Evaluations of knowledge, skills and practices of insulin storage and injection handling techniques of diabetic patients in Ethiopian primary hospitals

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Abstract

Background: Insulin is an effective therapeutic agent in the management of diabetes but it is also sensitive to external environment. Consequently, diabetic patients' adherence to insulin delivery recommendations is critical to its effectiveness. Lack of knowledge, skill, and irrational practices on appropriate insulin delivery techniques can result in therapeutic failure and increased costs of therapy. The aim of this study was to evaluate the knowledge, skills, and practices of insulin storage and injection technique of patients.

Methods : An interview-based cross-sectional study was conducted in conveniently selected participants in Northwest Ethiopian primary hospitals from March 1 to May 30, 2019. Knowledge levels were assessed with right or wrong responses and practice was measured by administering a 4-point Likert scale structured questionnaire through face-to-face interviews. Finally, a five-point observational (demonstration) techniques checklist assessed patients' skills.

Results: Among 194 patients approached, 166 participants completed the survey with a response rate of 85.6 %. From these participants, 54.8% were males and the mean age was 38.46±13.8 years . The overall patients' median knowledge and practice levels on insulin storage and handling techniques were moderately adequate (64.3%) and fair (55.4%), respectively. In patients' skill assessments, 94.6% showed injection sites, 70% indicated injection site rotations, and 60.75% practiced injection site rotations. Education ($p<0.001$), duration of insulin therapy ($p=0.008$) and duration of diabetes ($p=0.014$) had a significant effect on patients' knowledge level. Education ($p<0.001$), occupation ($p<0.001$), duration of insulin therapy ($p=0.001$), duration of diabetes ($p=0.036$) and patients' knowledge levels ($p<0.001$) were found to have a significant effects on the patients' practice level. A Mann-Whitney U test also disclosed that residency, ways to get insulin and mocked injection technique during first training had significant effects on patients' knowledge levels.

Conclusion: The current study revealed that patients had moderately adequate knowledge and fair practice levels on insulin storage and handling techniques. Moreover, patients missed important insulin administration skills. Healthcare professionals and stakeholders can play important roles in educating patients thereby improving the knowledge, practice, and administration techniques of patients.

Background

Insulin is an effective drug for the control of blood sugar levels. It is the mainstay treatment for type 1 diabetes (T1DM) and is often used as an adjuvant to oral hypoglycemic agents in patients with type 2 diabetes (T2DM) when failing to achieve target blood glucose levels [1, 2]{, #111;, #122;, #1;, #2}. Despite its effectiveness, insulin is a very sensitive drug and can be affected by many external factors. If not properly handled, it can be easily destroyed and lose its efficacy [3-5]. For handling this liability and getting the ultimate benefits, implementing the correct insulin delivery recommendations is very crucial. The updated directions for safe insulin handling and delivery for DM patients' injections pragmatically solve these problems [1].

The primary goal of diabetes management is to achieve the target blood sugar level. In order to achieve this goal, the appropriate delivery of insulin is very essential [1]. Diabetic individuals are very likely to benefit from good adherence and proper implementation of specific recommendations found in the Forum for Injection Technique and Therapy: Expert Recommendations (FITTER) [6] workshop held in Rome, Italy in 2015. The FITTER helps enhance therapeutic outcomes and lower costs of therapy [1].

Ignorant behaviors and violations of the recommended directions of insulin handling and delivering techniques may occur due to lack of knowledge, skill and irrational practices or because of inadequate training. Possible consequences of these include delayed drug action (lack of insulin stability and potency), therapeutic failure, and increased health expenditures [4, 5, 7-9]. Evidence-based skills and rational practices of insulin handling techniques are necessary for better patient outcomes, especially in patients living in low-income countries. Such patients rely on scientific underpin recommendations to a little extent, if at all, and depend on behavior and customs as evidence [2]. Moreover, there is limited accessibility of the updated guidelines and recommendations in East African countries [10] and there exists a problem of translating the guidelines and recommendations to local languages that could enable patients to implement them. The shortage of right storage equipment coupled with the harsh climatic conditions in this region may further compromise the overall quality of insulin.

