

## Original article

# Transportation, storage and injection practices of insulin among patients with diabetes mellitus attending a medical clinic at a tertiary care centre in Sri Lanka


Perera D<sup>1</sup>,  Thirumavalavan K<sup>1</sup><sup>1</sup>National Hospital of Sri Lanka, Colombo, Sri Lanka

## Article Information

## Corresponding Author

D Perera

Email: perera.adnw@gmail.com

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## Abstract

**Background:** Failure to maintain the cold chain during the transportation and storage of insulin and incorrect techniques of insulin injection lead to fluctuations of glycaemic control and complications among patients with diabetes mellitus.

**Objective:** The study assessed transportation, storage, and injection practices of insulin among diabetic patients.

**Methods:** A descriptive cross-sectional study was conducted among 200 consecutive diabetic patients on regular insulin attending a follow-up medical clinic at National Hospital, Colombo. An interviewer-administered questionnaire was used to collect data on patients' socio-demographic factors, insulin transportation methods, storage, and injection practices.

**Results:** All the study participants (age 59 SD±11.5; males 44.5%; females 55.5%) were on premixed insulin while 15% (n=30) used additional soluble insulin. The majority (56%) failed to maintain the cold chain during transportation while 1.5% (n=3) stored insulin in the freezer compartment. Only 33.5% (n=67) had glucometers at home to monitor their glucose levels and 27% failed to comply with the recommended dosage. Only 52.5% (n=105) adhered to the correct timing recommended. The majority (95.5%; n=191) practiced rotation of the injection site and 32% (n=64) rolled the vial between palms before injection. A minority (24.5%) failed to clean the injection site while 63.5% (n=127) practiced pinching of the skin fold before injection. All 6 steps of insulin injection were correctly practiced by 6.5% (n=13) denoting significant lapses in their knowledge and technique.

**Conclusion:** A significant number of insulin users follow incorrect transportation and injection practices. Interventions are required to improve them.

**Keywords:** diabetes mellitus, disposal of needles, injection practices, insulin, storage, transportation

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## Introduction

Diabetes mellitus is one of the leading non-communicable diseases (NCD) causing significant mortality and morbidity worldwide. In Sri Lanka, a significant proportion of the urban and rural population is burdened by the disease. Insulin is the key treatment modality in Type 1 Diabetes whereas, in Type 2 diabetes, the patients are initially treated with oral hypoglycaemic agents, and may require insulin at some point, with the progression of the disease.

Factors such as correct dosage, correct timing, and proper injection techniques are extremely important in achieving the desired glycaemic targets in patients who have been prescribed insulin.<sup>1</sup> Several biological, psychological, and social factors affect the insulin injection technique of a given patient.<sup>1</sup> The preferred site of injection, depth of subcutaneous tissues, visual impairment due to cataract or diabetic retinopathy, and the visual acuity of the patient or the person who injects insulin at home are important biological determinants.<sup>1</sup> Fear of needles, and previous negative conditioning due to pain with injections are important psychological factors<sup>1</sup> whereas, the patient's knowledge, previous training given regarding injection technique, and the patient's ability to learn and comply competently with the correct technique are important social factors.<sup>1</sup>

Correct timing with meals, selecting the appropriate site for injection, proper preparation including cleaning the site of injection, administering the correct dose subcutaneously with correctly pinched skin fold according to the site of injection, slow injection, and gradual withdrawal of the needle constitutes proper insulin injection techniques.<sup>1,2</sup> Incorrect technique can result in intra-dermal or intramuscular injections with various adverse outcomes such as fluctuating blood sugar levels due to unpredictable dynamics in the absorption of insulin. Similarly, correct rotation of the site of insulin injections is vital to prevent lipohypertrophy due to the proliferation of adipocytes at the site of injection. Repeated use of needles increases the likelihood of lipohypertrophy,<sup>1,2,3</sup> thus should be avoided to prevent erroneous absorption of insulin.

The cold chain should be strictly maintained when transporting and storing insulin. Generally, insulin is best stored in an environment with a stable temperature of 2-8°C in accordance with the manufacturers' specifications.<sup>1,7</sup> Even though refrigeration is the storage of choice, alternative methods have been tried in resource-poor settings. Methods such as storage in earthenware

pitchers, half filled with water, or in thermo cool boxes with dry ice have been used in such resource-poor settings,<sup>1,2</sup> and limited data was available regarding the effectiveness of such storing methods.

