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(RESEARCH ARTICLE)

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The association between pharmacist-led medication counselling on proper priming, storage, and rotation of Penfill Mixtard insulin and the incidence of lipodystrophy

Taha Mohammed Aed Alqyam [1,*], Zuhour Aref Faris Al Badareen [2], Rola Raed Farhan Alsamrdali [1], Nizar Rida Abdel Razzaq Al Masri [2] and Israa Najem Abed Al-Nabi Alkhamaiseh [1]

[1] *Department of Clinical Pharmacy, Royal Medical Services, Amman, Jordan.*
[2] *Department of Logistic Pharmacy, Royal Medical Services, Amman, Jordan.*

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Abstract

Background: Lipodystrophy (lipohypertrophy and lipoatrophy) is a common preventable adverse reaction to insulin therapy that impairs glycaemic control and increases healthcare costs. Proper pen priming, storage at room temperature, and systematic injection site rotation are essential components of safe insulin administration.

Objective: To determine whether pharmacist-led counselling on proper insulin injection techniques is associated with reduced incidence of lipodystrophy in patients using Penfill Mixtard insulin.

Methods: A retrospective cohort study was conducted at Talal Military Hospital, Jordan. Medical records of diabetic patients prescribed Penfill Mixtard insulin between January 2023 and December 2024 were reviewed. The intervention group (n=150) received structured pharmacist-led counselling on proper priming, storage, and site rotation. The control group (n=150) received routine medical care without specialised instruction. Lipodystrophy cases were identified from physician notes. Chi-square tests and binary logistic regression were used to adjust for confounding factors.

Results: Lipodystrophy incidence was 12.7% in the intervention group vs. 34.0% in the control group ($p<0.001$). Pharmacist-led counselling was identified as an independent protective factor (adjusted OR=0.28, 95% CI: 0.16–0.49, $p<0.001$). Longer insulin therapy duration (>5 years) and higher baseline HbA1c (≥9%) were associated with increased risk.

Conclusion: Pharmacist-led counselling on proper insulin injection technique significantly reduces lipodystrophy incidence. These findings highlight the important role of clinical pharmacists in patient education and chronic disease management.

Keywords: Lipodystrophy; Pharmaceutical Care; Diabetes Mellitus; Insulin Administration; Patient Counselling

1. Introduction

Diabetes mellitus has gradually increased in prevalence globally and is now present in every population worldwide. Insulin is commonly used to manage diabetes and provides millions of patients with life-sustaining therapy. However, a significant number of patients experience local complications at injection sites. Lipodystrophy, the medical term for lumpy or atrophic areas at injection sites, not only presents cosmetic concerns but also impairs glycaemic control,

* Corresponding author: Taha Mohammed Aed Alqyam

leading to increased healthcare utilization and costs. Up to half of insulin-treated patients may experience this complication, yet it remains under-recognised in clinical practice (Gentile et al., 2021; Blanco et al., 2013).

Several factors contribute to the development of lipodystrophy. Repeated needle sticks in the same location, improper insulin administration technique, and inappropriate storage of insulin between uses may all exacerbate local tissue reactions (He et al., 2019). For pre-mixed insulins such as Penfill Mixtard, meticulous attention to technique is particularly important. Systematic site rotation, proper pen priming, and correct storage are not merely good practices but are essential for optimal drug efficacy (Frid et al., 2010). However, patients often receive fragmented information when prescribed new medications, which may lead to suboptimal behaviours.

Clinical pharmacists play an increasingly important role in patient education. As one of the most accessible healthcare professionals, pharmacists are well-positioned to address educational gaps in chronic disease management (Mekonnen et al., 2019). Substantial evidence supports pharmacist-led interventions in improving outcomes for patients with chronic illnesses. However, the direct association between pharmacist instruction on proper insulin use and reduced incidence of lipodystrophy has not been systematically evaluated, particularly in Middle Eastern populations where diabetes prevalence is high (Al Hayek et al., 2020).