Furthermore, the negative attitudes of diabetic patients towards insulin administration by injection may further compromise their interest to learn the appropriate instructions of storage and handling techniques. Thus, educating and changing their perceptions, beliefs, and attitudes towards storage and administering techniques should be an additional goal of experts [11]. In addition to implementing recommendations in the guidelines, healthcare professionals (HCP) play a discernible role for better delivery of essential topics on injection techniques prior to starting injection therapy [12-14]. It is not easy to deliver the right instructions for all patients regarding insulin delivery [15, 16], and decisions about injection therapy should be mutually agreed by the patients and the HCPs [13, 17]. Regular training and assessments of practices of insulin handlings, storages, and injections can improve therapeutic outcomes and prevent injection site anomalies [18].

To the best of the authors' knowledge and search, no study had been found to evaluate the knowledge, skills, and practices of insulin storage and injection technique of patients in the study area. With this, the purpose of the current study was to evaluate the knowledge, skills, and practices of insulin storage and injection technique of patients in randomly selected primary hospitals of Northwest Ethiopia.

Methods

Study design and setting

An institutional-based cross-sectional study was conducted in randomly selected primary hospitals of Northwest Ethiopia, located Northwest of Addis Ababa. The study period was from March 1 to May 30, 2019. Essential information was obtained through the administration of structured questionnaire-based interviews. The study area had one comprehensive specialized referral and teaching hospital, one private general hospital in Gondar town, ten primary hospitals, and a number of health centers. The study

participants were recruited from the selected primary hospitals located in the towns of Addis Zemen, Debark, Wogera, Kolladiba, Chilga, and Metema.

Source population, Sample size determination and Sampling procedure

The source population was all diabetic patients who had been treated with insulin in the study area. The study population included those diabetic patients who were using insulin as their primary therapy or as additional therapy and visited those hospitals during the study period. Patients or patient caregivers who were 18 years of age and above were included in the study. Patients should be on insulin treatment for at least one month and refilling insulin prescriptions at one of the hospitals. Patients who did not consent to participate in the study or those who were seriously ill, unable to hear or speak, physically disabled, having dementia or cognitive impairment and difficulty of getting consent were excluded from the study. A convenient sampling technique was used to collect data.

Data collection instruments, procedure and management

The data collection format was initially prepared in English. It was then translated to the local language (Amharic) and back-translated to English to ensure proper meaning. Trained pharmacy professionals, under investigators' daily supervision, collected the data. The questionnaire focused on socio-demographic and related information, experiences, practices and knowledge of insulin storage and handling techniques, and an observational checklist of patients' skills related to self-insulin administration. Both the practice and the knowledge questions contain 14 items. Practices were measured by Likert scale type (Never=1; Sometimes=2; Often/Usually =3; Always=4) and graded as poor, fair and good for scores of <50% (<28), 51-75% (29-42) and >75% (>42) out of 56 points, respectively. The knowledge of respondents' was measured with dichotomous outcomes as "right" who answered the question correctly and "wrong" who answered the question incorrectly. Finally, all the responses were summed up to an overall score and categorized into three levels such as adequate, moderately adequate, and inadequate knowledge levels. Scores of >75% (>10.5), 51-75% (8-10.5), and <50% (<7) out of 14 points were said to be adequate, moderately adequate, and inadequate, respectively [19]. The respondents' skills were measured through a checklists of five observational (demonstration) techniques related to insulin self-administration procedures. Based on American diabetic association of insulin administration, the checklist was marked as correct, incorrect, and skipped and given scores of 2, 1, and 0, respectively [20, 21]. If a patient or a caregiver correctly performed all the critical steps, the observation (demonstration) was considered as correct; if any of the critical steps was missed or performed incorrectly, the demonstration was considered as incorrect; and it is considered as skipped if any of the steps was jumped.

Data entry, analysis, and interpretation

The data was entered and analyzed using statistical package for social sciences (SPSS), version 22.0.[22]. Frequency, percentages and median were used to describe the variables in univariate analysis while Chi-square, Mann-Whitney U and Kruskal-Wallis tests were used to describe and test the statistical significance of variables in the bivariate analysis. Pairwise multiple comparisons were done for those groups who had significant knowledge and practice median differences on the Kruskal-Wallis H test. The knowledge and

practice data were transformed into categorical values. The knowledge levels were classified as inadequate, moderately adequate and adequate knowledge; and practice levels were expressed as poor, fair, and good practices. P-value < 0.05 and 95% confidence interval (CI) were used as cut-off points for determining the statistical significance of associations among different variables. Pearson's correlation coefficient test was done to assess the degree of correlation between the patients' knowledge, and their practice levels in their insulin handling techniques and injection practices.

