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Injection practices among the diabetes patients on insulin therapy in Chitradurga

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ABSTRACT

Background: Diabetes mellitus has emerged as a global health problem. Insulin is the essential treatment modality for significant number of diabetic patients. Nearly 4 out of 10 patients with T2DM in India are using insulin, either alone or in combination with oral hypoglycemic drugs (OADs). The present study was conducted with the objectives to assess the knowledge and insulin injection practices, risk factors of sharps injury among diabetic patients who are on insulin treatment.

Methods: Cross sectional study was conducted at a Basaveshwara hospital, Chitradurga, among diabetic patients on insulin treatment for minimum of past 6 months. Insulin injection technique questionnaire (ITQ) was administered to study participants and proforma was filled by interview technique.

Results: 100 patients participated in the study. Syringe and needle device and 6 mm needle are most commonly used devices. 5-10 seconds was the most common duration of time (54%) for which the patients continued to keep the needle inserted in injection site after insulin injection. A 26% patients had lip hypertrophy at injection sites. Among households of the insulin users, a high percentage of children (41%) and house keeper/waste collectors (32%) were at risk of sharps injury. A majority of 55% of the insulin users reported that they didn't have appropriate disposal containers for the used sharps.

Conclusions: A 29% of participants did not practice proper rotation of injection site. Reuse of insulin needles was common practice. Pain/tenderness, lipo-hypertrophy and leakage of insulin after injection were noted at injection site. 10 seconds dwell time was reportedly practiced by only 23%, about half of patients skipped insulin injections and didn't follow appropriate disposal of used sharps, thereby exposing both family members and waste collectors/handlers to higher risks of sharps injuries.

Keywords: Insulin injection technique, Diabetes mellitus, Lipodystrophy, Insulin site reactions, Dwell time

INTRODUCTION

Diabetes mellitus is a global health problem which has increased in epidemic proportions. Globally around 366 million people are suffering from diabetes, among whom about 3/4th are belonging to low- and middle-income

countries.¹ About 5 million deaths are attributed to diabetes. The challenging aspect is that about 50% of those with diabetes remain undiagnosed. India has approximately 65 million people with diabetes and the magnitude is expected to rise beyond 101million by 2030. Diabetes is contributing to 3.1% of total deaths and 2.2% of total disability adjusted life years (DALYs) in India.

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There is a wide range of variation in prevalence rates across Indian subcontinent (5-17%) with highest prevalence recorded in South Indian states and in Delhi.^{2,3}

Insulin is the essential treatment modality for significant number of diabetic patients.3 Nearly half of diabetic patients are using Human insulin, its analogs and glucagon-like peptide-1 receptor agonists for antidiabetic treatment either alone or in combination with oral hypoglycemic drugs (OADs). For better bio-availability and to achieve glycemic control, correct insulin injecting techniques have to be followed by the patients.⁴ The improper insulin injection techniques will also result in local adverse events such as Lipodystrophy which comprises of lipo hypertrophy (LH) and lipoatrophy (LA). These adverse events are caused by chronic reuse of needles and injections at the same site, improper or lack of rotation of sites. LH retards insulin absorption significantly and can have an adverse effect on diabetes control.5-8

It is evident from the previous studies that the awareness about insulin injection technique significantly influences adherence, outcome of treatment. These highlight the need to understand the existing knowledge, attitude and practice regarding insulin usage technique among diabetic patients.⁴ With this background, the present study was conducted at a tertiary care Basaveshwara hospital in Chitradurga, among diabetes patients on insulin treatment. The aim and objectives of the study were a) to assess the knowledge and insulin injection practices, b) to assess the risk factors of sharps injury among them.