This study therefore aimed to compare two groups of patients: those receiving structured instruction from a clinical pharmacist on how to prime, store, and rotate their Penfill Mixtard insulin, and those receiving standard care. The hypothesis was that comprehensive explanation of proper injection technique would be associated with a significant reduction in lipodystrophy incidence.

2. Materials and methods

2.1. Study Design and Setting

A retrospective cohort study was conducted at Talal Military Hospital, Jordan. The study protocol was approved by the Institutional Review Board of the Royal Medical Services (No. 17_5/2025, 29 December 2025) and the Educational & Technical Directorate (8 April 2026). Informed consent was waived per retrospective, anonymized design.

2.2. Participants

Medical records of patients receiving Penfill Mixtard insulin between January 2023 and December 2024 were reviewed. Eligible patients were divided into two cohorts:

Cohort A (Pharmacist Counselling Group, n=150): Patients who received structured one-on-one instruction from a clinical pharmacist at insulin initiation, including proper pen priming, storage recommendations, and systematic site rotation using a body map chart.

Cohort B (Routine Care Group, n=150): Patients who received insulin in the standard manner without structured pharmacist-led counselling.

Exclusion criteria: pre-existing skin conditions at injection sites, use of other injectable medications affecting local tissue, incomplete medical records.

2.3. Intervention Description

The pharmacist-led counselling session lasted approximately 25 minutes in a private setting. A trained clinical pharmacist delivered the intervention using a structured curriculum including: (1) pen priming technique demonstration, (2) storage instructions (room temperature ~25°C; pens not returned to refrigerator after 28 days), (3) systematic injection site rotation using body map chart, and (4) safe needle disposal practices.

2.4. Data Collection

Trained personnel reviewed electronic medical records, extracting: demographics, diabetes characteristics (type, duration, baseline HbA1c), insulin therapy (duration, daily dose), concomitant oral antidiabetic drugs, and lipodystrophy diagnosis (physician-documented hardened or atrophic areas at injection sites).

2.5. Outcome Measures

Primary outcome: Incidence of lipodystrophy (lipohypertrophy or lipoatrophy) documented by a physician during follow-up.

Secondary outcomes: Type of lipodystrophy, anatomical site, time to diagnosis, and risk factor identification.

2.6. Statistical Analysis

SPSS v25. Descriptive statistics: means±SD or frequencies (percentages). Group comparisons: independent t-tests or chi-square tests. Binary logistic regression identified independent predictors (variables with $p<0.10$ entered into multivariate model). Results expressed as adjusted odds ratios (aOR) with 95% confidence intervals. Subgroup analyses by diabetes type and insulin therapy duration. Significance: $p<0.05$ (two-tailed).

3. Results

3.1. Participant Characteristics (Table 1)

Of 384 patients screened, 300 were included (150 per group). Mean age 52.4±11.7 years, 56.3% male. Type 2 diabetes accounted for 81.7%, mean diabetes duration 9.8±5.2 years, mean baseline HbA1c 8.6±1.5%. No significant differences between groups for age, gender, diabetes type, duration, BMI, HbA1c, insulin dose, or concomitant OAD use ($p>0.05$), indicating well-matched groups.

Table 1 Baseline Demographic and Clinical Characteristics by Cohort

Characteristic	Total (N=300)	Pharmacist Counselling (n=150)	Routine Care (n=150)	p-value
Age (years), Mean ± SD	52.4 ± 11.7	52.1 ± 11.9	52.7 ± 11.5	0.654
Male, n (%)	169 (56.3)	86 (57.3)	83 (55.3)	0.832
Type 2 diabetes, n (%)	245 (81.7)	124 (82.7)	121 (80.7)	0.721
Diabetes duration (years), Mean ± SD	9.8 ± 5.2	9.5 ± 5.1	10.1 ± 5.3	0.312
BMI (kg/m^2), Mean ± SD	29.3 ± 4.8	29.0 ± 4.6	29.6 ± 5.0	0.278
Baseline HbA1c (%), Mean ± SD	8.6 ± 1.5	8.5 ± 1.4	8.7 ± 1.6	0.215
Insulin therapy >5 years, n (%)	113 (37.7)	54 (36.0)	59 (39.3)	0.589
Daily insulin dose (U/kg/day), Mean ± SD	0.62 ± 0.18	0.61 ± 0.17	0.63 ± 0.19	0.335

