



REVIEW

Optimising Insulin Injection Techniques to Improve Diabetes Outcomes

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ABSTRACT

The effectiveness of therapy in patients with diabetes depends on the correct use of the insulin injection technique. However, despite many established recommendations and evidence that an effective insulin injection technique is essential to improve glycaemic control and minimise the risk associated with diabetes, there is still a need to identify impediments to the insulin injection technique among patients and create awareness among patients and healthcare professionals about the importance

of the optimisation of insulin injection techniques. This review focuses on the recent advancements in delivery devices, insulin injection technique teaching methods, monitoring, and complication management and highlights regional best practices and recommendations for optimising injection techniques to improve diabetes outcomes.

Keywords: Asia–Pacific; Diabetes; Injection technique; Insulin; Insulin needles; Lipohypertrophy

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Key Summary Points

Despite well-established guidelines being in place and evidence that a proper insulin injection technique is crucial for better glucose control and reducing diabetes risks, there is still a need to recognise barriers to a proper technique among patients and to raise awareness among both patients and healthcare providers about the importance of optimizing insulin injection techniques.

The use of short and thin needles in insulin injections has been demonstrated to improve the insulin injection technique by decreasing the amount of pain experienced during the injection process, reducing the likelihood of intramuscular injection, and improving the rate and completeness of insulin absorption.

Re-education and training of patients has been shown to be an effective method to improve the insulin injection technique, resulting in better glycaemic control, increased adherence, a reduced risk of lipohypertrophy, and improved patient outcomes.

Stakeholders in insulin therapy, including diabetes educators and healthcare providers, play a crucial role in patient education. A physician's goal should be to educate patients with diabetes and their caregivers on the safe handling and use of injectables, proper injection techniques, and cost-effectiveness to ensure they have the necessary knowledge and skills.

The implementation of comprehensive insulin stewardship programs in healthcare facilities such as hospitals, wards, and intensive care units is crucial in ensuring safe and effective insulin usage by establishing standard procedures and reducing the risk of improper insulin prescription and administration.

AWARENESS AND THE NEED TO IMPROVE INJECTION TECHNIQUES IN DIABETES MANAGEMENT

Diabetes is a major health issue with high prevalence worldwide. Around 537 million adults between the ages of 20 years and 79 years are estimated to have diabetes [1]. Patients with diabetes account for 10.5% of the world's population [1]. Insulin therapy is an important aspect of type 1 and type 2 diabetes management [2]. As insulin injection procedures are operator dependent, a thorough understanding of injection techniques is critical for healthcare professionals (HCPs) and patients to achieve a desirable outcome in patients with diabetes [3].

The use of pen injection devices for daily self-administered insulin injections is well established and commonly used in the treatment of diabetes. Patients consider pen injection devices to be more convenient compared to using a syringe to dispense insulin from a vial [4]. Physicians must be informed that proper injection practice is an aspect of improving glycaemic control in patients. In addition to managing uncontrolled diabetes and its repercussions, nursing staff and physicians also deal with a lack of knowledge and time spent on improving the insulin injection technique [5].

Insulin injection technique recommendations include findings from the Forum For Injection Technique (FITTER) Injection Technique Questionnaire (ITQ), one of the biggest worldwide surveys of its kind [6]. Results from this survey indicated suboptimal knowledge and poor insulin injection skills among patients with diabetes [6]. The lack of knowledge, expertise, and practice associated with insulin administration strategies among patients with diabetes may contribute to erratic insulin absorption and increased therapy costs [6, 7]. This survey served as the basis for numerous recommendations made by various diabetes groups.

Despite many established recommendations and evidence that an effective insulin injection technique is essential to improve glycaemic control and minimise the risk associated with

diabetes, there is still a need to identify impediments in the insulin injection technique among patients and create awareness among patients and HCPs about the importance of the optimisation of insulin injection techniques.