Care should be taken when traveling with insulin. Insulin can be kept in a flask with ice during long-distance travel.<sup>1</sup>

Needles used to inject insulin are the most common medical sharps in the world. However, many studies have revealed that the correct disposal of sharps after use is suboptimal.<sup>4</sup> A significant number of needles and sharps used by the patients end up in public trash and constitute a major accidental needle prick risk.<sup>4,5</sup>

Therefore, it is essential to educate and follow up with the patients who have been prescribed insulin regarding the importance of proper transportation, storage, and correct injection practices as well as safe disposal of needles and sharps. Hence our study was conducted to assess the insulin injection technique, method of transportation and storage as well as disposal of needles and sharps among the study population.

## Methodology

A descriptive cross-sectional study was conducted among 200 consecutive patients with diabetes mellitus who have been prescribed insulin for regular usage, attending the follow-up outpatient general medical clinic at the National Hospital of Sri Lanka. Patients who have not undergone health education sessions regarding insulin injection techniques, conducted by a healthcare professional, within three months of commencing the study, were excluded.

An interviewer-administered trilingual questionnaire consisting of 35 questions regarding patients' demographic details, methods used to transport and store insulin, insulin injection technique, methods used to dispose of needles, and other related practices, was utilized to collect data after obtaining informed written consent from the patients. Strict confidentiality and anonymity regarding the patient's identity and data were maintained at all times.

Ethical clearance was obtained from the Ethics Review Committee of the Post Graduate Institute of Medicine (PGIM), University of Colombo. The institutional permission was obtained from the Director of the National Hospital of Sri Lanka. Statistical Package for Social Sciences (SPSS) version 20 software was used for data analysis.

## Results

The study group consisted of 44.5% (n=89) males and 55.5% (n=111) females with a mean age of 59 years (SD ± 11.5). Among them, 93% (n=186) were Type 2 diabetics while 7% (n=14) were Type 1 diabetics. The majority of the subjects (53.5%; n=107) were educated up to GCE Ordinary Level (O/L), while 10.5% (n=21) had no formal education. Only 6% (n=12) have had tertiary education. All the participants were prescribed pre-mixed insulin while 15% (n=30) used additional soluble insulin. Only 6 patients with Type 1 Diabetes (42.8%) and 61 with Type 2 Diabetes (32.7%) had glucometer facilities for monitoring blood glucose levels at home (Table 1).

The majority of participants (69%; n=138) claimed that they took more than 60 minutes to reach home carrying insulin dispatched from the hospital clinic and 56% (n=112) failed to maintain the cold chain during transportation of insulin. The majority (98.5%; n=197) practiced correct storage of insulin at home at 4°C in a

refrigerator. However, 3 individuals (1.5%) stored insulin in the freezer compartment reflecting incorrect storage method (Table 2).

A significant number (27%) failed to comply with the prescribed dose of insulin while the majority (90.7%) took lower doses than the prescribed dose.

All the subjects who participated in the study used insulin syringes while none could afford insulin pens. Insulin was self-injected by 72% while 25% and 3% of the subjects were injected by a trained family member or a healthcare professional respectively (Figure 1).

Regarding injection practices, only 52.5% (n=105) adhered to the correct timing recommended, while 21.5% (n=43) used insulin just before meals and 26% (n=52) injected just after meals.

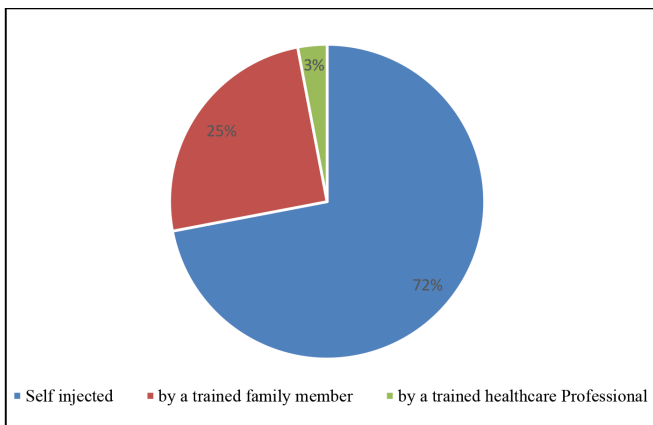
The abdomen (80%) was used as the preferred site of injection, while the majority (95.5%; n=191) practiced rotation of the injection site as recommended (Figure 2).