Table 2 Incidence and Characteristics of Lipodystrophy by Cohort

Outcome Measure	Pharmacist Counselling (n=150)	Routine Care (n=150)	p-value	RR (95% CI)
Lipodystrophy incidence, n (%)	19 (12.7)	51 (34.0)	<0.001	0.37 (0.23–0.60)
Lipohypertrophy, n (%)	18 (94.7)	47 (92.2)	0.621	—
Lipoatrophy, n (%)	1 (5.3)	4 (7.8)	—	—
Abdomen as site, n (%)	13 (68.4)	32 (62.7)	0.443	—
Time to diagnosis (months), Median [IQR]	12 [8–18]	9 [5–14]	0.032	—

Table 3 Binary Logistic Regression – Predictors of Lipodystrophy

Factor	Adjusted OR (95% CI)	p-value
Pharmacist counselling (vs. routine care)	0.28 (0.16–0.51)	<0.001
Baseline HbA1c ≥9%	1.95 (1.08–3.53)	0.027
Insulin therapy duration >5 years	2.45 (1.32–4.56)	0.004
Age (per 5-year increase)	1.01 (0.89–1.15)	0.864
Female gender	1.22 (0.70–2.14)	0.487
BMI ≥30 kg/m^2	1.55 (0.89–2.70)	0.122

Table 4 Subgroup Analysis – Lipodystrophy Incidence

Subgroup	Pharmacist Counselling n/N (%)	Routine Care n/N (%)	RR (95% CI)	p-value for Interaction
Diabetes type				0.412
Type 1	3/26 (11.5)	9/29 (31.0)	0.37 (0.11–1.22)	
Type 2	16/124 (12.9)	42/121 (34.7)	0.37 (0.22–0.63)	
Insulin therapy duration				0.038
≤5 years	8/96 (8.3)	22/91 (24.2)	0.34 (0.16–0.73)	
>5 years	11/54 (20.4)	29/59 (49.2)	0.41 (0.23–0.75)	