This review focuses on the recent advancements in delivery devices, insulin injection technique teaching methods, monitoring, and complication management and highlights regional best practices and recommendations for optimising injection techniques to improve diabetes outcomes. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

IMPROVEMENT IN DELIVERY DEVICES AND ANCILLARY DEVICES

There have been rapid advances in insulin delivery devices in the past decade. The emergence of hybrid closed-loop systems, the incorporation of consumer electronics, and the use of cloud-based data platforms have accelerated diabetes technology advancement, which began with the insulin syringe and evolved to insulin pens, insulin pumps, and sensor-augmented pumps [8].

VIALS AND SYRINGES

Insulin was initially delivered using heavy reusable syringes with long, large-bore needles that needed to be disinfected by boiling to enable efficient reuse [8]. In 1924, Becton Dickinson (BD) manufactured the first specialised syringe for insulin injection, which was followed by the launch of the “Novo Syringe” by Novo Nordisk in 1925. The patented innovation of the Luer lock fit for hypodermic needles significantly decreased syringe disengagement during injection, leading to the development of disposable Luer lock syringes [9, 10].

One-millilitre Luer lock syringes with detachable or permanently attached needles were introduced by BD in the 1960s, and were associated with less pain and a reduced risk of needle-related infections [8]. In 2012, a less

painful BD Veo insulin syringe with an ultra-fine 6-mm needle was introduced, which presented a lower risk of intramuscular injections and a decreased plunger force to improve the flow of high insulin doses [8]. Even though the demand for the “conventional” syringe technology has decreased in recent times, vials and syringes were the only choices for insulin delivery for more than five decades [8].

PENS AND NEEDLES

Insulin pens provide several advantages over conventional vial and syringe injections, including ease of use, particularly for individuals with eyesight or motor dexterity issues, and discretion of use (Table 1) [11–14]. Attachment of pen needles is required for injecting insulin with pen devices, and this provides a more convenient injection experience [15].

Pen needles have become shorter and thinner over the years [4]. Needles of a smaller bore size and shorter lengths (3.5–4.0 mm) are currently used instead of long, large-bore-sized, reusable needles for insulin injection [8, 16, 17]. The advantages of short, fine-gauge needles over longer needles have been reported in a series of clinical trials, specifically for quality-of-life metrics, such as decreased pain and increased patient preference [17, 18]. In a clinical study on injection experience conducted among patients with type 1 or type 2 diabetes mellitus, pen needles with extra-thin walls were most favoured as they require less time and thumb force to inject and offer higher confidence that a full dosage has been administered compared to traditional pen needles [15].

The safety and efficacy of the 4-mm pen needle have been assessed and proven in several clinical trials in adults and children, as well as in obese and nonobese adults with diabetes [5, 19]. Furthermore, the 4-mm pen needle has been recommended for use in most adult patients of all sizes where the lifting of a skin fold is not required (Fig. 1) [20]. The scientific literature on pen needle length for enhancing insulin delivery from the perspective of the skin thickness and subcutaneous tissue layers has been reviewed and acknowledged by current medical

Table 1 The advantages and disadvantages of insulin delivery devices

	Advantages	Disadvantages
Vials and syringes	<ul style="list-style-type: none"> • Allow the mixing of two different types of insulin • More affordable than pens and needles^a 	<ul style="list-style-type: none"> • Inconvenient to use and carry • Increased pain during injection compared to pens • May not be suitable for individuals with impaired vision or dexterity
Pens and needles	<ul style="list-style-type: none"> • Greater convenience to use and carry • A suitable option for individuals with impaired vision or dexterity • Allows for more accurate dosing compared to syringes 	<ul style="list-style-type: none"> • Does not facilitate the mixing of two different types of insulin^b • More expensive than a syringe^a

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^aFinancial budget and/or insurance coverage may be the deciding factor when choosing between pens and vial and syringe

^bSome insulin pens come with premixed insulin

association guidelines, which noted that current evidence supports the effectiveness and acceptability of short needles for subcutaneous tissue insulin [17, 21].

Initially, needle length was determined by local practices or economic considerations, or,

at best, based on the patient's physical assessment [5]. However, studies employing ultrasonography to examine the skin and subcutaneous tissue anatomy have offered accurate data on patients with diabetes, making needle length selection more evidence based [22].