Data quality control

Before any data collection was performed, a pretest was done on 15 patients from one of the randomly selected primary hospitals. These patients were not included in the final data analysis. Important amendments were made and formatted as needed. The data accuracy and completeness were consistently checked by using double entry and any mistakes and omissions were corrected.

Informed consent and Confidentiality

Before any of the activities, written informed consent was sought from each of the participants. The voluntariness of the participation and the aims of the study were explained clearly. The participants were given the right to interrupt at any time if they do not want to continue. The respondents were interviewed and observed while doing a demonstration privately and independently. All information was kept confidentially by giving serial numbers.

Result

Respondent characteristics

A total of 194 patients were approached, of which 28 patients declined to participate in the study for various reasons. The remaining 166 participants completed the survey giving a response rate of 85.6%. Among the included participants more than half (54.8%) were males. Most of the respondents (29.5%) were between the ages of 18-27 years with a mean age of 38.46±13.8 years. Greater than half of the respondents (56.6%) were married and 33.7% were single. There was a gender difference in marital status (p=0.02). More than half (53%) of the study samples had attended their primary (1-8 grades) education and above. Almost half (48.8%) of the participants were living with DM for 1-5 years with a mean (SD) of 2.51 ± 0.89 years and there was a significant gender difference with durations of the diseases (p=0.002). The majority (58.4%) of the respondents used insulin therapy for about 1-5 years with a mean (SD) duration of 2.31 ± 0.76 years. There was a substantial gender difference in insulin therapy (p<0.001). More than half (55.4%) of the participants had to pay for getting insulin (Table 1).

Knowledge score

The overall median (IQR) knowledge level of the study subjects on insulin storage and handling techniques was 9 (7.75-11) (out of 14) (64.3%) (Figure1). Most of the participants (44%) had moderately adequate knowledge, while nearly one-third of them (31.3%) had adequate knowledge, and the rest of the patients (24.7%) had inadequate knowledge levels. About 82% of patients knew that outdated (expired) insulin

should not be used. On the other hand, less than half (44%) of the respondents were aware of the distance to rotate on the same site, which should be one thumb (Fig. 1).

A non-parametric Kruskal Wallis H test was performed to compare the effect of educational status, duration of insulin therapy, and duration of diabetes on patients' level of knowledge for insulin storage and handling techniques. The test showed that education $X^2(3) = 18.89$, $p<0.001$; duration of insulin therapy $X^2(3) = 11.71$, $p=0.008$; and duration of diabetes $X^2(3) = 10.67$, $p=0.014$ had significant effects on patients' knowledge level. The Pairwise multiple comparisons at an adjusted alpha level of 0.0125 were used to compare all pairs of groups, and patients who achieved colleges and above (Median (Mdn) =12) had a higher median knowledge level than illiterates (Mdn=8), $p<0.001$. Patients who had been on insulin for 5-10 years (Mdn=10) had a better knowledge level than those who had been on it for three months to one year (Mdn=8), $p=0.001$ (Table 2).

A Mann-Whitney U test was also performed for the two-group predictor variables, such as residency, ways to get insulin, and mocked injection technique during first training, to compare their effects on patients' overall knowledge levels. A Mann-Whitney U test on residency ($U=2410$, $p=0.001$), ways to get insulin ($U=1874$, $p<0.001$) and mocked injection technique during first training ($U=1959.5$, $p=0.016$) showed that there were statistically significant differences. The median knowledge score level of urban dwellers (Mdn=10) was higher than those of rural dwellers (Mdn=8) and, similarly, patients charged for insulin (Mdn=10) had a better knowledge level than getting insulin freely (Mdn=8). Patients who mocked injection technique during first training (Mdn=9.5) had slightly better scores than those who did not mock (Mdn=8.5) (Table 3).

Practice score

The participants 'insulin storage and injection practices were assessed by using the stated 14-item questionnaire. The median (IQR) practice level of study subjects was 31 (28-33.25) (out of 56) (55.4%). Most (64.5%) of the participants practiced fairly. Only 1.2% of them had good practice and the rest (34.33%) had poor practice. As illustrated in figure 2, the majority (73.25%) of the patients mixed the cloudy insulin (NPH) prior to use and about one-third (33.75%) of patients had ever injected their insulin through their clothes.

