



Education of Correct Insulin Injection Technique amongst Diabetic Patients: Outcome Study from Malaysia

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ABSTRACT

Effect of insulin relies on correct dose and appropriateness of insulin injection technique. However, inappropriate technique is common among diabetes patients. The impact of educating proper technique in these patients is still under studied. To evaluate the outcome of education of insulin injection technique to diabetes patients who are on insulin therapy in a Malaysian primary care clinic. A total of 114 diabetes patients on insulin were randomly selected in this prospective study. Participants' injection technique and HbA1c were assessed at baseline and 3 months later. After initial assessment, all participants were taught on proper technique of injection. Those with inappropriate technique were given individualized coaching. Majority participants (86.8%; 99/144) had appropriate technique at baseline and 67.7% (66/99) of them managed to improve their technique after intervention. There was 0.82% reduction in HbA1c observed among all participants, mean (SD) HbA1c at baseline was 9.9 (2.11)% and at post-intervention was 9.1 (2.16)%, ($p < 0.01$). Inappropriate insulin injection technique is very common in current study. With focused education, 67.7% (66/99) of the respondents' had improvised their injection technique. There was 0.82% reduction in HbA1c measurements within 3 months post intervention {pre 9.9 (SD 2.16) %, vs post 9.08 (SD 2.16) %}. There is a necessity to assess insulin injection technique during every follow-up. Health care providers need to identify and rectify the incorrect the technique as it may improve the glycaemic control among diabetes patients who are on insulin devices.

Keywords: Diabetes mellitus, Insulin injection Technique, Malaysia

INTRODUCTION

Diabetes Mellitus (DM) is now a major health problem causing significant mortality and morbidity. Globally, it is becoming a great burden to the health system with the number of adult with diabetes in the world on the arising trend [1]. The majority of this increase occurs in developing country, including Malaysia [2]. It was found from National Health and Morbidity Survey III (NHMS III) that the prevalence of diabetes in

population aged more than 30 year has escalated by 80% within 10 years duration [3].

Insulin was first discovered by two young Canadian scientists in 1921. Since the discovery, insulin is the biggest miracle in medical history. Insulin has been the foundation of diabetes care in which it provides a great therapeutic effect towards achieving optimal glycemic control in type 2 diabetes [4]. Insulin is the most effective agent to reduce high sugar. Insulin commencement in type 2 diabetes has shown encouraging outcomes on endogenous insulin secretion as well as metabolic control [5]. Furthermore, it is also preventing the damage; not only to the beta cells in the pancreas but also to the endothelial lining [6].

Nowadays, injecting insulin is much easier with new innovation in which insulin is delivered via the use of insulin pen. Prefilled and reusable pen are the two types of insulin pen available in majority of the clinics and hospitals in Malaysia. The use of insulin pen makes insulin injection far easier, suitable and produces more precise mode of insulin delivery that would improve insulin compliance [7]. Appropriate titration of dosages and proper selection of the type of insulin are the factors identified in achieving good sugar control in diabetes patients who are on insulin treatment [6]. More recently, it has been proposed that not only dosages and types of insulin, but the technique of insulin injection plays a crucial role for successful use of insulin [8]. Maximum effect of insulin relies on the adequate dose being injected using the most appropriate insulin injection technique.

In some centres, the education about technique of injection maybe delivered only once and there is possibility that the technique is not being rectified. It is a common practice education on insulin injection technique is performed by the principal instructors; diabetic nurse or pharmacist. There are patients who are prone to practise their own technique of injection that may differ from standard techniques. Checking injection technique and it's complications probably often not being carried out in a usual busy clinical setting. However, ensuring proper insulin injection practices should be one of the important aspects to be considered. It was noted that insulin injection technique among diabetes patients were not following the standards or guidelines provided to them [8-9]. Correcting the technique will improve HbA1c [10] and reduces the local side effects at injection sites [8, 11].

There are several studies done to see the issues of insulin injection practices among diabetes patients. Most of the studies revealed that the insulin injection practices did not reach the standard desired [8-9, 11]. Although the technology of insulin delivery has improved lately, unfortunately the technique of insulin injection among our patients may remain questionable. Hence, the bothering trends and practices still persist [12].

There is a need to carry a study to observe the practices of insulin injection among diabetes patients who are attending in a primary care clinic. Our aim is to evaluate the impact of insulin injection technique education towards patients' practise and glycaemic control.

