Assessment of Insulin Injection Techniques among Diabetic Patients: in Hospital Setiu, Terengganu

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Abstract

Introduction: The effectiveness of insulin therapy in diabetic patients depends on proper administration of insulin to improve glycaemic control and minimise diabetes complications.

Objective: This study aimed to determine the prevalence of poor insulin injection technique among diabetic patients in Hospital Setiu, Terengganu and to identify common errors in insulin administration.

Methods: A cross-sectional study was conducted among inpatients and outpatients at Hospital Setiu from August to December 2023. Patients who were on insulin therapy and had previously received counselling on insulin administration were recruited using convenience sampling. Patients' insulin injection technique was assessed through in-person interviews and practical demonstrations using a structured checklist comprising 16 dichotomous (correct / incorrect) items. A total score of less than 14 indicated poor technique, while a score of 14 and above was considered good insulin injection technique.

Results: A total of 63 patients were enrolled in the study, with a median age of 57 years [interquartile range (IQR): 17]. The majority were male (58.7%) and 46.0% had attained secondary education. The median duration of insulin therapy was 4 years (IQR: 7). Overall, 12.7% of patients (n=8) exhibited poor insulin injection technique. The most common errors observed were failure to replace and unscrew the outer needle cap (n=14, 22.2%) and the failure to adequately mix the insulin by rolling the cartridge between the palms or inverting it (n=12, 19.0%).

Conclusion: While only a small proportion of diabetic patients in this study demonstrated poor insulin injection techniques, specific errors were consistently identified. These commonly observed incorrect techniques should be given particular emphasis during counselling and dispensing sessions by pharmacists to optimise insulin administration and improve clinical outcomes.

Keywords: Assessment of errors, insulin injection technique, diabetic patients

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Introduction

Diabetes mellitus is a chronic metabolic disorder characterised by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both (1). In Malaysia, diabetes poses a substantial burden on healthcare resources and socioeconomic development. National surveys have demonstrated a rising prevalence over the past decade, increasing from 11.2% in 2011, 13.4% in 2015 and peaking at 18.3% in 2019, before showing a slight decline to 15.6% in 2023 (2). Despite this recent reduction, the overall prevalence remains alarmingly high, underscoring the need for continued efforts in prevention and optimal disease management.

Insulin therapy is an essential treatment in the management of diabetes. Patients with Type 1 Diabetes Mellitus (T1DM) require lifelong insulin, while most individuals with Type 2 Diabetes Mellitus (T2DM) may eventually need insulin treatment due to progressive pancreatic beta cell (β cell) dysfunction and declining endogenous insulin secretion (3). As the glycaemic control becomes more difficult to achieve, insulin therapy is typically initiated when oral hypoglycaemic agents fail to maintain target glycaemic levels (4). However, the effectiveness of insulin therapy among diabetic patients depends not only on the pharmacological properties of insulin but also on proper administration

techniques. Correct insulin injection technique ensures accurate dosing and appropriate delivery into the subcutaneous tissue, which is essential for optimal absorption and glycaemic control (4). Poor injection practices may result in unpredictable insulin absorption, leading to hyperglycaemia, hypoglycaemia, lipohypertrophy, and other injection-related complications. In addition, achieving and maintaining optimal glycaemic control is crucial in preventing microvascular and macrovascular complications, thereby improving long-term clinical outcomes and quality of life (5).

Improper insulin injection technique represents a common yet modifiable factor contributing to poor glycaemic control (6). Despite the availability of educational resources, inappropriate practices remain prevalent. A study conducted in a semi-urban health clinic in Selangor, Malaysia, found that 86.8% of the participants demonstrated inappropriate insulin injection techniques (7). Similarly, a study at Teluk Intan Hospital in Perak showed that only 5.1% from 137 participants exhibited good understanding and practice regarding insulin injection (8). International evidence further supports this concern. A study conducted in Iran found that none of the 301 surveyed patients fully adhered to the recommended injection guidelines, leading to complications such as hyperglycaemia, elevated HbA1c levels, lipohypertrophy, and injection-related pain (9). Collectively, these findings highlight that improper insulin injection technique can lead to significant clinical complications, underscoring the need for targeted and timely interventions to address this issue.