A more recent innovation is the redesign of the needle hub, which is located at the needle shaft (cannula) base and connects the needle to an insulin pen [17]. This redesign was prompted by studies on people and animal models which revealed that the differences in injection depth correlated to the variations in the force applied to the skin during injections [17]. To reduce the effects of varying the injection force, the redesigned hub design distributes insertion forces over a contoured and bigger surface area [17].

The re-engineered hub design of the BD Nano PRO needle was found to precisely accomplish the 4-mm target needle penetration depth with noticeably less variability than commercial posted-hub pen needle devices over the varied range of applied injection forces [23]. The BD Nano PRO needle was rated less painful and more comfortable, associated with better ease of administration, and overall preferred by patients compared to other pen needles of a similar gauge and length [16].

IMPROVEMENT IN TEACHING METHODS

Despite significant advancements in technology and therapy over the last decade, insulin injection techniques among patients have not improved [24]. Standardised and proper injection techniques should be adhered to, as they have been associated with improved outcomes in patients with diabetes [25, 26]. A proper injection technique is defined as the technique that successfully delivers the drug into the subcutaneous area with minimal pain and no leakage [24, 27]. A good technique includes proper injection site rotation and not injecting into lipohypertrophic areas [18]. However, according to an ITQ survey, nearly 50% of patients have or have had symptoms that suggest lipohypertrophy (LH), and 21% of patients

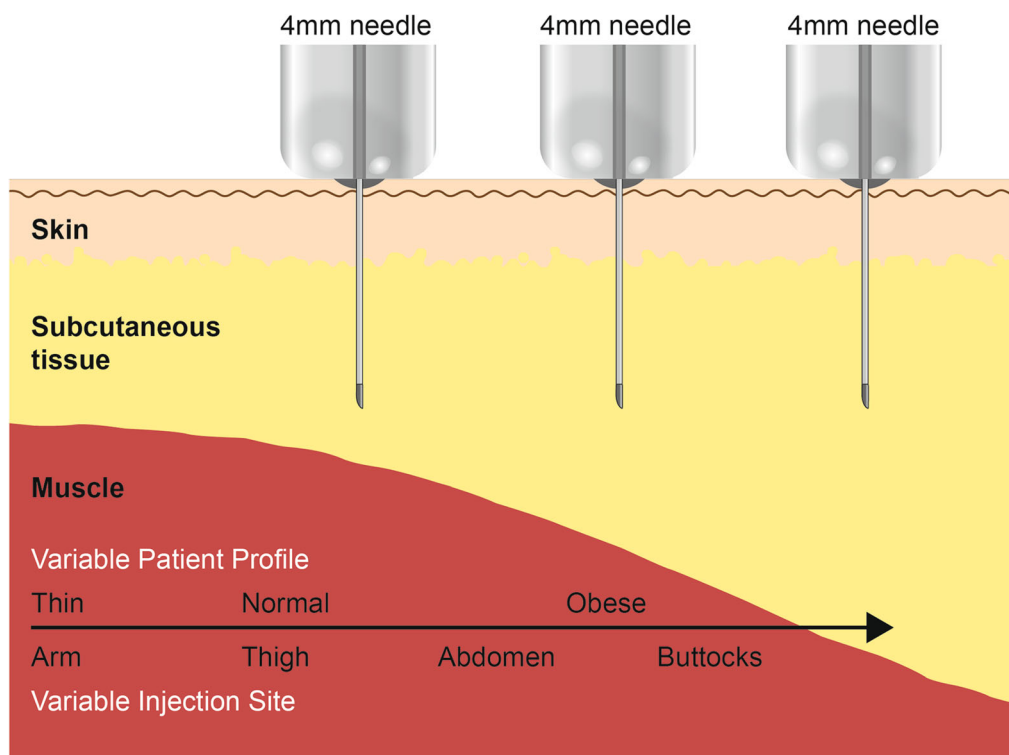


Fig. 1 The use of a 4-mm needle is appropriate for subcutaneous injections at all injection sites

reported repeating a whole day or even a few days of daily injections at the same spot [28]. Furthermore, 26% of respondents reported that they have occasionally injected insulin into lipohypertrophic sites [28].