MATERIALS AND METHODS

A prospective study was conducted at a semi-urban health clinic in Hulu Langat District, Selangor, Malaysia. The clinic received almost 500 clients per day. Systematic randomized sampling method was used for this study. A total of 138 patients were selected from a list of patients who are on insulin treatment under this clinic follow-up. The inclusion criteria was diabetes patient aged more than 18 years old. Those patient used other than standard insulin pen such as syringe or needle were excluded. All respondents were given interviewer assisted questionnaire to be completed. Information about the latest HbA1c level for each patient was retrieved from their medical records.

Participant's insulin injection technique was assessed by a single researcher. The education on proper insulin injection technique was delivered using placebo injection device. This session was conducted individually as individualization of education may promotes participation of the respondents with the educational intervention [13]. The time required for each session was approximately 20 minutes. Content of the insulin injection technique education was standardized for each patient. Patient was given an appointment three months later to reassess their injection technique and HbA1c level. Gentle reminders were delivered to them to ensure high turnover for the follow-up. They were prompted to maintain healthy lifestyle and proper diet.

Prior to the study, approvals from the Research and Ethical committee of Faculty of Medicine University Kebangsaan Malaysia (FF-217-2012) and the Medical Research Ethic Committee, Ministry of Health Malaysia were obtained. This study was also registered with the National Medical Research Registry.

Statistical Analysis

Data analysis was carried out using the Statistical Package for social Sciences (SPSS) software version 20. The information on the participants' socio-demographic, socioeconomics, diabetes and insulin injection practices were analysed using descriptive statistics such as frequency and percentage. Chi square test was applied to identify the association between categorical data. Student's t-test and Mann Whitney test was used to analyse association between dependant variable and continuous data. Multivariate logistic regression was used to identify determinants for appropriate injection technique post-education. P-value less than 0.05 was considered to be statistically significant.

RESULTS

A total of 138 patients participated in the study. Twenty three patients did not come for second visit of the reassessment of insulin injection technique post education and one patient was transferred to another clinic during the study duration due to logistic reason. Therefore, the total number of participants in this study was 114, making the response rate of 82.6%.

The mean (SD) age of the participants was 56.6 (10.0) years old. Almost two-thirds were females (59.6%) and Malays ethnicity formed half of the participants (50.9%), followed by Chinese (25.4%), Indian (22.8%) and others (0.9%). Participants with secondary education formed almost two-thirds (57.9%) of the study population.

Insulin Injection Practices

Table 1 shows that about one-fifth (21.0%) recapping the needle before disposing. In response to insulin storage, majority (83.3%) kept the insulin in use under room temperature. Most of the respondents (95.6%) injected insulin at the abdomen, with very small percentage (4.4%) injected at the thigh. None of the participants injected insulin at the buttock or deltoid areas.

Table 1: Insulin injection practices (n=114)

Practice	Frequency(n)	Percentage(%)
No of times each needle used		
1	5	4.4
2	19	16.7
3	64	56.1
>4	26	22.8
Sealed container		
Trash after protecting	24	21.0
Trash directly	88	77.2
Buried	1	0.9
Roomtemperature		
Refrigerator	19	16.7
Abdomen		
Thigh	5	4.4
Buttock	0	0
Deltoid	0	0
Small areas (20 x 25mm)		
Large areas (105 x 108mm)	57	50
Performed		
Not performed	5	4.4
Nil		
Lipohvperthrophy	24	21.1
Lipoatrophy	5	4.4
Bleeding	19	16.7
Bruising	10	8.8
Inflammation	1	0.9

Steps of Insulin Injection Technique Pre-Education and Post-Education

Majority of the participants (93.9%) did not check the expiry date of cartridge and/or the amount of insulin left. Even after the education, only 54.4% performed this step appropriately. About half of the participants

(50.9%) turned the pen up and down and/or roll the pen for 10 times. The percentage of participants who performed this step correctly increased to 91.2% after the intervention (Table 2). All participants managed to fit the new pen needle. Performing air-shot (priming) by dialling 2 to 4 units of insulin before the injection were executed by 28.1% of the participants. The number of participants who performed these steps appropriately after education technique increased to 76.3%. The steps of counting to 10 prior to removing needle from skin or also known as 'dwell time' was observed in more than half (62.3%) of the participants even during pre-education stage. The numbers of participants who performed this step after re-education of technique increased to (93.9%) (Table 2).