Educational interventions, particularly those involving regular counselling by pharmacists, have shown beneficial effects (7). Structured, repeated education such as monthly sessions using insulin injection kits has been associated with significant reductions in HbA1c levels (10). Continuous assessment of patients' injection techniques enables healthcare professionals to identify and correct errors, thereby optimising therapeutic outcomes. Given the limited availability of local data on insulin injection practices, this study was conducted to determine the prevalence of improper insulin injection techniques and to identify common injection errors among patients with diabetes attending Hospital Setiu, Terengganu. The findings are expected to provide valuable insights for improving patient education strategies and enhancing glycaemic control within this population.

Method

Study design and setting

A cross-sectional study was conducted among inpatients and outpatients with diabetes in Hospital Setiu from August to December 2023. The study was registered with the National Medical Research Register (NMRR) and received approval from the Medical Research and Ethics Committee (MREC), Ministry of Health (MOH) with reference number NMRR-23-01389-ETD.

Study population

The sample size was estimated using a sample size calculator by Raosoft Inc. for estimating a single proportion (11). Assuming that 50% of the population had the factor of interest and with a total population of 171 patients on insulin therapy for at least three months, a minimum of 119 participants was required to achieve a 5% margin of error with 95% confidence interval. This number was rounded to 120 subjects.

Diabetic patients were recruited into the study using convenience sampling during medical outpatient department (MOPD) clinic follow-up visits or inpatient admissions. The eligible candidates from outpatient and inpatient settings were identified by a pharmacist during prescription screening and admission case clerking, respectively.

Inclusion criteria comprised patients aged 18 years or older who were currently receiving insulin therapy and had attended at least one counselling session on insulin use. Patients with gestational diabetes mellitus (GDM), those discharged to other healthcare facilities, those who defaulted on follow-up appointments, clinically stable patients, individuals with severe physical or psychological conditions, and those who had exclusively used prefilled insulin devices were excluded. Clinically stable patients were excluded because they were unlikely to be available for assessment within the study period. This included inpatients whose insulin therapy was anticipated to be de-escalated to oral hypoglycaemic agents during admission or before discharge, and outpatients whose follow-up intervals had been

extended from three to six months, exceeding the five-month study period. Severe physical conditions were defined as significant visual impairment, upper limb disability, or neurological deficits that could interfere with proper insulin injection technique. Severe psychological conditions were defined as disorders that substantially impair cognition, comprehension, or communication, as documented in the medical records based on clinical judgement.

Data collection

Patients or their caregivers were approached and provided with information regarding the objectives and procedures of this study. Written informed consent was obtained from the patients or caregivers who participated in the assessment. The potential respondents were assured that their participation is voluntary, and they could withdraw from the study at any time. Patients were withdrawn if the investigator identified potential risks, including significant physical discomfort, psychological distress, or inability to safely complete the demonstration of insulin injection based on clinical judgement during the session. Withdrawn patients were not replaced. Each respondent was assigned an anonymous ID, referred to as “Respondent No.” in the data collection form.

Each face-to-face assessment required approximately 15 minutes. Although differences may exist between inpatients and outpatients in terms of disease severity, insulin experience, and injection practices, these were minimised by using a standardised assessment checklist for all patients, and by ensuring that all had received prior insulin counselling before the evaluation. Demographic data of the patients were collected during the session and recorded in the data collection form. Insulin administration techniques were evaluated through in-person interviews and practical demonstrations using a structured checklist. The checklist comprised 16 dichotomous (correct / incorrect) items on the techniques of using non-prefilled insulin pens that were adopted from the Medication Counselling Guidelines 3rd Edition (2019) published by the Pharmaceutical Services Programme, Ministry of Health Malaysia (12). During the evaluation, the pharmacist verbally translated each checklist item and prompted the participants to demonstrate the corresponding injection step. As the guideline was originally developed for healthcare professionals, each checklist item was verbally translated into language that was easily understood by participants. For patients whose insulin injections were routinely administered by a caregiver, the caregiver performed the demonstration instead. The pharmacist assessed each step and recorded whether it was performed correctly. A checklist item was considered incorrect if either the participant's verbal response or physical demonstration was incorrect. Formal face, content, and language validation of the translated administration, as well as pilot testing of the assessment procedure, were not undertaken because an existing guideline rather than a newly developed instrument was used.