METHODS

A cross sectional study was conducted in the outpatient department (OPD) of General Medicine, Basaveshwara Medical College Hospital and Research Centre, Chitradurga, after obtaining ethical clearance from Institutional ethics committee. All the patients diagnosed to be suffering from diabetes mellitus (type 1 DM, type 2 DM, gestational diabetes mellitus), and being treated by insulin therapy for a minimum duration of past 6 months, attending the OPD of Dept. of General Medicine, of this hospital, during Jan 1, 2018 to June 30, 2018 (6 months) were included in the study. The patients were explained the purpose of the study and their informed consent was obtained. Participants were required to have used insulin for at least 6 months. In order to eliminate selection bias, all the consecutive eligible patients who gave consent and who fulfilled the eligibility criteria were included in the study. A standard and validated insulin injection technique questionnaire (ITQ) was administered to the study participants by interview technique.⁶

The study questionnaire collected the information regarding the socio-demographic and anthropometric details of the patient, type of DM, average duration of DM, average duration of treatment, details of insulin dosage and insulin type used by these participants. Details

of knowledge of patients regarding insulin injection techniques, number of episodes of hypo and hyperglycemia, hospitalizations for hypoglycemia, diabetic ketoacidosis, glucose variability, unexpected hypoglycemia, safety precautions followed during injection, needle stick injuries, risk factors for sharps injuries and disposal habits for used sharps, were also collected.

Besides these parameters, the ITQ questionnaire also queried key insulin injection methods such as 'current practice' which consisted of details of the injection device used, needle length, number of injections per day, choice of injection site, technique of injection such as skin fold characteristics, needle entry angle, dwell time of needle time under the skin. Details regarding needle reuse, sharps injury and the risk factors for the needles/sharps injury were also elicited. Observed anomalies at the injection site included insulin leakage, bruising, lipoatrophy, lipo hypertrophy, inflammation and tenderness which were recorded by the investigator.

Statistical analysis

The data was compiled in Microsoft excel spread sheet and analysed using SPSS for windows version 16.0. All the characteristics are summarized descriptively. For continuous variables, the summary statistics of N and mean are used. For categorical data, the number and percentage are used in the data summarized.

RESULTS

A total of 100 patients who fulfilled the study criteria participated in the study. 56% of participants were males, 44% were females. A majority of 87% of patients were suffering from type 2 DM (T2DM), 11% had type 1 (T1DM) and 2% had gestational (GDM). The average age and BMI (Body mass index) of participants were 50.5±1.9 years and 26.1±4 kg/m² respectively. The average age at diagnosis of DM among these patients was 40.1±3 years. The patients had been on OHA treatment for an average duration of 10.5±1.4 years and were on insulin therapy for an average duration of 4.2±2 years. Majority of the participants were self-injecting adults (98%), 2% of the participants were self-injecting adolescents. There were no self injecting children in the study (Table 1).

Most commonly used device by the participants for insulin injection is syringe and needle (59%) followed by insulin pen (38%). A 3% of participants used either pen or syringe. The length of 6mm needle (59%) is most commonly used needle length by the patients. A 25% of participants used 4mm needle, 15% used 5mm needle and least commonly used (2%) needle length is 8mm (5%). A majority of both pen and syringe-needle device users reported that they practiced repeated reuse of the needles. A maximum of 52% of participants reported that they reused the same needle for 3-5 times (Table 2).

The Table 3 shows the details regarding the type of insulin used by patient, the injecting frequency and injection site. It was found that Premix human or analogue was the most commonly used insulin (55%), followed by short-acting human insulin (25%). A majority of 67% of patients were taking 2 injections per day. The most commonly used injection site was thigh (46%) and abdomen (29%), followed by arm (25%). Correct rotation of the injection site was practiced by 71% of the patients.

Table 1: Characteristics of the patients.

Variable	Percentage (%) (n=100)
Average age of the patients (mean±SD) (yrs)	50.5±1.9
Sex (%)	
Male	56
Female	44
Average BMI (body mass index) (kg/m²)	26.1±4
Average number of years with DM (yrs)	12.1±4
Average age at diagnosis (yrs)	40.1±3
Average number of years on pills (yrs)	10.5±1.4
Average number of years on insulin (yrs)	4.2±2
Self-injecting adult (18 years old or older)	98
Self-injecting adolescent (13-17 years old)	2
Self-injecting child (<13 years old)	0
Parent who gives injections to child/adolescent	0
Type and dosage of Insulin (%)	
TDDa regular (IU)	53
TDD rapid analogues (IU)	Not used
TDD NPH (IU)	17
TDD basal analogues (IU)	21
TDD premix (IU)	34
Overall TDD (IU)	35
Average HbA1c level (gm%)	8.9±1.1

TTD (total daily dose) of insulin is the combined total of all insulin used in 1 day in IU (international units).

