame" reporting system for needlestick injuries to encourage prompt reporting and follow-up. (131, 256)

15.2 Preventing cross-contamination

1. All injectable delivery systems must be single-patient use only. Syringes, pen needles, cartridges, and infusion devices must never be shared, regardless of partial use. (69, 73)
2. Injection devices and supplies must be stored, prepared, and handled in a manner that prevents contamination. Patients should never be injected with equipment that has been used or touched in another patient's environment. (109)

CLINICAL TIP

"One pen, one patient!"

15.0 Institutions

15.3 Injection procedure

1 Injection sites should be clean and free of infection, edema, bruising, scarring, or lipohypertrophy. (65, 81, 110)

2 The abdomen is the preferred site for injection. Rotation within sites is mandatory, with each injection a minimum of 2-3 cm apart. (119) The outer aspect of the arm is an alternate site for trained caregivers using a safety-engineered device.

3 Alcohol swabs may be used to clean the injection site. Cleaning the site with soap and water is an alternative. The skin should be thoroughly dry before injecting. (82, 119, 257, 258)

4 To avoid intramuscular injection, the use of shorter, safety-engineered pen needles (5-mm) or an angled injection (syringe only) is preferred over a skin lift to reduce the risk of needlestick injury. (85, 114, 119)

15.4 Institutional policies and procedures

1 All institutions should have an established education and training program to ensure standardized procedures are used for injections and/or infusions. (119, 257)

2 Written policies should identify safe injection practices, device selection, sharps disposal procedures, and workflow that reduces unnecessary risk. (260, 261)

3 All healthcare personnel involved in injections/infusions should be assessed on a regular basis for competency in injection technique, safe handling of injectable medications and devices, and prevention of lipohypertrophy. (131, 257, 259, 260)

4 Institutions are responsible for the development, implementation, and maintenance of a “safety culture” in injection technique. (202, 257, 260-262)

5 All institutions should have clear policies and procedures and established protocols for insulin pump management in the non-critical patient.

16.0 Best practice recommendations

16.1 Educational strategies

1 Early in diabetes management, healthcare professionals should engage patients in a collaborative, patient-centred conversation to discuss the potential use of injectable therapies. (20)

2 Assessment with the patient prior to the introduction of injectable therapy should include discussion of their type of diabetes, any physical or mental health limitations, and their support network. (263)

3 Clear, simple questions should be asked to understand the patient's perspective and preferences, such as: "What are your concerns regarding injections or infusions?" and "How do you prefer to learn?" (264)

4 A variety of teaching methods should be used, with an emphasis on experiential learning. Demonstration and teach-back methods should be included in the initial session. (24, 25, 100)

5 Ongoing feedback should be solicited to ensure that correct technique is being used and to support the patient. (25, 263)

6 All healthcare professionals involved in the use of injectable therapies should be up to date with the latest technology. (9, 23, 31)

7 All healthcare professionals involved in infusion therapy should be up to date with the latest technology, particularly the functionality of insulin pumps. Failure to understand pump mechanics may have serious consequences. (242-244, 256)

16.0 Best practice recommendations

16.2 Injection technique

1 Prepare patients regarding the need for injection therapy, provide appropriate education, and ensure regular assessment of injection sites and techniques.

2 To reduce the risk of lipohypertrophy, reinforce rotation of injection sites within all zones of an anatomical area. Teach this with an individualized, hands-on approach. Needle reuse should be discouraged.

3 Healthcare professionals should inspect and palpate injection sites for lumps at each visit, and patients should be educated on how to do it themselves.

4 The use of non-posted (contoured) pen needle designs may reduce the impact of unintended user pressure across a range of injection forces and subsequent inadvertent intramuscular injections, compared to conventional posted-hub pen needle devices of equivalent lengths. (86)

5 The abdomen (including the flanks, or sides of the waist) is the preferred injection area due to its consistent absorption and ease of injection. Areas of lipohypertrophy should be avoided. Use of the arm may be appropriate in some cases; however, in older adults, this site can be more difficult to access for self-injection and may require caregiver support.

6 Glycemic variability and poor glycemic control may be related to injection technique, including the use of excessive injection force.

7 If lipohypertrophy is identified, the affected site should be avoided for at least 3 months and not reused until it has been reassessed. Provide individualized guidance on site rotation, consider potential reductions in insulin dosage, increase glucose monitoring, and ensure ongoing assessment and follow-up.

8 The injection technique for GLP-1 receptor agonists is similar to that for insulin, with a few practical differences. Patients should avoid injecting GLP-1 receptor agonists into areas of lipohypertrophy.

9 Concentrated insulins are not available in vials; therefore, it is imperative that there is NO pen-to-syringe transfer, to avoid dosing errors. It is also important that none of the concentrated insulins be removed from the prefilled pen device for use in a syringe, pump, or other delivery device, to avoid potential overdose or hypoglycemia.

10 With respect to special populations:

- The lateral sides of the abdomen are the preferred injection sites for pregnant women.
- Safety is a primary consideration in the elderly population; cognitive and functional abilities should be assessed.
- Young children who self-inject, and older children and adolescents who are suspected of insulin under- or overdosing, should be closely supervised by a parent or caregiver.