In response to the lack of proper knowledge and clear recommendations on insulin injection techniques, an international group of 183 nurses, diabetes educators, and HCPs from 54 countries gathered in 2015 to present practical and thorough recommendations for diabetes injections and infusions [21]. Regional, evidence-based recommendations for diabetes injections have been developed in many countries [12, 29].

Individualised injection technique training has been associated with better glycaemic control, increased therapeutic satisfaction, adherence, improved injection techniques, and possibly a lower consumption of insulin [24, 26]. In a study evaluating the effectiveness of the re-education of 87 insulin-treated patients with diabetes on the insulin injection technique, re-education was performed once a

month for approximately 4 months. This led to a significant improvement in glycaemic control and a reduction in HbA_{1c} levels ($p < 0.01$), particularly in those who had poor knowledge of the procedure before re-education [30]. This observation was further supported by a recent survey conducted among 158 patients with type 2 diabetes mellitus, which reported that insulin-treated patients with diabetes require intensive educational refresher courses at 3-month intervals at least. Compared to patients who were left unsupported, patients who received a second follow-up of comprehensive injection-technique-specific education maintained the good results achieved after the initial 6 months of educational intervention [31].

According to the most recent ITQ study, patients who received injection technique guidance from their HCP within the last 6 months were more likely to successfully conduct site rotation [21]. Despite injecting for an average of 9 years, less than 40% of patients surveyed reported receiving injection instructions in the past 6 months, and 10% had never

received training on correct injection techniques [21]. Studies have indicated that the use of proper injection techniques by patients, such as the proper rotation of injection sites, using a new needle with each injection, and switching to shorter needles, facilitates good glycaemic control and decreased rates of LH [5, 12, 20, 22, 32]. Liang et al. recently developed a series of training methods that employ simulation tools to provide patients with an opportunity to practise injecting techniques. The use of these simulation tools, coupled with administration videos and manuals (which form the standard procedure used to train patients with diabetes on insulin injection), significantly improved the insulin injection skills of patients and eased patients' fear of injection [25]. As this educational method is both economical and easily adaptable, it may be utilised outside of hospitals in developing nations to help patients learn more about proper insulin injection techniques.

Figure 2 illustrates an optimal sequence for the insulin injection technique, which can be easily adopted by both patients and HCPs to minimise the associated risks [12].

IMPROVEMENT IN INJECTION TECHNIQUE COMPLICATION MANAGEMENT

Implementing correct injection techniques and providing structured education on the technique play an important role in decreasing skin complications, including LH, insulin-derived amyloidosis (IDA), local inflammation, bruising, and subsequent hypoglycaemia [31]. LH manifests as an abnormal build-up of fat under the skin surface and is associated with recurrent trauma related to performing frequent or daily insulin injections at the same site [33]. The prevalence of LH has been reported to be 38% in insulin-treated patients according to a recent meta-analysis [34].

Risk factors associated with the development of LH include the reuse of needles, site rotation frequency, duration of insulin treatment, high doses of insulin, glycaemic control issues, and a lack of patient education [24, 33]. Insulin

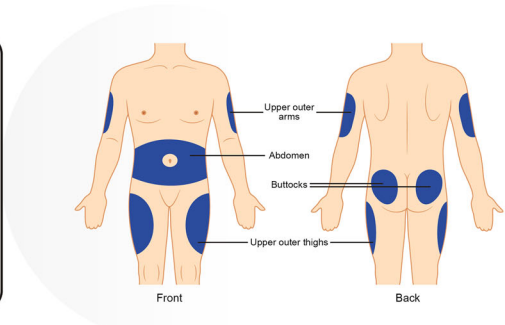
Fig. 2 Optimal injection technique sequence. *IM* intramuscular. Adapted with permission from [12] (released under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0))

injections into LH lesions can result in an erratic increase in insulin dose and, as a result, the patient may incur greater costs [35]. When insulin analogues were used instead of human insulin, the risk of LH in patients receiving numerous daily insulin injections was lower [36]. LH prevention should be a priority for physicians. Visual and physical examinations are crucial to detect abnormalities at the injection site. Patients should also be educated on how to inspect and recognise LH at injection sites [24].