The details regarding the injecting technique practiced by the patients are enumerated in the Table 4. It was found that 5-10 seconds was the most common duration of time (54%) for which the patients continued to keep the needle inserted in the injection site after insulin injection. A 17% of patients kept the needle in the injection site for less than 5 seconds, 23% of patients kept for more than 10 seconds, whereas 6% reported that they were not aware about how long the needle was supposed to be kept in the place of insertion (Table 4).

Table 2: Details of the device usage practices.

Variable	Percentage (%) (n=100)			
Device use				
Syringe	59			
Pen	38			
Pump	0			
Pen or syringe	3			
Needle length used (mm)				
4	25			
5	15			
6	59			
8	02			
Needle reuse (n=38) (%)				
Among insulin pen users				
Reuse practiced	32 (84)			
Reuse not practiced	6 (16)			
Among syringe-needle users (%)				
Reuse practiced	47 (78)			
Reuse not practiced:	12 (22)			
Number of times needle reused (n=100)				
Reuse not practised	18			
2 times reusage	14			
3–5 times reusage	52			
6–10 times reusage	8			
>10 times resuage	8			

Table 3: Details of type of insulin used, injection frequency and injecting site.

Parameters	Percentage (%)	
Type of insulin		
Short-acting human (R or regular)	25	
Rapid-acting analogue	Nil	
NPH	8	
Long-acting analogue	12	
Premix human or analogue	55	
Number of injections/day		
1	20	
2	67	
>3	13	
Injection sites used		
Abdomen	29	
Thigh	46	
Buttocks	0	
Arm	25	
Correct rotation of injecting site		
Yes	71	
No	29	
Total	100	

Table 4: Details of injecting technique practiced by the participants.

Parameter	Percentage (%) (n=100)	
Cleaning injection area with spirit before injecting		
Regular	62	
Irregular	38	
Duration of keeping the pen inserted in the injection site after pen injection (s)		
<5	17	
5–10	54	
>10	23	
"Not aware of how long"	6	
Timing of release of skin-fold		
Once the needle is in the skin	17	
Once the insulin is totally injected and before the needle was removed from the injection site	35	
Once the insulin is injected and the needle is removed from the skin	48	
Number of times cloudy insulin tippe	d or rolled	
before injecting among the reconstituting insulin		
users (n=63)		
<10 times	9 (14.2)	
10 times	53 (84.1)	
20 times	1 (1.6)	
Frequency of skipping injections (n=100)		
Often (several times a week)	9	
Sometimes (several times a month)	53	
Almost never (several times a year)	38	
Angle of needle (n=100)		
Inject into a skinfold	79	
Inject into skin at 90°	21	

Table 5: Insulin injection site.

Parameter	Percentage (%) (n=100)
Pain or tenderness or inflammation at insulin injection site	67
Lipoatrophy	4
Lipohypertrophy	26
Leakage of insulin after injection	22
Scarring	15
Insulin syringe match	
Insulin and syringe match	90
Insulin and syringe mis-match	10

A majority of 48% of the participants reported that they released the skin-fold of injection site after the injecting insulin and removing the needle from the injection site. 35% reported that they released the skin fold as soon as the insulin was injected and before the needle was removed from the injection site, whereas 17% reported

that they released the skin fold as soon as needle was inserted in the skin, before injecting insulin (Table 4).

Table 5, depicts the local injection site reactions. It was found in this study that 67% of patients had complains of pain in the injection site, 26% had lipohypertrophy in the injection sites, 22% reported that there was leakage of insulin after injection and 15% reported presence of scars at injection sites.

Table 6: Risk factors for sharps injury.

People in household at risk of sharps injury	Percentage (%) (n=100)
Children	41
Other family members (e.g., spouse)	25
Nurse or other professional	2
House keeper or rubbish collector	32
Risk factors for sharps injury	
I don't use devices that prevent injuries to others (safety devices)	20
I don't have appropriate disposal containers for my used sharps	55
Used sharps are sometimes left in places where others might get stuck	25
I'm positive for hepatitis or another blood-borne illness	0
Where are they disposed?	
Into a container specially made for used sharps	0
Into a home container such as an empty bottle	10
Into the general waste bins with the cap on	69
Into the general waste bins without recapping	21
I clip off the needle and it stays in the clipper	0

Table 6, depicts the risk factors for the needle/sharp's injuries and details of the people at risk of these injuries in the household of the patients. It was found that among the households of the insulin users, a high percentage of children (41%) and house keeper/waste collectors (32%) were at risk of sharps injury.