A Kruskal-Wallis H test showed the effects of different predictor variables on patients' level of practice for insulin storage and handling techniques. The test showed that education $X^2(3) = 25.86$, $p<0.001$; occupation $X^2(4) = 23.24$, $p<0.001$; duration of insulin therapy $X^2(3) = 15.85$, $p=0.001$; duration of diabetes $X^2(3) = 8.55$, $p=0.036$; and patients knowledge levels $X^2(2) = 19.26$, $p<0.001$ were found to have significant effects on the patients' practice level. As to the Pairwise multiple comparisons at an adjusted alpha level of 0.0125 for education, patients who completed primary and secondary educations (Mdn=31) had better practice levels than those who were illiterates (Mdn=28), $p=0.001$. Those who achieved colleges and above (Mdn=32) were found with higher practice levels than illiterates ($p<0.001$) and those who read and write (Mdn=28), $p=0.01$. The Pairwise multiple comparisons at an adjusted alpha level of 0.01 for occupations indicated that students (Mdn=32) practiced insulin handling techniques better than farmers (Mdn=28), $p=0.003$ and merchants (Mdn=29), $p=0.002$ did. At an adjusted alpha level of 0.017, the pairwise multiple comparisons of

patients who scored adequate knowledge levels (Mdn=32.5) had better practice levels than those of scored moderately adequate (Mdn=30), p=0.008 and inadequate knowledge levels (Mdn=29), p<0.001 (Table 2). The Pearson's correlation coefficient test also showed that there is a moderately positive linear relationship between the patients' knowledge level in their insulin handling techniques and their practice of insulin injections (r(164) =0.5, p<0.001).

Insulin self-administration skill assessment

Based on the observational checklists used to assess the patients' skills related to insulin-self administration, a significant (94.6%) number of respondents correctly showed the injection sites and about 70% of the participants properly indicated how to rotate the injection sites. Conversely, about half of the respondents either performed incorrectly or skipped very critical and important steps such as shaking of cloudy NPH insulin, skin pinching and 45° injection skill, and drawing of insulin from the vials (Table 4).

Discussion

When assessing patients' knowledge and practice levels, our study revealed that the overall median knowledge and practice levels of the study samples on insulin storage and handling techniques were moderately adequate and fair, respectively. The present study showed that the overall knowledge and practice scores represented as a median of all the knowledge and practice levels rather than the individual patients' scores. Proper knowledge and good practices on insulin storage and administration habits have a noteworthy outcome on the control of acute and chronic insulin administration-related complications of DM. However, many of the DM patients did not well aware about the wrong insulin handling practice consequences and the management skills. The knowledge levels observed in our study was almost comparable with reports (62.13%) in other studies conducted in Ethiopia [23], but higher than reports (57.55%) from Nepal [24] and India [19]. However, the practice levels found in our study was lower than what is reported in Nepal (73.98%) [24]. The knowledge levels found in our study were found to be higher than other reports, but their practice levels were lower. This is because the patients in the study areas might be less committed, not confident for their practices, and might not be reinforced by HCP for what they did. For improving knowledge and practice levels, patients are still in need of further professional innervations on instructions, commands, and be compliant to it. Various published articles had revealed that DM patients have poor knowledge of disease management and self-care practices [25, 26].

In the present study, residency, payment status to get insulin, mocked demonstrations of injection technique during the first visit, educations levels, duration of insulin therapy, and duration of illness affected the patients' knowledge levels. Educated patients are very likely to understand and practice instructions and commands of storage and administration techniques better than the illiterates, which is similar to the study done in Nepal [24]. Similarly, participants who stayed with the disease for a longer time, and those who took insulin for a longer time had better knowledge levels, which enabled them to do the recommended practices. This illustrates that more frequent insulin self-administration might improve the patients' knowledge and their practice levels. It is clear that as time spent on insulin therapy increases their exposures to information also increases; usually patients might learn from the bad consequences of poor insulin handling manners.

The findings of the present study are aligned with what Surendranath A. et al. reported. The duration of insulin self-administration was meaningfully influenced by the patients' level of knowledge ($p < 0.05$) [19]. Worldwide studies showed that various recommendations on the insulin injections and storage had no enough logical and scientific supports, but rather it is based on the community habits and traditions [2, 27]. Insulin handling knowledge, practice and skills can be significantly improved if patients are trained both verbally and with practical demonstrations. This is because applying verbal and practical training will complement one another and help patients to easily understand and remember**.** Practical mock demonstration of the administration procedures at first visit had positive effects on the respondents' level of knowledge for insulin storage and administration techniques. Allowing patients to do mock injection demonstrations in a private diabetic injection training room at their first encounter could possibly build their confidence in self-care.