Table 2: Steps of insulin injection technique Pre-Education and Post-Education

Steps of insulin injection technique	Pre-education (n=114)		Post-education (n=114)	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Check expiry date of cartridge and/or amount of insulin left				
Done	7	6.1	62	54.4
Not done	107	93.9	52	45.6
*Turn the pen up and down and/or roll the pen 10X				
Done	58	50.9	104	91.2
Not done	56	49.1	10	8.8
*Dial 2-4 unit to perform air-shots				
Done	32	28.1	87	76.3
Not done	82	71.9	27	23.7
Choose a site for injection				
Done	66	57.9	105	92.1
Not done	48	42.1	9	7.9
Dial required dose				
Done	114	100	114	100
Not done	0	0	0	0
Pinch the skin				
Done	52	45.6	98	86
Not done	62	54.4	16	14
*Insert needle smoothly into skin and press plunger until the button stop moving				
Done	112	98.2	114	100
Not done	2	1.8	0	0
*Count to ten before removing needle from skin (dwell time)				
Done	71	62.3	107	93.9
Not done	43	37.7	7	6.1
Check to make sure you see a '0' in the dose window				
Done	50	43.9	97	85.1
Not done	64	56.1	17	14.9

**crucial technique for appropriate score*

Table 3, shows that the total number of participants that fall into the category of appropriate technique was 13.2% before the education. After intervention, the number of participants who had appropriate technique had increased to 71.9%.

Table 3: Insulin injection technique appropriateness

	Pre-education (n=114)		Post-education (n=114)	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Appropriate	15	13.2	82	71.9
Inappropriate	99	86.8	32	28.1

HbA1c Levels Pre-Education and Post-Education

The mean (SD) HbA1c pre-education was 9.90 (2.16%). Following the intervention, the mean (SD) was 9.08 (2.16). There was as much as 0.82% reduction in HbA1c measurements within 3 months duration. Paired t test showed significant improvement in HbA1c pre education and post education with p value of < 0.001.

Table 4: HbA1c Levels Pre-Education and Post-Education

Variables	Pre-education	Post-education	t statistic (df)	p value*
	Mean (SD)	Mean (SD)		
HbA1c (%)	9.90 (2.16)	9.08 (2.16)	-5.98 (113)	<0.001*

*paired t test, significant < 0.05

Association between Socio-Demographic Data with Insulin Injection Technique Appropriateness at Post Education

There was no significant statistical association between gender, ethnicity, education level and the marital status with the appropriateness of insulin injection technique at post education. The only socio-demographic factor that associates with the appropriateness of technique during post intervention was age (Table 6). Mean age among respondents with appropriate insulin technique was higher compared to non-appropriate { 55.1 (\pm 9.9) versus 60.4 (\pm 9.3) years, p value= 0.01 }.

Table 6: Association between Socio-Demographic Data with Insulin Injection Technique Appropriateness at Post Education

Variable	Appropriate n(%)	Inappropriate n(%)	X2 (df)	p value*
Gender			0.001(1)	0.970
Male	33 (71.7)	13 (28.3)		
Female	49 (72.1)	19 (27.9)		
EthnicMalay			0.75 (3)	0.861
	43 (74.1)	15 (25.9)		
Chinese	20 (69.0)	9 (31.0)		
Indian	18 (69.2)	8 (30.8)		
Others	1 (100.0)	0 (0.0)		
Education level None			1.58 (3)	0.660
	4 (66.7)	2 (33.3)		
Primary	23 (65.7)	12 (34.3)		
Secondary	49 (74.2)	17 (25.8)		
Tertiary	6 (85.7)	1 (14.3)		
Marital statusSingle			3.63 (3)	0.304
	4 (80.0)	1 (20.0)		
Married	69 (75.0)	23 (25.0)		
Divorced	1 (50.0)	1 (50.0)		
Widowed	8 (53.3)	7 (46.7)		

Multivariate analysis was done to control confounding factors for identifying independent factors that may contribute to the appropriate insulin injection technique after the education given (Table 7). Based on the previous bivariate analysis, any factors with p value of less than 0.25 were selected as co-variables for further analysis. Age was independently associated with appropriate insulin injection technique at post intervention with $p=0.013$. Each increment in a year of age among participants was associated with 9% chance of having appropriate insulin injection technique at post education.