11 Education about the functionality of insulin pumps is essential. Failure to understand pump mechanics may have serious consequences.

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Glossary

A1C (glycated hemoglobin) A blood test that reflects the average level of blood glucose over approximately the previous 2 to 3 months.

Adhesive reaction Skin irritation, redness, itching, or inflammation caused by adhesives used with infusion sets, patch pumps, or glucose monitoring devices.

Adipocyte A fat cell; insulin exposure and repeated local trauma may contribute to changes in adipocytes at injection sites.

Adipose tissue Body fat tissue located under the skin and around organs; in injection technique, this mainly refers to subcutaneous fat.

Automated insulin delivery (AID) An insulin delivery system that uses CGM data and a dosing algorithm to automatically adjust insulin delivery. See also: Closed-loop system.

Basal insulin Background insulin delivered continuously by a pump or provided by long-acting insulin to cover glucose needs between meals and overnight.

Blood glucose The concentration of glucose in the blood, usually expressed in millimoles per litre (mmol/L) in Canada.

Blood glucose targets The blood glucose range recommended by a diabetes healthcare professional to support safe and effective diabetes management.

Body mass index (BMI) A measure based on weight and height that is used to classify body size; lower BMI may increase the risk of intramuscular injection.

Bolus insulin A dose of rapid-acting insulin given to cover carbohydrate intake, correct hyperglycemia, or both.

Bruising Local skin discoloration caused by blood leaking into tissue after minor capillary injury at or near an injection or infusion site.

Cannula A small flexible or steel tube inserted under the skin to deliver insulin from an insulin pump or infusion set.

Closed-loop system (automated insulin delivery) An integrated insulin pump, continuous glucose monitoring system, and dosing algorithm that automatically adjusts insulin delivery based on glucose readings.

Cloudy insulin Insulin formulations such as NPH or premixed insulin that appear milky and must be gently resuspended before injection according to manufacturer instructions.

Concentrated insulin Insulin supplied at a concentration higher than U-100, allowing the same number of insulin units to be delivered in a smaller volume.

Continuous glucose monitoring (CGM) Use of a sensor inserted under the skin to measure glucose levels in interstitial fluid over time and display glucose trends.

Continuous subcutaneous insulin infusion (CSII) Insulin pump therapy in which rapid-acting insulin is delivered continuously into subcutaneous tissue through an infusion set or patch pump.

Cryotrauma Tissue irritation or injury caused by exposure to cold, such as injecting insulin before it has warmed to room temperature.

Dermis The skin layer beneath the epidermis that contains blood vessels, nerves, glands, and connective tissue.

Diabetes A metabolic disorder characterized by hyperglycemia due to impaired insulin secretion, impaired insulin action, or both.

Diabetic ketoacidosis (DKA) A serious and potentially life-threatening complication of diabetes that occurs when insufficient insulin leads to ketone production, hyperglycemia, dehydration, and metabolic acidosis.

Epidermis The outermost layer of the skin.

Flow check (priming) A step performed before dosing to confirm that medication flows correctly through the pen needle or infusion system and to remove air from the pathway.

GLP-1 receptor agonist A non-insulin injectable medication that mimics glucagon-like peptide-1 to help manage glucose, often by increasing glucose-dependent insulin secretion and slowing gastric emptying.

Glycemic variability The degree to which a person's blood glucose fluctuates between high and low levels.

Hypalgesia Reduced sensitivity to pain; lipohypertrophic areas may be less painful, encouraging repeated injection into affected tissue.

Hyperglycemia The presence of excessively high levels of glucose in the blood, which occurs when the body does not have enough insulin or cannot use insulin effectively.

Hypoglycemia An abnormally low concentration of glucose in the blood; in this document, hypoglycemia is defined as blood glucose below 4.0 mmol/L.

Incretin therapy Therapy that acts on incretin pathways, including GLP-1 receptor agonists, to help manage glucose levels.

Infusion set The tubing and cannula system that connects an insulin pump to the body and allows continuous insulin delivery into subcutaneous tissue.

Infusion site The area of the body where the cannula of an insulin pump or patch pump is inserted; proper rotation helps prevent irritation and lipohypertrophy.

Injection area (anatomical area) A broader body region suitable for injection, such as the abdomen, thighs, buttocks, or back of the arm.

Injection force The pressure applied when inserting or pressing an injection device; excessive force can indent the skin, increase bruising, and increase intramuscular injection risk.

Injection site The specific point where medication is inserted or injected.

Injection site rotation A structured system for moving injection sites so medication is not repeatedly injected into the same point, helping to prevent lipohypertrophy and support consistent absorption.

Injection zone A defined subdivision within an injection area, such as quadrants of the abdomen or halves of the thighs.

Insulin A hormone produced by the pancreas that helps regulate blood glucose by supporting glucose uptake into cells and storage as glycogen and fat.

Insulin analogues Modified forms of insulin designed to have specific absorption or action profiles while performing the same glucose-lowering role as insulin.

