

ORIGINAL RESEARCH

A study to assess the effectiveness of a structured teaching programme on knowledge and practice of safe insulin administration among nurses in a tertiary care hospital: A pre-post design

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ABSTRACT

Background and objective: Diabetes Mellitus (DM) is not only a health issue but also an economic issue in India. Incorrect insulin injection techniques can lead to side effects such as pain, lipohypertrophy, and poor glycemic control. We designed the present study to assess nurses' knowledge about safe insulin administration and evaluate the role of a planned teaching programme on knowledge and practices of safe insulin injection techniques in a group of nurses in tertiary care hospital.

Methods: This is a pre-post design to study the effectiveness of the structured training programme - one hour of didactic lecture followed by demonstration of safe injection practices. Demographic data and knowledge about safe insulin practices were collected at baseline. We conducted two post training assessments—day one and three months after training. The injection practices were assessed using a check-list. We used the random effects linear regression model to identify factors associated with change in scores over these three observations.

Results: The mean (SD) scores for insulin knowledge at baseline was 6.81 (2.28). It significantly increased to 16.85 (1.84) immediately after training ($p < .001$). These scores reduced significantly after three months compared with post-training scores (14.18 [2.14]; $p < .001$). A significantly higher proportion of nurses had used re-suspension technique for insulin injection after three months (76.3% vs 52.5%, $p = .003$) and cleaned the injection site with alcohol swab before injection (93.8% vs. 75.0%, $p = .001$). On an average, knowledge scores changed by -0.15 (95% CI: -0.29, -0.02; $p = .03$) with each unit increase in age (years). The average score in nurses with a degree was significantly higher compared with those who had a diploma (1.02, 95% CI: 0.28, 1.76; $p = .007$).

Conclusions: The study demonstrated that insulin injection practices improve with adequate guidance and information. However, there is a need to have a regular training programme to sustain the practices. Certain practices such as site rotation and assessing lipo-hypertrophy, and the relation between these two should be emphasized in these sessions.

Key Words: Insulin injection, Technique, Knowledge, Practice

1. INTRODUCTION

Diabetes Mellitus (DM)—a chronic condition—may affect multiple organs and is an important global health condi-

tion.^[1] According to the Global Burden of Disease database, DM accounted for 2.23% of total Disability Adjusted Life Years (DALYs) in the in India, and 3.93% of DALYs among

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50-69 year old.^[2] Furthermore, DM accounted for 3.11% of total deaths and 4.67% of those who were more than 70 years of age.^[2] Another study found that drugs costs were an important economic burden in individuals with DM, particularly in the low-income groups in India.^[3] Thus, DM is not only a health issue but also an economic issue in India.^[4,5]

Though, authors have suggested the role of diet and exercise in management of diabetes; hormonal treatment with insulin, nonetheless, is an important treatment option.^[6] Insulin is considered to be a life-saving drug; however, regular access to low-cost insulin – particularly the newer analogue types – may be reduced in economically poor countries and individuals.^[1] When available, insulin should be administered appropriately for proper management of DM and reduction of side effects. It has been reported that incorrect techniques can lead to side effects such as pain, lipohypertrophy, and poor glycemic control.^[7-9] Injection techniques are considered to be very important and guidelines have been developed for proper insulin techniques globally and in various countries including India.^[10,11] These guidelines cover multiple aspects, such as counselling, selection of site, size of needle, storage, and addressing potential complications.^[10] Furthermore, health education to patients and nurses helps to reduce morbidity and mortality due to diabetes mellitus by improving knowledge of individual, family and community regarding diabetes management and insulin administration.^[12] Literature has also suggested that training programmes should be aimed at reducing the gap between theoretical knowledge and clinical practices in nursing care.^[13-16] Thus, training the individuals who administer the injections in theoretical aspects of these techniques and monitoring of these practices is important for effective management of DM patients.

With this background, we designed the present study to: assess nurses' knowledge about safe insulin administration; and evaluate the role of a planned teaching programme on knowledge and practices of safe insulin injection techniques in these nurses.

2. METHODS

This is a pre-post design to assess the effectiveness of a planned teaching programme on knowledge and practices about safe insulin practices in 80 nurses in a tertiary hospital in Mumbai, India.

2.1 Study site

The study was conducted at the Hiranandani Hospital in Mumbai, India. It is a tertiary care private hospital in suburban Mumbai with multiple specialties and sub-specialties (such a critical care, neurology, pediatrics, orthopedics, gynecology etc.). About 600 patients are managed in the out-

patient clinic and 50 indoor patients are managed by the nursing staff daily. Furthermore, diabetes care is an important component of clinical care in the hospital.

2.2 Study procedures

All consecutive consenting nurses who manage diabetes patients were enrolled for the present study from September 2017 to December 2017. The components of the procedure included:

A) Baseline assessment: We collected demographic data (age, gender, academic training, years of experience, department) and knowledge about safe insulin practices using a structured questionnaire at baseline. The structured questionnaire included: insulin storage, handling of insulin, safe administration of insulin, safe disposal, hazards of needle reuse, hypoglycemia management, side effects of injection.

B) Structured programme: It was one-time teaching programme – one hour of didactic lecture followed by demonstration of safe injection practices. The teaching was conducted in groups. A total of four teaching sessions were conducted to include all the participants. The lecture covered the following topics: a) Information about insulin and types; b) Methods of administration; c) Site selection for administration; d) Hazards of needle reuse and identification of potential complications; e) Tips for making injection less painful; f) Storage of insulin; g) Disposal of needles; h) Management of hypoglycemia; and i) Nurses' role in management of diabetes. The training was conducted by the same individual for all the groups (who was a certified Diabetes Educator from the Indian Association of Diabetes Educator).