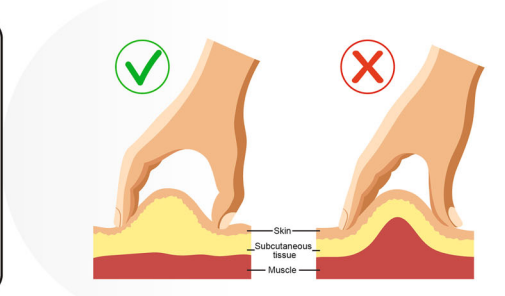
A complication of insulin treatment that affects the skin is called IDA, a nodular form of the disease [37, 38]. The insulin-derived amyloid fibril protein creates deposits of amyloid at the sites of insulin injection [39]. Despite the lack of actual prevalence data, IDA may be mistaken for LH in insulin-treated patients [38]. As the insulin absorption at the IDA site is remarkably reduced compared to that at the normal site [39], IDA causes poor glycaemic control and increased insulin dose requirements [37, 39]. Additionally, IDA results in hypoglycaemia due to the delivery of an increased dose of insulin into normal sites [39]. Therefore, it is necessary to reduce the dose of insulin when alternating the insulin injection site from the IDA site to the normal site [3, 39]. Recently, cases of IDA without a palpable mass have been reported [40]. In these cases, differentiating between IDA and LH by physical examination is difficult, and imaging studies, such as magnetic resonance imaging (MRI) and ultrasound, are necessary. Long-term, recurrent, same-site insulin injection is regarded as the most significant risk factor for developing IDA [38, 39]. To prevent IDA, it is important to educate patients about proper injection site rotation as well as ways to prevent LH [3].

The patient's injection site rotation scheme should be reviewed by HCPs at least once annually [12]. An effective and widely used rotation scheme involves dividing the

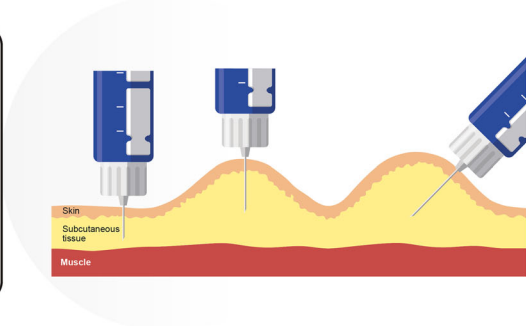
1 It is important to choose the right injection site. Typically, the abdomen, thighs, and buttocks are the most common sites due to their consistent absorption rates. It is not advisable to utilize the upper arm and lower leg regions as access to the correct zone may be limited and the lower thickness of subcutaneous fat in these regions may increase the risk of IM injection



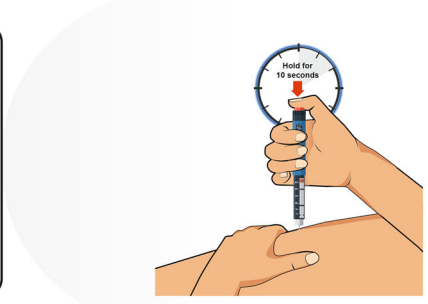
2 If required, it is essential to lift a fold of skin. This involves gently lifting the skin and the underlying subcutaneous tissue, or fatty layer between the thumb and index finger, while leaving the muscle untouched.



3 Insert the needle at a 90° angle into the skin. For patients with a lean build, combined use of lifted skin fold and angled insertion may be done. Avoid indenting the skin while injecting to prevent the needle from penetrating the muscle.



4 Inject insulin gradually and withdraw the syringe needle at the same angle. Keep the needle under the skin for at least 10 seconds after pressing the plunger.