Insulin concentration The strength of insulin expressed as units per millilitre, such as U-100, U-200, U-300, or U-500.

Insulin pen A pen-shaped injection device that contains an insulin cartridge or prefilled reservoir and a dose-dialing mechanism.

Insulin pump A programmable device that delivers rapid-acting insulin continuously for basal needs and in bolus doses for meals or corrections through an infusion set or patch-pump cannula.

Intradermal injection Injection into the dermis rather than the subcutaneous fat layer; intradermal insulin injection can lead to unpredictable absorption, pain, or leakage.

Intramuscular injection Injection into muscle rather than subcutaneous tissue; for insulin, this may cause faster, less predictable absorption and increase hypoglycemia risk.

Kinking Bending or folding of a soft cannula or tubing that can interrupt insulin delivery.

Leakage Loss of medication from the injection site or needle tip after injection, which may occur if the needle is withdrawn too quickly or the dose is large.

Lipoatrophy The loss of subcutaneous fat from an area of the body, sometimes appearing as a depression in the skin.

Lipodystrophy A medical condition characterized by abnormal or degenerative changes in adipose tissue, including lipoatrophy and lipohypertrophy.

Lipohypertrophy A thickened, swollen, or rubbery area of subcutaneous fat tissue associated with repeated insulin injection or infusion into the same area.

Needle A hollow, pointed instrument used to deliver injectable medications. A pen needle includes a hollow needle embedded in a plastic hub that attaches to an injection pen.

Needle anxiety Fear, worry, or distress related to injections or needles that may interfere with starting or continuing injectable therapy.

Needle gauge A measure of needle diameter; a higher gauge number indicates a thinner needle.

Needle length The distance from the needle tip to the hub; shorter lengths can help reduce the risk of intramuscular injection.

Needle phobia A severe fear of needles that may cause significant distress or avoidance of needed injections or blood testing.

Needle reuse Using the same needle more than once; this can increase the risk of needle damage, discomfort, inaccurate dosing, and injection-site complications.

Needlestick injury (NSI) An injury caused by a used or exposed needle or sharp, which may create a risk of bloodborne pathogen exposure.

Non-posted/contoured pen needle A pen needle design with a shaped base that may reduce the impact of excessive user pressure during injection.

NPH insulin Intermediate-acting insulin that appears cloudy and must be gently resuspended before injection.

Occlusion A blockage or interruption of insulin flow through an infusion set, cannula, tubing, or pump system.

Open-loop control A pump and CGM system in which the user must make insulin dosing decisions rather than having the system automatically adjust insulin delivery.

Palpation Using the fingertips to feel the skin and subcutaneous tissue for changes such as lipohypertrophy.

Patch pump A tubeless insulin pump that adheres directly to the skin and delivers insulin through a subcutaneous cannula.

Pen needle A single-use needle that attaches to an injection pen to deliver insulin or another injectable medication.

Pharmacoadherence The extent to which a person uses medication as agreed with their healthcare team, including correct timing, dose, and technique.

Pharmacodynamics What a drug does to the body, including the intensity and duration of its effect.

Pharmacokinetics How a drug moves through the body, including absorption, distribution, metabolism, and elimination.

Premixed insulin A fixed combination of intermediate-acting and rapid- or short-acting insulin in one formulation.

Re-suspension The process of gently mixing cloudy insulin so the insulin particles are evenly distributed before injection.

Reservoir The container in an insulin pump that holds insulin before it is delivered through tubing and an infusion set.

Safety-engineered device (SED) A device with a built-in safety feature, such as automatic shielding, designed to reduce the risk of needlestick injury.

Sensor-augmented pump (SAP) An insulin pump used with a CGM sensor that may provide alerts or suspend insulin delivery based on glucose data.

Sharps Needles, lancets, syringes, infusion-set introducers, and other items that can puncture skin.

Sharps container A puncture-resistant container used for the safe disposal of used needles and other sharps.

Silent occlusion An interruption in insulin flow that does not trigger a pump alarm and may lead to unexplained hyperglycemia.

Skin lift A manoeuvre in which skin and subcutaneous tissue are gently lifted between the thumb and finger to reduce the risk of intramuscular injection.

Steel cannula A metal cannula used in some infusion sets; it is less likely to kink than a soft Teflon cannula.

Subcutaneous injection Injection into the fat layer beneath the skin rather than into the dermis or muscle.

Subcutaneous tissue The tissue layer beneath the dermis that contains fat and connective tissue; this is the intended delivery layer for most insulin injections.

Teach-back A teaching method in which the patient demonstrates or explains the technique back to the healthcare professional to confirm understanding.

Teflon cannula A soft, flexible cannula used in many infusion sets; it may be inserted straight or at an angle and can kink in some situations.

Tubing The flexible line that connects a tubed insulin pump to the infusion set.

Ultrasound An imaging method that uses sound waves to visualize tissue; it can help detect deeper lipohypertrophic lesions.

Unexplained hyperglycemia High blood glucose without an obvious cause, which may indicate missed insulin, injection-site problems, infusion-set failure, occlusion, or pump malfunction.



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