**Table 1. Characteristics of the study population**

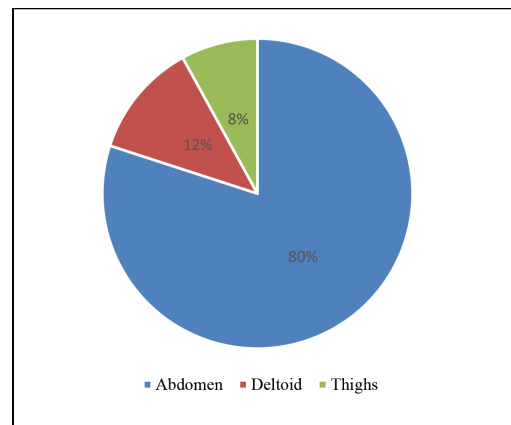
<i>Characteristics</i>	<i>Number (%)</i>
<b>Gender</b>	
Male	89 (44.5%)
Female	111 (55.5%)
<b>Level of Education</b>	
No formal education	21 (10.5%)
Up to Grade 5	39 (19.5%)
Up to O/L	107 (53.5%)
Up to A/L	21 (10.5%)
Tertiary education	12 (6%)
<b>Type of Diabetes</b>	
Type 1	14 (7%)
Type 2	186 (93%)
<b>Availability of Glucometer at home</b>	
Yes	67 (33.5%)
No	133 (66.5%)

**Table 2. Practices regarding transportation and storage of insulin**

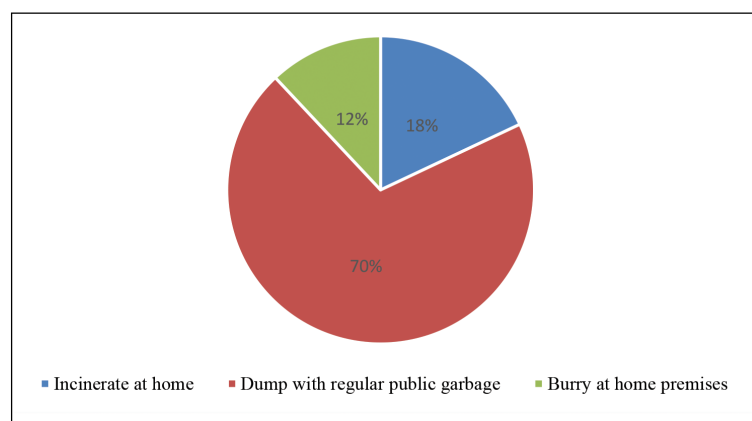
Characteristics	Number (%)
<b>Average time taken to reach home from the clinic while carrying insulin</b>	
Less than 30 minutes	30 (15%)
30 to 59 minutes	32 (16%)
60 to 120 minutes	110 (55%)
More than 120 minutes	28 (14%)
<b>Methods used to transport insulin from the clinic</b>	
Insulator box with Ice	48 (24%)
Insulator box without Ice	40 (20%)
No measures taken to maintain cold chain	112 (56%)
<b>Methods used to store insulin at home</b>	
Refrigerate at 4 degrees celsius	197 (98.5%)
Store in freezer compartment	03 (1.5%)



**Figure 1.** Administration of insulin.



**Figure 2.** Preferred site of insulin injection.



**Figure 3.** Methods employed to dispose used needles and sharps.

A significant number of patients (82%; n=164) who took part in the study did not practice safe disposal of sharps and needles used for injections (Figure 3).

Premixed insulin was not mixed by 12% before injection while 56% (n=112) mixed by shaking the vial and only 32% (n=64) followed the correct practice of rolling the vial between palms. Only 57% (n=114) of the subjects followed the correct practice of cleaning the site of injection with surgical spirit while 18.5% (n=37) used soap and water for cleaning. The majority (89%; n=178) failed to clean the top of the insulin vial with an antiseptic before drawing insulin into the syringe. Only 26.5% (n=53) knew that they should

routinely tap the end of the syringe to get rid of air bubbles trapped in the syringe before injecting. The correct technique of pinching the skin fold to ensure subcutaneous administration of insulin was practiced by 63.5% (n=127), while a significant number of patients (36.5%; n=73) demonstrated gross deficiencies in the practices. The majority (56.5%; n=113), did not wait for at least 5 seconds before withdrawing the needle from the site of injection to ensure gradual withdrawal. Overall, all the steps in insulin injection were correctly practiced only by 6.5% (n=13) denoting significant lapses in their knowledge and practices that require immediate attention and further interventions (Table 3).