5 Once done, discard the used needle safely.



injection site into quadrants for the abdomen or halves for the thighs, buttocks, and arms. The patient should use one quadrant or half per week and then switch to another quadrant or half, either clockwise or anticlockwise, the following week [12]. It is recommended that the new insulin injection site be at least 1–2 cm away from the previous injection site [12].

Gentile et al. defined a structured palpation technique that allows HCPs to detect skin LH lesions in insulin-treated patients with diabetes [41]. After undergoing specialised training involving repeated and well-codified palpation manoeuvres, inexperienced HCPs were able to quickly procure diagnostic accuracy in identifying LH lesions regardless of the site, size, and BMI [41]. However, the palpation method is not always feasible and is likely insufficient to detect LH, particularly in individuals who need high-dose insulin to manage hyperglycaemia [42]. Superficial subcutaneous ultrasonography would be a suitable method to assess the existence of LH [42].

In a study, Wang et al. reported how the management of LH was affected by ultrasound evaluation and intense injection technique training [43]. The results of the study revealed that a combination of ultrasound examination and intensive injection technique education considerably lowered seven-point glucose control and the occurrence of adverse blood glucose events without increasing the insulin dosage [43]. Ultrasound examination offers higher sensitivity and specificity compared to physical evaluation, particularly in the case of LH lesions without visible or palpable changes [43]. Furthermore, ultrasound examination provides a precise way to measure the subcutaneous fat thickness to select optimal injection sites for patients with diabetes who have concerns related to LH [43].

IMPROVEMENT IN INJECTION TECHNIQUE MONITORING

Through connected devices, software, and applications, recent advancements in digital health technologies can address the fundamental challenges associated with blood

glucose control in diabetes care [44]. Smart pens have progressed over the last decade from traditional insulin pens in terms of functionality, and they have the potential to facilitate the use of optimal doses of insulin and improve diabetes management by offering automated storing and transmission of insulin dosing data, which can assist physicians in promoting patient-administered self-care [44, 45].

The data recorded and stored by smart pens on the amount and timing of insulin injections allow patients to obtain an accurate overview of their insulin-related data and provide downloadable reports to their HCP [44, 45]. Furthermore, the insulin dosing data from smart pens may be combined with glucose data from continuous glucose monitoring to provide patients with a better understanding of how insulin doses affect glucose levels and thereby allow better dosing decisions [45]. To encourage the usage of smart pens, patients and HCPs must be educated on the benefits of smart pens and provided with recommendations on how to use the technology, evaluate data, and execute suitable treatment strategies [45].

Table 2 Aspects of insulin stewardship (Reproduced from [48])

Insulin inventory	<ul style="list-style-type: none"> • Preparation/trade name • Strength • Delivery device
Insulin initiation	<ul style="list-style-type: none"> • Prescription • Counselling/motivation • Injection technique
Insulin monitoring	<ul style="list-style-type: none"> • Glucose monitoring • Hypoglycaemia awareness • Titration regimen
Insulin safety	<ul style="list-style-type: none"> • Injection technique for nursing/medical professionals • Disposal • Troubleshooting for needle stick injuries

Table 3 Summary of key improvements and recommendations for the discussed insulin injection technique

Category	Improvements
Needle length [8, 16, 17, 20, 21, 49]	<ul style="list-style-type: none"> • Initial insulin therapy should begin with small needles • Adult patients can utilise shorter needles regardless of their size or weight, and, in most cases, there is no need to lift the skin fold (specifically 4-mm needles)
Teaching methods/education [5, 12, 20, 22, 32, 49]	<ul style="list-style-type: none"> • An intensive re-education programme on injection techniques at least every 3 months is recommended for patients with diabetes • Patient should be taught not to inject into sites of LH, stop needle reuse, and follow an easy-to-follow rotation structure from the onset of injection therapy • Training methods utilising simulation tools, coupled with operating videos and manuals, may provide patients with an opportunity to practise injecting abilities
Lipohypertrophy [24, 36, 49]	<ul style="list-style-type: none"> • The use of purified human insulin or analogues is the best strategy to reduce the risk of LH in patients receiving numerous insulin injections daily • Patients should also be educated on how to self-inspect and recognise LH at injection sites • In the case of LH lesions without visible or palpable changes, an ultrasound examination may offer higher sensitivity and specificity compared to a physical evaluation
Insulin-derived amyloidosis [37–40]	<ul style="list-style-type: none"> • IDA may be confused with LH in insulin-treated patients • Long-term, recurrent, same-site insulin injection is regarded to be the most significant risk factor for developing IDA • It is necessary to lower the insulin dose when alternating the insulin injection site from the IDA site to the normal site to prevent hypoglycaemia
Monitoring [44, 45, 47, 48]	<ul style="list-style-type: none"> • Smart pens • Self-examination of the insulin injection site (SelfIE) • Insulin stewardship programme