Patients might benefit from regular assessments of their storage and injection practices. In addition, reinforcing them on these practices in subsequent follow-up visits could probably enhance their knowledge and practice levels than their counterparts. From the occupation perspective, students had better practice levels than their counterparts did. This is because students possibly read and search the given instructions and recommendations, and even they might request what they could not understand. The correlation coefficient test showed a positive linear relationship between knowledge and practice levels of insulin injection. In addition, the Kruskal Wallis H test also revealed that the patients' knowledge levels had a significant effect on practice levels and handling skills. These all indicate that patients' injection practice levels may improve when the patients' knowledge levels became adequate in insulin handling techniques.

From the practical skill observational checklist assessment of insulin-self administration technique, a significant (94.6%) number of respondents showed the injection sites, about 70% properly indicated how to rotate the injection sites and more than half (60.75%) of them practiced the injection sites rotations. This indicates that most of the patients were aware that regular injection site rotations could prevent painful injections, lipodystrophy, and safeguard the normal tissue for normal absorption and this is supported by a number of articles [1, 28-30]**.**

Our study revealed that 73.25% of the patients mixed the cloudy insulin (NPH) prior to use; however, only 55.4% of them showed correctly how to shake NPH (the recommended rolls or tips for completely remixing crystalline insulin is 20 times). Adequate numbers of rolls or tips of the insulin vails allowed patients to make the suspensions to solutions and failure to do this could make uneven concentrations of insulin that may possibly lead to hypo- or hyperglycemia. The practices of mixing insulin before use in the present study seem higher than what was reported in India (66.3%), however, higher numbers of patients (97%) in India [31] and (70.8%) in the rest of the world tip or roll the vial 10 times or less. The difference of the results between our study and reports in India and in the rest of the world might be attributed to the smaller sample size of the present study.

Generally, about half of the respondents either performed incorrectly or skipped very important practical skills and critical steps of insulin delivery recommendation. Even though the study results indicate that the patients' knowledge and practice level were moderately adequate and fair, their practical skills were

significantly poor. Herein, patients might be unwilling to practice what they had already known and counseled by professionals, or they had forgotten and might have difficulties of remembering all critical steps. In addition, diabetic patients are commonly frustrated and stigmatized for the needle injections, so that they are always searching for other means of insulin delivery other than injections. This also could be another challenge for the patients and could render them not to be passionate about adapting the appropriate instructions of insulin delivery methods and handling practices. Thus, educating and changing their wrong perceptions, beliefs and attitudes towards storage and administering techniques should be an additional goal of professionals [11].

Limitation

The present study is not without limitations. Since we included only patients who visited the randomly selected hospitals during the data collection period, not all potential respondents might be included. Due to the small sample size and the limited number of hospitals, it might be difficult to generalize to the multi-cultural and highly diverse Ethiopian population. Therefore, the median scores on the levels of knowledge and practices may be overestimated. Because the study was conducted in the hospitals where healthcare professionals were available, patients might feel under pressure as they may think would be blamed for their poor practices.

Conclusion

The DM patients in the present study had moderately adequate knowledge and fair practices on insulin storage and administration techniques. The patients' skills on the important and critical steps of administrations were poor. Healthcare professionals and stakeholders should engage in the development of instructions and guidelines which are very crucial in improving patients' knowledge and practices, in addition to educating and changing their wrong perceptions, beliefs and attitudes towards storage and administering techniques. Moreover, studies with better study designs and higher sample sizes are needed.

List Of Abbreviations

CI: confidence interval; DF: Degree of freedom; DM: diabetic mellitus; FITTER: Forum for Injection Technique and Therapy: Expert Recommendations; IQR: interquartile range; T1DM: type one diabetic mellitus; T2DM: type 2 diabetic mellitus; MD: mean difference; SD: standard deviation; SPSS: Statistical packages for social science.