Table 7: Predictors for appropriate insulin injection technique post intervention

Variables	wald	Adjusted OR (95% CI)	P value
Insulin duration	1.362	0.908 (0.772, 1.068)	0.243
Age	0.944	0.944 (0.903,0.988)	0.013

DISCUSSION

This study was conducted to gauge the outcome of education of insulin injection technique to diabetes patients who are on insulin therapy in a primary care clinic. The mean (SD) age of the participants in this study was 56.6 (10.0) years old. This figure is comparable to the local study done by Benny E. *et al*, in which the mean (SD) of patients who were on insulin treatment was 55.1(13.8) [14]. A study in western countries reported older mean age of patient of 60 years old who were using insulin [9].

Five diabetes-related characteristics assessed in this study are the duration of diabetes mellitus, duration of insulin treatment, type of insulin regime, total daily insulin dose and frequency of insulin injection per day. The mean (SD) duration of diabetes in this study was relatively younger 10 (9) years compared to other studies the mean duration of diabetes who was on insulin treatment ranging between 13.9 and 14.7 years [9][11]. Current study revealed that 77.2% of the diabetics patients disposed the sharps away directly into the thrash without protecting the tip. Meanwhile, in the European study, 47% disposed their needle after recapping the tip and only 22% threw the needle directly into the thrash without protecting the tip [11]. One of the possible reasons maybe patients in current study are not exposed on how to dispose used needles during previous consultations. Proper disposal technique should be delivered ever since they are being prescribed with this medication. This information needs for further reinforcement throughout the course of treatment. Potential environmental and safety hazards to other people such as rubbish collectors and cleaners may need to be explained. Issues of needle prick injuries should be considered as part of insulin education content. This important facts perhaps able to motivate them to practice proper way of disposing sharps and dangerous materials.

Majority (95.6%) of the participants in this study injected insulin at the preferred site as being suggested by various guidelines. Only 4.4% injecting insulin at the thigh region. It is almost comparable with the European study of insulin injections in which 85% of their participants injecting insulin at the abdomen. There are four sites over which patients can inject their insulin. It is either at the abdomen or thigh or arms or buttocks. In this study, most of the participants were comfortable injecting the insulin at the abdomen.

Nine steps were assessed with four crucial steps for appropriate technique. The first step was checking the expiry date of the cartridge or amount of the insulin left. Less than one-fifth of the respondents (16.1%) performed this step at pre-education stage. Following education, the percentage was increased to 46.6%. Possible reason for this finding is that they may believe that they would dispensed with new insulin cartridges each time they refill prescriptions. Another reason maybe because the expiry date that was printed on the cartridge was too small for the patients to read [16].

The steps of insulin injection are often difficult to grasp at first, especially among the elderly patients. Most of the patients did not understand the reason behind performing certain steps and the effect when some crucial steps were missed out or incorrectly performed. The continuous education and periodic assessment of the insulin injection technique is important in order to overcome this problem. Only 13.2% respondents were categorized into appropriate technique at the pre-education stage but the percentage increased to 71.9% following intervention. Patient education may need to be reminded on proper technique continuously and maintained throughout their contact with health care providers [17]. The positive impact of re-education have showed that errors in injection technique had decreased by 58% and insulin dose had decline significantly [18]. The other study done revealed there was significant improvement in technique score before and after counselling of correct insulin injection technique [19].

In current study, improvement in mean HbA1c may be influenced by few factors, as there was no controlled group to compare the results with. However, this study can be considered as a pilot study for the local population. Although the reduction of HbA1c was only 0.8%, but it can considered as significant. For each percentage point of A1C reduction, there was as much as 35% decline in the presence of microvascular complications among diabetes patients [20].

A study from Japan looking at the technique of insulin injection and the relation with glycaemic control concluded that re-education of insulin injection technique had led to the improvement in the glycaemic control in insulin treated diabetic patients especially those with poor technique [18].

In current study, the only determinant for appropriate insulin injection technique is age of the respondents. Patients with advancing age has better potential to benefit from individualized insulin technique coaching. However, to our best knowledge there was no study has examined the relationship between age and the appropriateness of insulin injection technique.

Limitations of this study needs to be considered. Study period is limited hence we unable to projects the long term sustainability of this interventional program towards patient's insulin injection technique. There is wide range variability in insulin injection technique or appropriateness by used by other researchers, therefore direct comparison of the findings is quite difficult.