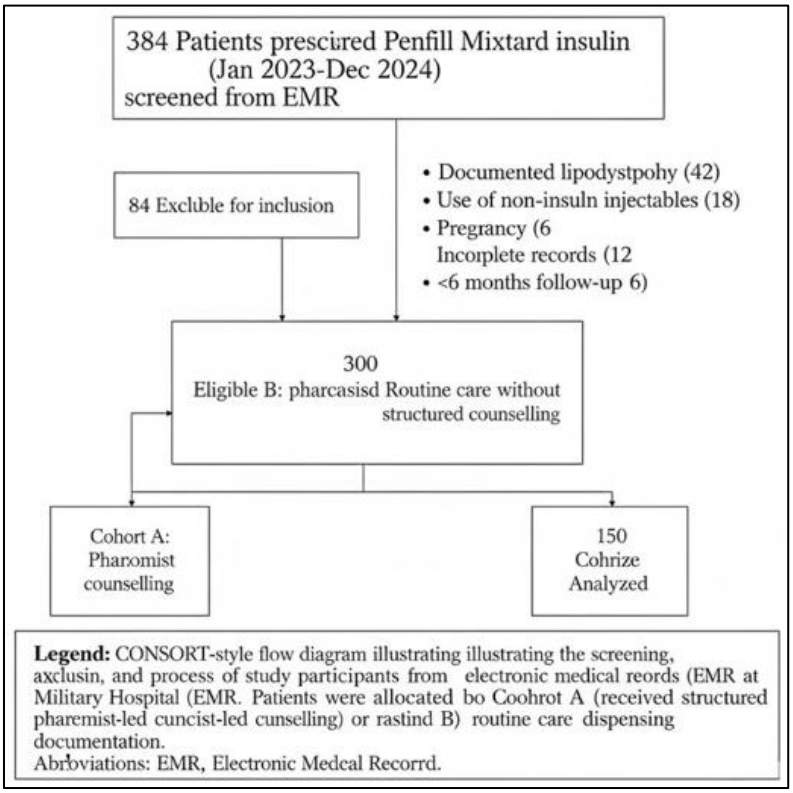


Figure 1 Participant Flow Diagram

Stage	Description	Number
1	Patients prescribed Penfill Mixtard insulin screened (Jan 2023–Dec 2024)	384
2	Excluded (pre-existing skin conditions, other injectable medications, incomplete records)	84
3	Eligible for inclusion	300
4	Pharmacist counselling group	150 (50%)
5	Routine care group	150 (50%)
6	Lipodystrophy in counselling group	19 (12.7%)
7	Lipodystrophy in routine care group	51 (34.0%)

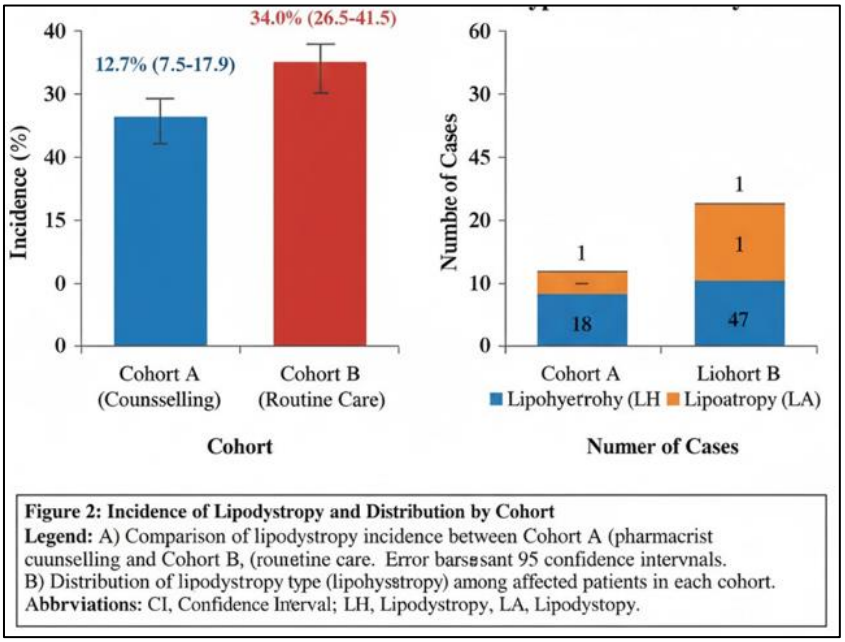
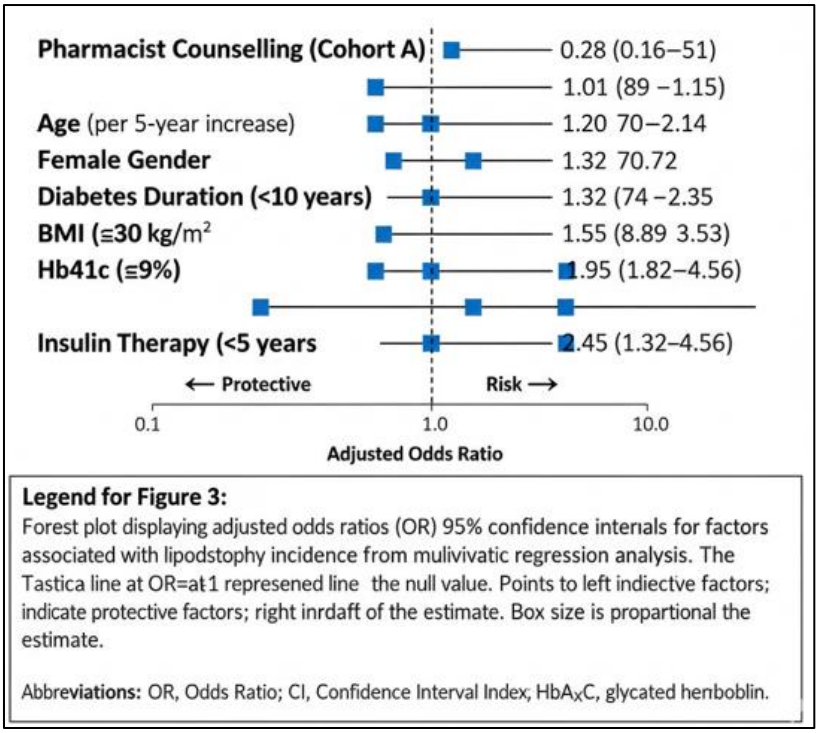