A majority of 55% of the insulin users reported that they didn't have appropriate disposal containers for the used sharps. A 25% of patients also reported that they sometimes left the sharps in places where others could have been at risk of getting needle prick injuries. None of the patients had a container specially made for used sharps. Most of 69% of users disposed the needles into the household waste with the cap on, whereas 21% disposed into the household waste without recapping. (Table 6).

DISCUSSION

Appropriate insulin injection technique is an indispensable part of diabetes management. The present study was an attempt to understand the knowledge and prevalent insulin injection practices followed by the diabetic patients. The participants in the present study were suffering from diabetes mellitus for an average age of 12.1±4 years. They were on insulin therapy for an average of 4.2±2 years. Their mean HbA1C levels were higher (8.9±1.1gm%) which shows that there is a need for better control measures to be adopted by them. The findings of this study are comparable with the study done by Kalra et al (Table 1).6

People with diabetes (PWD) on insulin therapy, can inject insulin by either syringe and needles or insulin pens. The syringe is the primary injection device used in India.⁵ Similar higher percentage of usage of syringes as injection devices (59%) is found in the present study also (Table 2). Insulin is available in the strengths of U-40, U-100, U-200 (insulin pen) and U-300 (insulin pen). To avoid dosing errors, syringes that match the concentration of U-40 and U-100 concentrations must be used. For the needle-syringe users, 6mm or shorter needles usage is recommended, so as to ensure the delivery of correct dosage of insulin subcutaneously and to minimise accidental intramuscular administration risk. 9,10 Needles longer than 6 mm are not recommended in adolescents or adults. Extremely lean patients should be using a skin fold to inject even with a 4 mm and 5 mm needle.8 In the present study 59% of patients used needle length of 6 mm, and a majority of 79% patients practiced injecting into the skinfold (Table 2 and 4).

Faulty injection techniques including reusage of injecting devices have potential to cause a spectrum of adverse effects like pain, bleeding, contamination, inaccurate dose, lipohypertrophy among others. Correct injection technique and use of shorter needles (4 mm) are known to be associated with improved glucose control, greater satisfaction with therapy and lower consumption of insulin after only a 3 month period.7 In the present study, 79% of patients practiced reusing of the needles. Half of participants (52%) reported that they reused the needle for 3-5 times. (Table 2) Although sterility is guaranteed with the first use of the syringe and pen needles, the potential for contamination increases with repeated use. Biological material may get trapped in the pen needles or cartridges after injection. Bacteriostatic agents are added to most insulins to stop bacterial growth; however, needle re-use can increase the risk of infection. 7,11,12

Correct site rotation is defined as always injecting at least 1 cm from a previous injection site, which will also safeguard the normal tissue. Insulin absorption is different from various injection sites. Quick absorption occurs from abdomen, followed by arms and thighs. Slow absorption occurs from buttocks. Better glycemic control can be achieved by consistently rotating insulin injections

within a set area. It also prevents the formation of scars, fatty deposits, and hard lumps. Sites that should not be injected include an approximate two-inch circle around the umbilicus and near to moles and scars due to the tougher skin and variable rates of insulin absorption. After injecting, the site should not be massaged but rather light pressure should be applied to minimize bruising. If it appears that a significant amount of insulin has leaked out after the injection, the patient should monitor his or her blood sugar more closely afterwards. This method of correct rotation of the injection site was practiced by nearly 3/4th of the patients in the present study (Table 3), which is comparable with the study conducted by Kalra et al. 8

Cleaning of injection site with sterile cotton swabs dipped in alcohol or water prior to injection is of utmost importance to ensure prevention of healthcare-associated infections.8 In the present study, it was found that only 62% of the patients practiced cleansing of skin before injection (Table 4). Some longer-acting insulins contain a predetermined ratio of either crystalline insulin and solvent or crystalline insulin and rapid-acting soluble insulin. The crystalline elements must be resuspended prior to each injection. Inadequate resuspension of NPH insulin before pen injection leads to concentrations of NPH and unpredictable clinical responses to it. 13,14 In the present study, it was found that 84% of patients using reconstituting insulin, rolled the insulin suspension 10 times as against the recommended norms of 20 times. Similar results are found elsewhere. 13