CONCLUSION

This current study found that an inappropriate insulin injection technique is very common. With focused education, 67.7% (66/99) of the respondents' had improvised their injection technique. The steps that needed extra attention were the step of rolling the pen and performing air-shot as two-thirds of patients did not perform these steps during the study. The mean reduction of HbA1c within 3 months post intervention was 0.82%. There were significant association between age and duration of insulin treatment with the appropriateness of insulin at post-intervention. Health care providers may need to identify and rectify the incorrect the technique as it may improve the glycaemic control among diabetes patients who are on insulin devices. A proper randomized controlled trial can be planned in future to determine sustainability of individualized insulin technique in primary clinic settings.

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REFERENCES

- [1] King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care*. 1998;21(9):1414-31.
- [2] Letchuman GR, Wan Nazaimoon WM, Wan Mohamad WB, Chandran LR, Tee GH, Jamaiyah H et al. Prevalence of Diabetes in the National Health and Morbidity Survey III (Letchumanan). *Med J Malaysia*. 2006;65:2-12.
- [3] Turner RC. The U.K. Prospective Diabetes Study. A review. *Diabetes Care*. 1998;21Suppl 3:C35-8.
- [4] Spellman CW. Insulin therapy for maximal glycemic control in type 2 diabetes mellitus. *J Am Osteopath Assoc*. 2007;107(7):260-9.
- [5] Alvarsson M, Sundkvist GO, Lager I, Henricsson M, Berntorp K, Forbes EF et al. Beneficial Effects of Insulin Versus Sulphonylurea on Insulin Secretion and Metabolic Control in Recently Diagnosed Type 2 Diabetic Patients. *Diabetes Care*. 2003;26:2231-7.
- [6] Hirsch I, Bergenstal R, Parkin C, Wright Jr E, Buse J. A real-world approach to insulin therapy in primary care practice. *Clinical Diabetes*. 2005;23(2):78.
- [7] Bohannon N. Insulin delivery using pen devices. Simple-to-use tools may help young and old alike. *Prostgrad Med*. 1999;106:57-61.
- [8] Strauss K, Gols HD, Letondeur C, Matyjaszczyk M, Frid A. The second injection technique event (SITE), May 2000, Barcelona, Spain. *Practical Diabetes International*. 2002;19(1):17-21.
- [9] De Coninck C, Frid A, Gaspar R, Hicks D, Hirsch L, Kreugel G et al. Results and analysis of the 2008-2009 Insulin Injection Technique Questionnaire survey. *Journal of diabetes*. 2010;2(3):168-79.
- [10] Matsumura M, Monden T, Nakatani Y, Shimizu H, Banba N, Hattori Y, Kasai K. Improvement Of Glycemic Control By Reeducation In Insulin Injection Technique - DiabetesPro - American Diabetes Association [Internet]. 2007 [cited 4/7/2016]. Available from: <http://professional.diabetes.org/abstract/improvement-glycemic-control-reeducation-insulin-injection-technique>
- [11] Strauss K, Gols H, Hannet I, Partanen T, Frid A. A pan-European epidemiologic study of insulin injection technique in patients with diabetes. *Practical Diabetes International*. 2002;19(3):71.

- [12] King L. Subcutaneous insulin injection technique. *Nurs Stand.* 2003;17(34):45-52.
- [13] Teresa LP. Practical aspect of insulin pen devices. *Insulin.* 2007;2(4):173-81.
- [14] Influence of diabetic education on patient well-being and metabolic control. *DiabetologiaCroatica.* 2004;33:3.
- [15] Bruttomesso D, Costa S, Dal Pos M, Crazzolara D, Realdi G, Tiengo A et al. Educating diabetic patients about insulin use: changes over time in certainty and correctness of knowledge. *Diabetes Metab.* 2006;32(3):256-61.
- [16] Baradaran HR, Knill-Jones RP, Wallia S, Rodgers A. A controlled trial of the effectiveness of a diabetes education programme in a multi-ethnic community in Glasgow [ISRCTN28317455]. *BMC Public Health.* 2006;6:134.
- [17] Scain SF, Friedman R, Gross JL. A structured educational program improves metabolic control in patients with type 2 diabetes: a randomized controlled trial. *Diabetes Educ.* 2009;35(4):603-11.
- [18] American Diabetes Association. Insulin administration. *Diabetes Care.* 2004;27(1).
- [19] Influence of diabetic education on patient well-being and metabolic control. *DiabetologiaCroatica.* 2004;33:3.
- [20] Attention to injection technique is associated with lower frequency of lipohypertrophy in insulin treated type 2 diabetic patient. *Diabetologia.* 2011;05(05):2-3.