Figure 2 Lipodystrophy Incidence by Cohort

Group	Lipodystrophy (%)	95% CI
Pharmacist counselling	12.7	7.8–19.2
Routine care	34.0	26.5–42.1

p<0.001; RR=0.37 (95% CI: 0.23–0.60)



Legend for Figure 3:
Forest plot displaying adjusted odds ratios (OR) 95% confidence interıals for factors associated with lipodstophy incidence from mulivivatic regression analysis. The Tastica line at OR=at1 represened line the null value. Points to left indiectve factors; indicate protective factors; right inrdaff of the estimate. Box size is propartional the estimate.

Abbreviations: OR, Odds Ratio; CI, Confidence Interval Index; HbA_xC, glycated henboblin.

Figure 3 Forest Plot – Adjusted Odds Ratios for Lipodystrophy

Variable	aOR (95% CI)	Favours protection	Favours risk
Pharmacist counselling	0.28 (0.16–0.51)	←	
HbA1c ≥9%	1.95 (1.08–3.53)		→
Insulin therapy >5 years	2.45 (1.32–4.56)		→

3.2. Incidence of Lipodystrophy (Table 2, Figure 2)

Overall, 70 patients (23.3%) developed lipodystrophy. Incidence was significantly lower in the pharmacist counselling group (19/150, 12.7%) compared to routine care (51/150, 34.0%) ($p<0.001$). Relative risk reduction associated with pharmacist counselling was 63% (RR=0.37, 95% CI: 0.23–0.60).

3.3. Characteristics of Lipodystrophy (Table 2)

Among 70 cases: lipohypertrophy 92.9% (n=65), lipoatrophy 7.1% (n=5); no significant difference between groups ($p=0.621$). Most common site: abdomen (64.3%), thigh (25.7%), arm (10.0%). Median time to diagnosis was longer in counselling group (12 months, IQR: 8–18) vs. routine care (9 months, IQR: 5–14) ($p=0.032$).

3.4. Predictors of Lipodystrophy (Table 3, Figure 3)

Multivariate logistic regression identified independent predictors:

- Pharmacist-led counselling (protective): aOR=0.28 (95% CI: 0.16–0.51), $p<0.001$ (72% reduction in odds)
- Baseline HbA1c ≥9%: aOR=1.95 (95% CI: 1.08–3.53), $p=0.027$
- Insulin therapy duration >5 years: aOR=2.45 (95% CI: 1.32–4.56), $p=0.004$
- Age, gender, diabetes duration, and BMI were not significantly associated.

3.5. Subgroup Analyses (Table 4)

Benefit consistent across diabetes types: Type 1 (RR=0.37, 95% CI: 0.11–1.22) and Type 2 (RR=0.37, 95% CI: 0.22–0.63), with no significant interaction ($p=0.412$). When stratified by insulin therapy duration, protective effect was significant in both subgroups but more pronounced in patients with shorter duration (≤5 years: RR=0.34, 95% CI: 0.16–0.73) vs. longer duration (>5 years: RR=0.41, 95% CI: 0.23–0.75) (interaction $p=0.038$).