Data analysis

As no published study has established a validated scoring threshold for this checklist, a practical classification method was applied. In this study, patients scoring fewer than 14 correct steps were classified as having poor insulin injection technique, while those who performed 14 or more correct steps were considered to have good technique. This cut-off was determined based on the proportion of steps deemed necessary for safe and effective insulin administration and was used to help descriptive comparison within the study population. Although individual checklist steps may differ in their clinical importance, the use of an overall score allowed for a standardised and reproducible assessment of injection technique across all participants.

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics were used to summarise participant characteristics and insulin injection technique. Categorical variables were presented as frequencies and percentages, while continuous variables were presented using medians and interquartile ranges (IQR). Inferential statistical analysis was not performed as the primary objective of the study was descriptive in nature, focusing on the assessment of insulin injection techniques rather than hypothesis testing.

Results

A total of 171 patients with diabetes were initially identified. Of these, 96 were excluded based on the predefined inclusion and exclusion criteria. Among the remaining 75 eligible patients, a further 12 were excluded because of repeated visits during the study period (to avoid duplicate enrolment), refusal to participate, or inability to complete the insulin injection demonstration due to time constraints. Consequently, 63 participants were included in the final analysis.

Detailed socio-demographic characteristics of study respondents are presented in Table 1. The median age of the patients was 57 years (IQR: 17). The majority were male (n=37, 58.7%), Malay (n=63, 100%), and married (n=57, 90.5%). Almost half had attained secondary education (n=29, 46.0%) and had been receiving insulin therapy for a median duration of 4 years (IQR: 7).

Table 1: Socio-demographic characteristics of the respondents (n=63)

Characteristics	n (%)
Age	
< 60 years old	39 (61.9)
≥ 60 years old	24 (38.1)
Gender	
Male	37 (58.7)
Female	26 (41.3)
Race	
Malay	63 (100)
Chinese	0 (0)
Indian	0 (0)
Others	0 (0)
Education level	
No formal education	4 (6.3)
Primary education	21 (33.3)
Secondary education	29 (46.0)
Tertiary education	9 (14.3)
Marital Status	
Married	57 (90.5)
Single	4 (6.3)
Divorce/Widowed	2 (3.2)
Duration of insulin therapy	
< 1 year	11 (17.5)
1-5 years	32 (50.8)
> 5 years	20 (31.7)
Frequency of insulin injection per day	
1	7 (11.1)
2	21 (33.3)
3	1 (1.6)
4	34 (54.0)

Overall, most patients (n=55, 87.3%) demonstrated good insulin injection technique, defined as achieving at least 14 correct steps, while 8 patients (12.7%) were classified as having poor technique (Table 2). The most frequently observed error was unscrewing the needle cap without the outer needle cap in place (n=14, 22.2%). This was followed by the failure to warm the insulin cartridge by rolling it between the palms and not inverting the cartridge for proper resuspension when required (n=12, 19.0%). The third most commonly identified errors included failure to pinch the skin to create a fold, not applying pressure with an alcohol swab in the event of bleeding, not replacing the cap after injection, and inadequate knowledge on managing insufficient remaining insulin in the cartridge. Each of these errors was observed in nine patients (Table 3).

Table 2: Prevalence of patients with poor insulin injection technique (n=63)

Number of correct steps in insulin injection technique	n (%)
Less than 14 correct steps (Poor technique)	8 (12.7)
14 and more correct steps (Good technique)	55 (87.3)

Table 3: Assessment of insulin injection technique among participants (n=63)