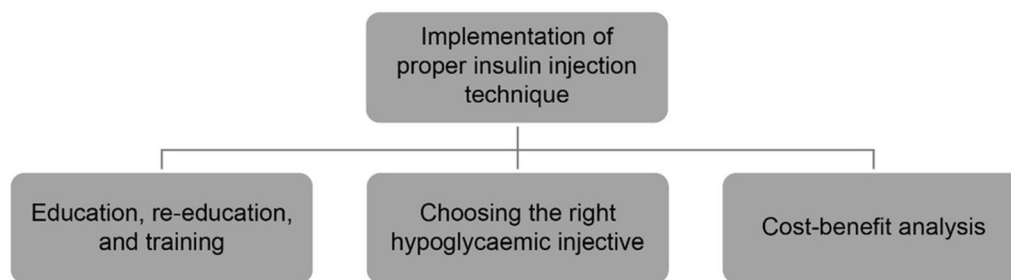


Fig. 3 Key aspects in the implementation of a safe insulin injection technique

Table 4 Regional best practices and recommendations for improving injection techniques

Bangladesh	<p>The Diabetic Association of Bangladesh (BADAS) has implemented the following for improving insulin injection techniques:</p> <ul style="list-style-type: none"> • Providing training modules, guidebooks, animation videos, and leaflets with pictorial instructions on insulin injection techniques to patients, physicians, nurses, health educators, and paramedics • Hands-on training classes for patients on injection technique with dummy pens • “Train the Trainer” program on insulin injection techniques for diabetes educators, doctors, and nurses • Continuous training, re-education, and evaluation of the diabetes educator and patients with diabetes
Korea	<ul style="list-style-type: none"> • Training patients on injection techniques using visual aids, such as photos and/or illustrations • Providing patients with video clips/URLs after insulin injection training so that they can revisit the videos • Evaluating patients regularly using the correct insulin injection technique checklist
India	<ul style="list-style-type: none"> • Each year Forum for Injection Technique (FIT) India’s focus has been to expand further on critical aspects of the insulin injection technique, such as covering special populations (pregnancy, dermatological disease, surgical disease), the insulin pump infusion technique, the injection mealtime interval, methods of minimising pain during injections, amyloidosis, and therapy adherence and insulin use in indoor settings • In the last decade, FITTER India has spearheaded many initiatives aimed at improving and upgrading insulin injection technique recommendations. 11 January was established as Insulin Injection Day • The FITTER India recommendations were published in 2017 [12] and continue to promote best practices in injection technique by (i) training HCPs and patients (since 2012, FITTER India has trained > 300,000 HCPs and > 400,000 patients with diabetes on the correct insulin injection technique), (ii) having publications in leading national journals and India ITQ data in international journals [51, 52], and (iii) conducting media awareness meetings every insulin injection month in January • In 2020, FITTER India launched its educational initiative IGNITE, “Insulin optimization Guidelines “N” Injection Technique Expertise”, with the purpose of sensitising physicians at the early stage of their practice around optimising the insulin injection technique and its impact on glycaemic control. Eight IGNITE webinars have been conducted across India in partnership with reputed medical institutions and led by FITTER members and eminent national speakers in the fields of endocrinology and diabetology, training over 700 physicians in medical colleges and private institutions. This has helped establish in-depth knowledge on the impact of the correct injection technique in insulin therapy among physicians at an early stage of their trainings