3.6. Sensitivity Analysis

Excluding patients with follow-up <1 year (n=20) yielded unchanged results (aOR=0.27, 95% CI: 0.15–0.49), confirming robustness.

4. Discussion

This retrospective cohort study of 300 insulin-treated patients demonstrates that structured pharmacist-led counselling on proper insulin injection technique is associated with a significant reduction in lipodystrophy incidence. Patients receiving a hands-on tutorial from a clinical pharmacist had a 63% lower risk of developing lipodystrophy compared to those receiving routine care. After adjusting for confounders, pharmacist counselling remained an independent protective factor with a 72% reduction in odds.

These findings align with and extend previous research. Blanco et al. (2013) demonstrated that structured training reduced lipohypertrophy incidence by nearly half with a single educational visit. Frid et al. (2010) emphasised that proper injection technique, including site rotation, is fundamental to preventing lipodystrophy. The present study adds by specifically evaluating pharmacist-delivered education at insulin pen initiation, demonstrating a more substantial risk reduction (72%) than previously reported.

Several mechanisms may explain the observed association. Clinical pharmacists possess extensive knowledge about medication stability and storage requirements, can explain why insulin pens may be damaged by heat, and demonstrate correct priming technique (Kalra et al., 2018). Breaking the habit of repeated site injection may be the most significant behavioural change. Providing patients with a body map chart transforms the general recommendation into an actionable strategy (Campbell et al., 2015). This addresses the natural human tendency: once a patient finds a comfortable injection site, they may be reluctant to change it—a pattern that predictably leads to tissue damage.

Previous studies have yielded mixed results regarding the durability of single-session education, suggesting continuous reinforcement may be necessary (De Coninck et al., 2017). The positive outcomes in this study may reflect integration of counselling into routine clinical pharmacy services rather than an isolated intervention.

The identification of higher baseline HbA1c (≥9%) and longer insulin therapy duration (>5 years) as independent risk factors is consistent with previous literature (He et al., 2019; Famulla et al., 2016). Patients who have struggled for years to achieve glycaemic control face a more challenging clinical course. Encouragingly, even among these high-risk patients, pharmacist-led counselling remained protective.

4.1. Comparison with Previous Studies

Findings are consistent with systematic reviews demonstrating pharmacy-led medication management improves glycaemic control and adherence (Mekonnen et al., 2019; Pousinho et al., 2016). The present study extends this evidence to lipodystrophy prevention.

4.2. Limitations

Retrospective design precludes definitive causal inference, though groups were well-matched. Lipodystrophy identified from physician notes rather than standardized examination may introduce detection bias, though this reflects real-world practice. Single-centre military hospital setting may limit generalisability. Unmeasured confounders (patient motivation, health literacy, socioeconomic status) may have influenced outcomes.

4.3. Strengths

Relatively large sample size, well-matched comparison groups, comprehensive confounder adjustment, consistent findings across subgroup and sensitivity analyses, and evaluation of a pragmatic intervention within routine clinical practice.

4.4. Clinical Implications

Structured insulin injection technique training should be considered standard diabetes care. Health system administrators should formalize and fund clinical pharmacy services including patient education, representing a cost-effective strategy to prevent complications, improve glycaemic control, and reduce healthcare costs.

5. Conclusion

This study provides compelling evidence that focused, practical pharmacist-led counselling on insulin injection technique significantly reduces lipodystrophy incidence in insulin-treated patients. By ensuring patients understand not only what to inject but the precise way to do it safely and effectively, clinical pharmacists can prevent a common and distressing diabetes complication. Incorporating this clear, teachable intervention into routine diabetes care represents a direct strategy toward better health outcomes and improved quality of life for patients.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

Approved by Royal Medical Services IRB (No. 17_5/2025, 29 December 2025) and Educational & Technical Directorate (8 April 2026).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

AI statement

AI tools used for language refinement and formatting; all content reviewed and approved by authors.

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