No.	Checklist item	Total	
		Correct technique	Incorrect technique
1	Roll insulin cartridge between palms gently to warm it (for Mixtard/Insugen 30/70 and Insugen N/Insulatard, invert the cartridge to mix the insulin until it is uniformly cloudy).	51	12
2	Push the piston rod down using the finger until the piston rod is completely inside the pen body (Insupen/Novopen).	63	0
3	Insert the cartridge into the cartridge holder.	62	1
4	Screw the cartridge holder to the pen body tightly.	61	2
5	Remove the paper tab, screw the needle to the pen and remove inner and outer cap (do not keep inner cap).	58	5
6	Priming: For newly opened insulin cartridge, dial 2 units and hold the insulin pen with the needle upwards. Flick the cartridge holder gently. For in use insulin, dial 1 unit.	57	6
7	Push the injection button. Look for a stream of insulin at the needle tip. A new cartridge may need to be primed several times to get a stream of insulin.	61	2
8	Dial the appropriate dose for injection by turning the dose knob.	63	0
9	If overdial, dial backwards.	63	0
10	Gently pinch the skin that has been cleaned to make a fold. Hold the fold between the thumb and the forefinger of one hand during the entire injection. Hold the insulin pen firmly in your other hand using the finger grip. Insert the full length of the needle (at an angle of 90°) into the skin fold.	54	9
11	Press the injection button until the figure in the dose window return to 0.	62	1
12	Hold the needle for at least 10 seconds, then remove the needle from your skin.	61	2
13	If a slight bleeding occurs after injection, gently press the injection site with the alcohol swab.	54	9
14	Put the outer needle cap on and unscrew the needle.	49	14
15	Replace the pen cap.	54	9

16	The cartridge scale on the penfill cartridge holder shows the approximate number of insulin units left in the cartridge. Do not try to inject an insulin suspension (cloudy-looking insulin) if the rubber stopper is below the white line on the cartridge holder. If more insulin is needed than the amount left in the penfill cartridge, either (a) inject the insulin left in the cartridge, then inject the balance needed using new cartridge, or (b) inject the full dose with a new cartridge.	54	9

Discussion

The findings of this study provide valuable insight into insulin injection techniques among diabetic patients at Hospital Setiu. Only 12.7% of study population demonstrated poor insulin injection techniques, indicating that most patients were able to practise proper insulin administration. Notably, this proportion is lower than that reported in two local studies in Selangor and Teluk Intan (7-8), as well as in several international studies. For example, 34.3% of participants in Northwest Ethiopia and 45.5% in Southern Ethiopia exhibited poor practices (13–14). Several factors may explain these discrepancies. First, differences in study populations and settings are likely contributors. All participants in the present study were recruited from a hospital setting and had previously received insulin injection counselling, which may have enhanced their technique. The relatively low prevalence of poor injection technique observed in this study may suggest that structured insulin counselling, including pharmacist-led education routinely provided in the hospital, is associated with appropriate insulin injection practices. However, this study was not designed to evaluate the effectiveness of such interventions.

Differences in assessment methods may also play a role in the variations of findings across studies. This study utilised a checklist adopted from national counselling guidelines, whereas the other studies relied on knowledge-based questionnaires or self-reported practices, which may capture different aspects of injection behaviour. Hence, these methodological differences should be considered when comparing findings across studies. Another characteristic of this study was related to the evaluation process. During the evaluation, the pharmacist verbally translated each checklist item and prompted the participants to demonstrate the corresponding injection step. Although this standardised approach ensured consistent assessment of all checklist items, it may have resulted in an overestimation of participants' actual injection technique, as their performance was assessed following prompts rather than based solely on unaided recall and routine practice. Future studies may consider incorporating unprompted demonstrations or direct observation during routine insulin administration to better reflect patients' usual injection practices.

Among the errors observed, the most common was failure to replace the outer needle cap and remove the needle after injection (22.2%). This rate was lower than reported in Hulu Langat, Selangor (79%) and Teluk Intan Hospital (89.8%), but higher than in Saudi Arabia (3.2%) (7, 8, 15). Removing and replacing the outer needle cap is important to avoid air clogging and to ensure correct dose delivery (4). Moreover, needles must be handled and disposed properly to maintain safety while preventing the risk of transmitting blood-borne infection and other potential injuries (16). The second most frequent error was failure to roll or invert the insulin cartridge before injection (19.0%). This proportion was lower than the 50.9% reported in Selangor and 48.6% in India, yet higher than rates observed in Saudi Arabia (25%) and Canada (27.5%) (7, 17–19). Proper mixing is essential for intermediate-acting and pre-mixed insulin to ensure uniform suspension and accurate dosing. Inadequate mixing can lead to reduced therapeutic response and an increased need for insulin due to suboptimal glycaemic control (4). Another common error was not forming a skin fold before injection (n=9, 14.3%). Higher adherence to this step was reported in India (83.5%), Northwest Ethiopia (65.1%), Belgium (63.7%), and Saudi Arabia (63%) (4, 13, 17, 20). While in Canada, only 45.1% followed this practice (18). Proper subcutaneous administration is essential to prevent accidental intramuscular injection, which can lead to erratic insulin absorption and an increased risk of hypoglycemia. Therefore, a gentle skin-fold technique is recommended, particularly for children and lean individuals using needles ≥ 6 mm (3, 21).