Declarations

Ethics approval and consent to participate: Institutional Review committee of the University of Gondar, School of Pharmacy reviewed and ethically approved this study with an approval number of SOP286/2018. The collected data was kept anonymous and recorded in such a way that the identity of the involved pharmacy professionals and patients could not be known. The exit interviews were conducted where a third party could not overhear questions and answers to ensure the privacy and confidentiality of clients. The

information obtained from the study was not disclosed to the third body. Only coded numbers were used to identify study participants.

Consent for publication: Not applicable

Availability of data and materials: All relevant materials and data supporting the findings of this study are contained within the manuscript and the datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that there is no competing interest.

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Authors' contribution: AKN contributed in conceptualization, project administration, formal analysis, investigation, methodology. AKN and SAB contributed supervision, data curation, resources, writing and original draft of the manuscript and writing, review and editing of the final manuscript. EAG and EA contributed in the formal analysis, methodology, data curation, writing the original draft of the manuscript. All authors of this manuscript read and approved the final version of this manuscript.

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Tables

Table 1: Distribution of selected characteristics of patients with diabetes mellitus by gender (N=166); 2019

Variables	Total	Male	Female	P-value
	N (166) % (100.0)	N (91) % (54.8)	N (75) % (45.2)	
Age in years: 18-27 28-40 41-50 >50 Mean ± SD	49 (29.5) 43 (25.9) 43 (25.9) 31 (18.7) 38.46±13.8	28 22 22 19	21 21 21 12	0.778
Residence: Rural Urban	86 (51.8) 80 (48.2)	43 48	43 32	//
Marital status: Single Married Divorced Widowed	56 (33.7) 94 (56.6) 10 (6) 6 (3.6)	31 52 8 0	25 42 2 6	**0.02**
Occupation: Farmer Employer Merchant Housewife Student	34 (20.5) 31 (18.7) 38 (22.8) 36 (21.7) 27 (16.3)	31 18 21 8 13	3 13 17 28 14	**<0.001**
Educational status: Illiterate Read & write only Primary and secondary education College & above	48 (28.9) 30 (18.1) 52 (31.32) 36 (21.7)	27 17 31 16	21 13 21 20	0.546
Duration of DM (in years): 0.25-1 >1-5 >5-10 >10 Mean ± SD	15 (9) 81 (48.8) 40 (24.1) 30 (18.1) 2.51 ± 0.89	5 38 23 25	10 43 17 5	**0.002**
Duration of Insulin therapy (in years): 0.25-1 >1-5 >5-10 >10 Mean ± SD	16 (9.6) 97 (58.4) 39 (23.5) 14 (8.4) 2.31 ± 0.76	6 44 27 14	10 53 12 0	**<0.001**
Getting of insulin: Freely Payment	74 (44.6) 92 (55.4)	39 52	35 40	//

Table 2: Kruskal Wallis H test for predictor variables on the level of knowledge and practices on insulin storage and injection differences among respondents' in northwest Ethiopia primary hospitals, Gondar, 2019 (N=166).

Variables	**Knowledge score**			**Practice score**		
	Median (IQR)	Test Statistics **(X^2),** (df)	P	Median (IQR)	Test Statistics **(X^2),** (df)	P
Educational status: Illiterate Read & write only **1ry** and **2ndry** education College & above	8 (7.25-8.75) 9 (8.54-10.20) 9.5 (8.62-9.77) 12 (9.52-11.48)	18.89, (3)	**<0.001****	28 (26.26-29.15) 28 (26-79-30.21) 31 (30.01-32.76) 32 (31.41-34.86)	25.86, (3)	**<0.001****
Occupation: Farmer Employer Merchant Housewife Student			0.076	28 (26.47-29.83) 32 (30.15-34.50) 29 (26.65-29.93) 31 (28.72-32.45) 32 (31.01-33.80)	23.24, (4)	**<0.001****
Years of insulin therapy: 0.25-1 >1-5 >5-10 >10	8 (6.52-8.85) 9 (8.47-9.51) 10 (9.08-10.76) 11 (8.72-11.14)	11.71, (3)	**0.008****	28.5 (23.01-29.99) 31 (30.27-32.51) 29 (27.66-30.03) 28.5 (27.81-31.61)	15.85, (3)	**0.001***
Years of disease: 0.25-1 >1-5 >5-10 >10	8 (6.91-9.22)	10.67, (3)	**0.014***	30 (23.40-30.87)	8.55, (3)	**0.036***

	9 (8.33-9.37) 10 (8.79-10.76) 10.5 (8.82-10.64)			31 (30.08-32.54) 30.5 (28.17-31.23) 28 (27.89-30.71)		
Knowledge level: Adequate (>10.5) Moderate (8-10.5) Inadequate (<7)	//	//	//	29 (25.63-29.10) 30 (28.79-30.96) 32.5 (31.46-34.20)	19.26, (2)	**<0.001****

***** Statistically significant effect on patients' knowledge and practice scores at **p=0.05**.
****** With Pairwise multiple comparisons of Kruskal Wallis 1-way ANOVA (k-samples) there is a significant difference among the groups.