**Table 3. Practices regarding insulin injections**

<i>Steps in insulin injection practice</i>	<i>Number (%)</i>
<b>Step 1: Mixing of premixed insulin vials</b>	
Do not mix at any point	24 (12%)
Mix by shaking the vial	112 (56%)
Mix by rolling the vial kept between the palms	64 (32%)
<b>Step 2: Cleaning the site of injection</b>	
Do not clean the site of injection	49 (24.5%)
Clean with soap and water	37 (18.5%)
Clean with surgical spirit or its equivalent	114 (57%)
<b>Step 3: Cleaning the top of the vial with an antiseptic before drawing insulin</b>	
Yes	22 (11%)
No	178 (89%)
<b>Step 4: Tap the end of the syringe to get rid of air bubbles</b>	
Yes	53 (26.5%)
No	147 (73.5%)
<b>Step 5: Correct pinching of the skin fold before injection</b>	
Yes	127 (63.5%)
No	73 (36.5%)
<b>Step 6: Slow withdrawal of the needle after injection</b>	
Less than 5 seconds	113 (56.5%)
5 seconds or more	87 (43.5%)
Correctly adhered to all six steps	
Yes	07 (3.5%)
No	193 (96.5%)

## Discussion

Our study was carried out to assess the practices regarding transportation, storage, and injection of insulin among a cohort of patients with diabetes who attended a follow-up medical clinic at the National Hospital, Colombo, Sri Lanka. The results demonstrate that a significant number of the study subjects failed to comply with the correct technique of insulin injection. It is important to highlight that only a mere 7% of the study subjects followed all 6 steps of the correct insulin injection technique elaborated above. This invariably reflects the importance of periodic surveillance of the insulin injection technique among diabetic patients, by an experienced healthcare professional to address these shortcomings.

However, the majority of patients (95.5%) were aware of the importance of rotation of the site of injection. A similar study conducted in Nepal by Poudel RS *et al*<sup>5</sup> revealed a lower rate of rotation of the site compared to our results even though a similar trend was demonstrated in failing to clean the insulin vials and deficiencies in mixing premixed insulin.

In contrast to some studies conducted worldwide,<sup>5,6,9</sup> our study did not show significant adverse outcomes such as lipoatrophy (3%) and hypertrophy (1.5%) at the site of injection, probably reflecting the good awareness and correct practice of rotation of the injection site.

A modest number of participants (27%) failed to comply with the prescribed dose of insulin while the majority of them (90.7%) took lower doses than the prescribed dose. Lower doses taken were attributed to the undue fear of getting hypoglycaemic events as the majority were unable to monitor blood sugar levels at home. This is further emphasized by the fact that only 33.5% had access to glucometers.

Interestingly, the study shows a significant lapse in the maintenance of the cold chain during the transportation of insulin. This invariably affects the efficacy of insulin resulting in unpredictable blood sugar control. Our results are on par with similar studies conducted in low socio-economic countries in the region.<sup>5,9</sup> Strategies need to be employed to improve the awareness among patients regarding the importance of maintaining the cold chain while transporting insulin, as well as to provide them with the required insulation gear for the transportation of insulin from the clinic to their homes.

As far as the storage of insulin is concerned, the majority employed the correct practice of refrigerating at 4°C. However, 3 subjects admitted that they stored insulin in the freezer compartment, which reflects the need for continuous educational programs to identify and correct

such gross deficiencies of knowledge pertaining to the storage of insulin. When compared with a study conducted in Nepal,<sup>5</sup> the age-old technique of storing insulin in a pot made of clay filled with water used in resource-poor settings, was no longer employed by our study participants. Perhaps this could be a reflection of the study population mainly encompassing urban and suburban areas of Colombo with access to electricity and refrigerator facilities.

Hazardous disposal of needles and sharps used for insulin injections increases the risk of needle stick injuries and hence the risk of transmission of blood-borne infections such as Hepatitis B, C, and HIV. Alarming, a significant proportion of the study population (70%) admitted that they dispose of these sharps in the public garbage collection system. A similar trend has been demonstrated worldwide in multiple studies.<sup>4,5,6</sup> It is high time that we take necessary action to empower the patients with knowledge and attitudes in this venture, highlighting these medical hazards and implications on health.

## Conclusions

A considerable number of insulin users follow incorrect transportation and injection practices. The hazardous disposal of clinical sharps needs to be addressed. Strategies are required to improve the knowledge and practices about the transportation, storage, and injection of insulin among patients with diabetes mellitus in Sri Lanka.

## Author Contribution

DP was the principal investigator and was involved in designing the study, data collection, data analysis, statistical analysis and drafted the manuscript. KT supervised the study and was involved in proof reading the manuscript.

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