Table 4 continued

Indonesia	<ul style="list-style-type: none"> • Improving the awareness and skills of HCPs through a continuing training program with hands-on workshops • The Indonesian Nutrition Association has implemented training for nutritionists on educating patients about injection techniques • Providing leaflets with instructions for insulin-using patients to pharmacies, hospital pharmacies, or other healthcare facilities) • Providing patients with a pre-insulin injection checklist on the location of the injection, rotation, and checking for the possibility of LH, scars, and infections • Encouraging group discussion among patients who use insulin periodically at the hospital or other health facilities • Ensuring that injection technique education is implemented in government healthcare facilities through subsidies, monitoring, and evaluation. The initiative also includes reimbursement policies for insulin and supplementary medical devices (pen needle, glucometer, and strips)
Vietnam	<ul style="list-style-type: none"> • Providing training modules, guidebooks, animation videos, and leaflets with pictorial instructions on insulin injection techniques to patients, physicians, nurses, health educators, and paramedics • Providing training programs on insulin injection techniques for diabetes educators, doctors, and nurses • Setting up Facebook groups for patients on insulin to educate patients on insulin classification, injection techniques, and common mistakes in insulin treatment
Japan	<ul style="list-style-type: none"> • As repeated insulin injections into the same site may cause IDA or LH, HCPs should observe the injection site regularly • Patients are instructed to follow proper injection technique points: (i) the injection site of insulin should be at least 2–3 cm away from the previous injection site; (ii) if a mass or induration is found at the injection site, avoid injecting insulin into that site; and (iii) check for a mass or induration at the injection site if poor glycaemic control is observed, and take appropriate measures such as changing the injection site and adjusting the dose

Additionally, the increasing prevalence of insulin regimens, preparations, and delivery methods raises the possibility of injection technique errors. This may jeopardise patient safety and well-being. Self-examination of the insulin injection site (SelfIE) is an important aspect of injection technique monitoring, as it may aid in the early detection of skin complications (such as LH) and unfavourable variability in glucose levels and may help to avoid excessive insulin use [46]. The development of an insulin strategy tailored to each intensive care unit or ward can enhance indoor glycaemic control and lower professional hazards associated with insulin injection. Kalra et al.

suggested that the initiation of complete insulin stewardship programmes in hospitals, wards, and intensive care units to address all elements of safe and rational insulin usage. Insulin stewardship programmes will establish standard operating procedures for choosing insulin regimens, preparations, and delivery devices, and will reduce the possibility of inappropriate insulin prescription and administration (Table 2) [47, 48]. Table 3 provides a summary of the key improvements and recommendations for the insulin injection technique discussed here.

CALL FOR ACTION

Consistent implementation of programmes involving patient education and re-education is needed to resolve issues associated with suboptimal insulin injection techniques. All stakeholders in insulin therapy should be included, particularly diabetes educators and HCPs, as they are at the forefront of patient education [49]. One of the physician's goals should be to ensure that patients with diabetes and their caregivers have the necessary knowledge and skills for the safe handling and use of injectables and the proper application of injection techniques and are fully informed on the anticipated cost savings. This will ensure that the complete therapeutic potential of insulin therapy can be achieved in patients with diabetes [21, 49, 50]. Figure 3 illustrates the key elements involved in implementing a safe technique for administering insulin injections.

BEST PRACTICES

Table 4 highlights regional best practices and suggestions by authors for enhancing injection methods.

CONCLUSION

An optimal insulin injection technique helps to avoid intradermal or intramuscular injections and ensures efficient insulin delivery to the subcutaneous tissue. Improving the insulin injection technique necessitates the involvement of all key stakeholders in insulin therapy, including diabetes educators and/or nurses, doctors, patients, and manufacturers of needles and devices. However, clear local recommendations for diabetes educators and HCPs are needed so that they may educate patients on how to self-manage their insulin administration. Adherence to recommendations regarding insulin injection techniques may allow patients with diabetes to optimise insulin therapy, experience better outcomes, and incur lower costs.

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Declarations

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Ethical Approval. This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

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