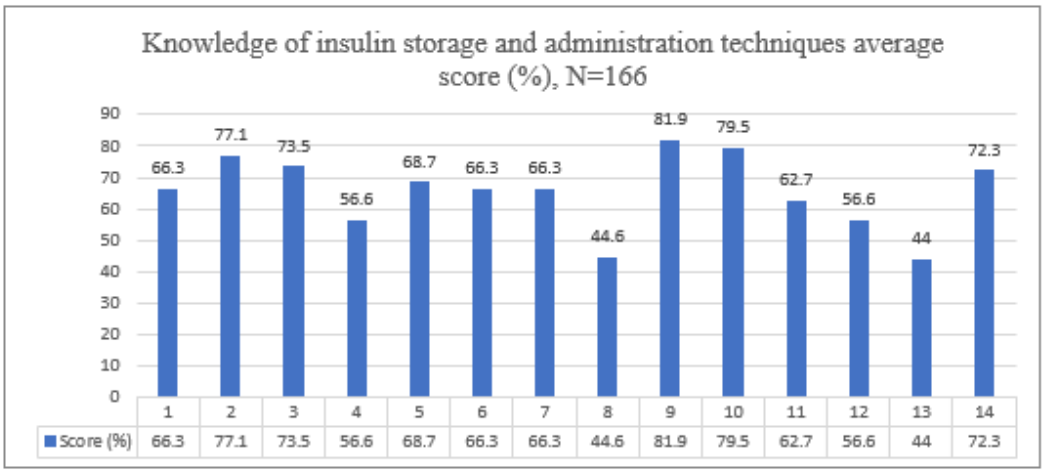
Table 3: The Mann-Whitney U test for the median scores of level of knowledge differences of between categories of predictor variables (N=166).

Variables	Overall knowledge score			
	Median (IQR)	Mann-Whitney U test	Z-score	P
Sex: Male Female				0.291
Residence: Urban Rural	10 (9.15-10.34) 8 (8.05-9.03)	2410	-3.36	**0.001***
Getting of insulin: Free Payment	8 (7.5-8.58) 10 (9.56-10.57)	1874	-5.01	**<0.001***
Trained on insulin injection: Yes No				0.075
Mocking the injection technique during first training: Yes No	9.5 (9.05-9.92) 8.5 (7.36-9.07)	1959.5	-2.41	**0.016***

Table 4: Observational checklist of patients' skill related to self-insulin administration

Items	Correct	Incorrect	Skipped
	N (%)	N (%)	N (%)
Showed injection sites	160 (94.6)	4 (2.4)	2 (1.2)
Showed injection site rotations	116 (69.9)	46 (27.7)	4 (2.4)
Showed how to shake NPH	92 (55.4)	44 (26.5)	30 (18.1)
Showed how to pinch (fold) skin and inject with (45º)	108 (65.1)	54 (32.5)	4 (2.4)
Showed how to draw insulin from the vial	86 (51.8)	49 (29.5)	31 (18.7)

Figures



Key

1. Do you know that vials and cartridges of insulin not currently (unopened) being used should be stored in the refrigerator (2 to 8 degrees) or (traditional equivalent methods) until their date of expiry away from freezing coils or freezer?
2. Do you know that Vials and cartridges, which are in current use (opened), should be kept at cool and dark places of room temperature (15-25ºC) or traditional equivalent methods?
3. Do you know that opened insulin should be discarded after 28 days of opening?
4. Do you know that in use cartridges should not be kept in the refrigerator?
5. Do you know that if using a vial, you should gently roll the vial between the palms of the hands and /or moving the insulin up and down 20 times?
6. Do you know that shaking or jarring can make insulin more likely to frost or clump?
7. Do you know that excess amount of insulin does not squirt back into the vial?
8. Do you know that insulin vials or cartridges should not keep in the glove box of a car?
9. Do you know that outdated (expired) insulin never be used?
10. Do you know that high temperatures/light/heat exposure can alter the effectiveness of insulin?
11. Do you know that cold insulin may sting and the action could be delayed?
12. Do you know that insulin should not be frozen?
13. Do you know that the distance to rotate on the same site is one thumb?
14. Do you know the suggested measures to avoid or minimize pain with injections?