The insulin should be injected slowly, the syringe or thumb button of pen should be completely depressed, followed by wait period of 10 seconds after dose delivery. This ensures full dosage delivery, without leakage/reflux.¹¹ In the present study, 31% of pen users practiced dwell time of 5-10 seconds. Similar results are found in studies conducted by study done by IPEN study group and Kalra et al.^{8,12,13}

For Subcutaneous injection, a skin fold should be made with use of thumb and index finger. The sequence of injection should be a) make skin fold; b) inject insulin slowly; c) leave the needle in the skin for 10 seconds (when injecting with a pen); d) withdraw needle from the skin; e) release skin fold; f) dispose of used needle safely. In the present study, only 48% of the patients correctly practiced this method of releasing the skin fold after injecting and withdrawing the needle from the skin (Table 4). These findings are comparable with the studies done elsewhere. 8,13

Insulin site reactions like lipodystrophy (LD) are caused by reuse of needles. It occurs as localized lesion at the injection site. Two subgroups of LD are lipohypertrophy (LH) and lipoatrophy (LA). Lipohypertrophy is found to be associated with improper rotation of site of injection. In the present study more than half of patients had complains of pain in the injection site, one fourth of

patients reported to have lipohypertrophy in the injection sites and 22% reported that there was leakage of insulin after injection and 15% reported presence of scars at injection sites. These findings are comparable to the study of Kalra et al and Tandon et al. 8,9,15

Healthcare workers and also children, housekeepers, sanitation and sewage treatment workers are at risk of sharps injuries.⁷ The daily work of healthcare workers (HCW) puts them at risk of serious infections with potentially dangerous pathogens, including hepatitis B, hepatitis C and HIV, through injuries with contaminated needles. Options for discarding a used needle for patients after insulin injection are: a) into a container specially designated for used needles/syringes; b) if not available, into another puncture-proof container such as a plastic bottle. Options for final disposal of the container to give it to a Health Care facility (e.g. hospital); or to another health care provider (e.g. laboratory, pharmacist). Sharps materials should not be disposed of into the public general wastes. But, in the present study, nearly half of the participants reported that there were children (41%), house-keepers/ waste collectors (32%), other family members (25%) present in their houses, were at risk of needle stick injuries (Table 6). But, 55% of patients reported that they didn't have appropriate disposal containers for used sharps and 25% reported that the used sharps were often left in such places where others might get a needle prick injury. Nearly half of the patients disposed the needles into the household waste with the cap on, whereas 8% disposed in the household waste without the cap on (Table 6). Similar results are found in studies conducted elsewhere in India by the IPEN group and Kalra et al.8

CONCLUSION

The primary device for insulin injection purpose are syringes, followed by insulin pen. The most common needle length used are 6mm for syringes and 4 or 5mm needle for insulin pens. 29% didn't practice proper rotation of injection site. Reuse of insulin needles was common practice documented in the study. Most of the patients reused needles for upto 3-5 times. Pain/ tenderness, lipohypertrophy and leakage of insulin after injection were noted at site of insulin injection. Dwell time of 10 seconds was practiced by only 23% of patients. A high percentage of 53% patients reported to be skipping insulin injections several times a month. A 55% patients didn't have appropriate disposal containers for used sharps and a 21% of patients disposed sharps in general waste bins without recapping, thereby exposing both family members and waste collectors/handlers to higher risks of sharps injuries.

Recommendations

Proper rotation of injection site and avoidance of needle reuse can prevent lipo-hypertrophy which in turn can lead to better glycemic control. Awareness about the harmful effects of needle reuse has to be explained to the patients. There is also a need to instruct patients regarding the dwell time of 10 seconds after insulin is injected, so as to ensure full delivery of the injected dose. Proper disposal of sharps needs to be addressed. Potential adverse events to the patients' family (e.g. needlestick injuries to children) as well as to service providers (e.g. rubbish collectors and cleaners) should be explained. Initiatives to enhance diabetes education for both patients and caregivers can improve self-care behaviours, knowledge and attitude domains profoundly.

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