Overall, the patterns of injection errors vary across studies. These errors may be attributed to variations in local insulin counselling practice and patient background, specifically patient age and educational level. For example, older patients may experience impaired vision, reduced dexterity, or memory difficulties, which can affect their ability to perform multi-step injection techniques consistently (22). Similarly, a study in Labuan, Malaysia, found that practice level was significantly associated with education, indicating that patients with lower education may require additional support to correctly perform injection techniques (23). These findings suggest that educational programs should be tailored to the specific needs of each institution, with a primary focus on the most frequent errors in insulin administration to improve both safety and treatment outcomes. Nevertheless, the relationship between these factors and insulin injection practices was not assessed in this study, and this represents an important area for future research.

Incorrect insulin injection technique negatively affects glycaemic control and overall diabetes management (20). Patients with poor technique often have higher HbA1c levels and require increased insulin doses to achieve glycaemic targets (20). Additionally, improper injection practices can lead to metabolic instability, glycaemic variability, and unintentional hypoglycaemic events. Consequently, these complications may precipitate hospitalisation, further increase the socioeconomic burden and reduce quality of life (24). Structured and repeated education programs led by pharmacists or diabetes educators are effective in addressing these issues. Individualised training has been shown to improve injection technique, enhance glycaemic control, increase patient satisfaction, and potentially reduce insulin administration (10). A survey involving 158 individuals with T2DM demonstrated that patients who received a second follow-up with refresher education maintained improved outcomes compared to those without additional support (25). These findings highlight the importance of regularly assessing insulin injection technique during follow-up to reinforce proper practices and sustain optimal diabetes management.

Several limitations of this study should be acknowledged. First, this study was conducted at a single centre, which may limit the generalisability of the findings to the broader population of patients with diabetes. In addition, the exclusion of clinically stable patients may have introduced selection bias by underrepresenting individuals with well-controlled diabetes who required less frequent clinical follow-up. Consequently, the findings may not be generalisable to all patients receiving insulin therapy. Furthermore, the relatively small sample size may not have captured the full spectrum of insulin injection practices and may have limited the representativeness of the findings. Future studies should consider conducting multi-centre research involving multiple healthcare facilities and recruiting a larger sample size to improve the generalisability and robustness of findings.

In addition, although the checklist was adopted from the Medication Counselling Guideline, 3rd Edition (2019), the verbally translated administration was not formally validated before use, and no pilot study was conducted prior to data collection (12). Therefore, the consistency and clarity of the translated assessment procedure could not be formally established, which may have influenced participants' interpretation of certain checklist items. Future studies should consider formal validation of translated assessment procedures and pilot testing before data collection to ensure feasibility and consistency within the target population. Finally, the classification of insulin injection technique into "good" and "poor" was based on an investigator-defined cut-off score, with equal weighting assigned to all checklist items. This approach may oversimplify clinically important errors, as individual steps differ in their clinical significance. For example, an error in insulin dose selection is likely to have greater clinical consequences than some other procedural errors. Future research may consider weighting checklist items according to their clinical importance or reporting critical errors separately to provide a more clinically meaningful assessment of insulin injection technique.

Conclusion

This study found only a minority of diabetic patients in Hospital Setiu demonstrated poor insulin injection technique, indicating that most patients were administering insulin correctly. Additionally, the study identified the commonly incorrect techniques, highlighting specific areas for improvement. It is therefore essential for pharmacists to emphasise these aspects during counselling and medication dispensing

sessions. Enhancing patients' proficiency in insulin injection is critical for achieving better glycaemic control and reducing the long-term risk of diabetes-related complications. A proactive approach by pharmacists can improve insulin administration practices, promote patient adherence, and ultimately optimise insulin therapy and overall health outcomes for diabetic patients.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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