Figure 1

Knowledge of insulin storage and administration techniques

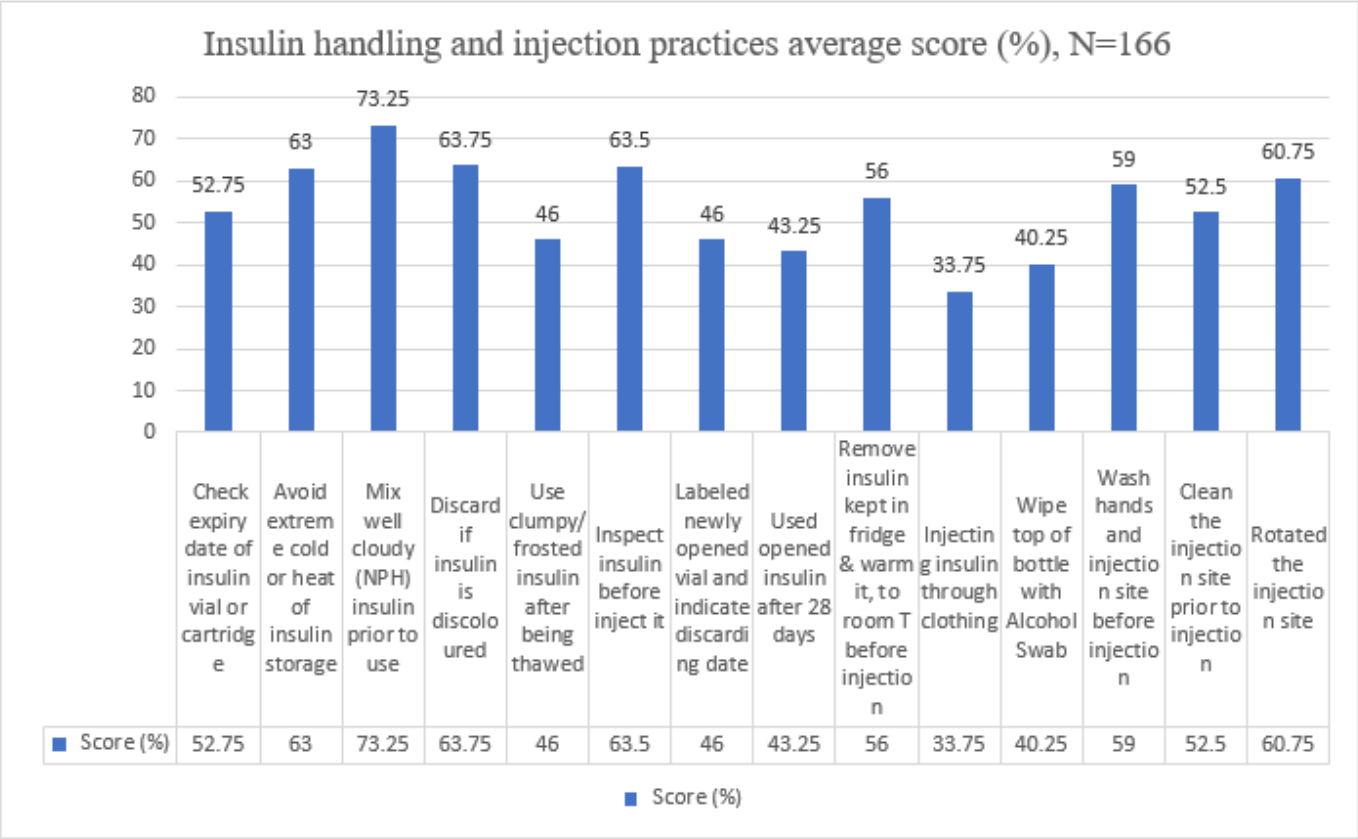


Figure 2

Insulin handling and injection experiences and practices

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Dataset.sav
- Strobestatementforstorage.docx
- Toolsofinsulinstorage.docx