C) Post training assessment: We conducted two post training assessments using the same structured questionnaire: first on the day of training and the second three months of training. We also assessed insulin administration practices using a check-list by observing the nurses in practice. The first practice assessment was after their three-month post-test evaluation and the second practice assessment was one week after the first assessment. All the assessments were done by the same individual

2.3 Statistical methods

Data were entered in Ms Excel (© Microsoft, USA) and analysed in Stata Version 13.1 (© College Station, Texas, USA). We calculated the means and standard deviations (SD), and median and inter-quartile (IQR) for continuous variables. We calculated proportions for categorical variables. The means were compared using *t*-test. The proportions were compared using chi square test or Fisher's exact test for low expected cell counts. A *p* value of < .05 was considered statistically significant.

We used the random effects linear regression model to identify factors associated with change in scores over these three observations. The main outcome variable in the regression model was insulin knowledge scores. The main explanatory variable was the observation point (pre-training, observation one and observation two). We also included age, gender, years of experience, and qualification as potential confounders in the regression model.

The study was approved by the Ethics Committee of Hiranandani Hospital, Mumbai, India (approval reference Number IECM/Res./September – 2017/0001).

3. RESULTS

The mean (SD) age of these 80 nurses was 25.9 (4.8) years. Majority of them were females (93%), were educated from a private nursing college (91%), and had a degree in nursing (71%). These nurses were posted in various departments of the hospital. They were posted in wards (50%), intensive care units (19%), and A&E (10%). The median (IQR) years of experience in our population was 2.08 (1.00, 3.92) years. Detailed demographic information have been presented in Table 1.

Table 1. Baseline characteristics of 80 nurses in Mumbai, India

Baseline characteristics	N	%
	N = 80	100
Age		
Mean (SD)	25.9 (4.8)	
Gender		
Female	74	92.5
Male	6	7.5
Training Sources		
Ministry of health	3	3.8
Public institute of higher learning	4	5.0
Private nursing college	73	91.3
Academic qualifications		
Diploma in nursing	23	28.8
Degree in nursing	57	71.3
Department (working currently)		
A&E	8	10.0
Day Care	4	5.0
Intensive Care Unit	15	18.8
Labour Room	2	2.5
Neonatal Intensive Care Unit	5	6.3
Out Patient Department	4	5.0
Scopy Department	2	2.5
Ward duties	40	50.0
Years of experience		
Median (IQR)	2.08	1.00, 3.92

The mean (SD) scores for insulin knowledge at baseline was

6.81 (2.28). It increased to 16.85 (1.84) immediately after training; this increase in scores was statistically significant ($p < .001$). These scores reduced significantly after three months compared with post-training scores (14.18 [2.14]; $p < .001$). However, these scores were significantly higher compared with baseline scores (see Table 2 and Figure 1). The mean (SD) increase in scores from baseline to post-training three-month assessment was 7.36 (2.70).

Table 2. Scores about Insulin injection in 80 nurses in Mumbai, India

Timeline	Mean Score	Std. Dev.	Minimum score	Maximum score
Baseline score	6.81	2.28	2.00	12.00
Post training-1	16.85	1.84	13.00	19.50
Post training-2	14.18	2.14	8.50	19.50

Note. $p < .001$ 1 vs. 0 $p < .001$, 2 vs. 0 $p < .001$, 2 vs. 1 $p < .001$

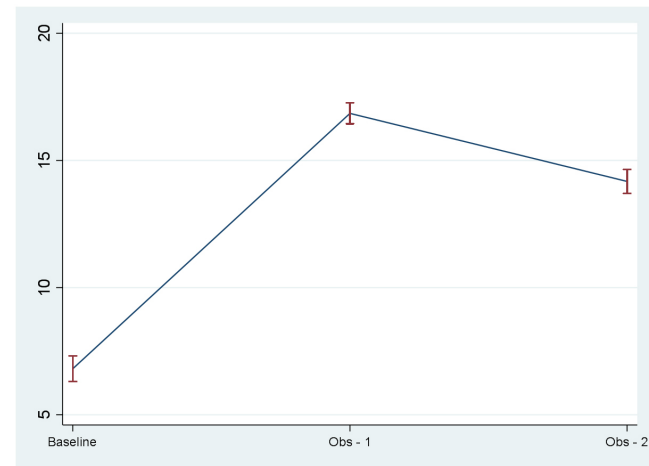


Figure 1. Change in knowledge scores over the three-month period among 80 nurses, Mumbai, India

In addition to these scores, there was a significant change in certain practices. We found that a significantly higher proportion of nurses had used re-suspension technique for insulin injection after three months (76.3% vs 52.5%, $p = .003$) and cleaned the injection site with alcohol swab before injection (93.8% vs. 75.0%, $p = .001$). Similarly, we found that a significantly higher proportion of nurses assessed lumps (48.8% vs 30.0%; $p = .02$), followed systemic rotation of sites (70.0% vs 51.9%; $p = .02$), and injected slowly to ensure that plunger/thumb button is fully depressed (100.0% vs 92.5%; $p = .03$). A higher proportion of nurses who followed systemic rotation, assessed lumps and avoided these sites during the first observation compared with those who did not follow systemic rotation (36.6% vs 23.7%; $p = .21$); the difference was not statistically significant. In the second observation, however, this difference in proportion was statistically significant (62.5% vs 16.7%; $p < .001$). We

have provided detailed proportions for the first and second observation in Table 3.

In the multivariate analysis, after adjusting for age, gender, years of experience, and academic qualifications, the average increase in scores in the first post training observation was 10.04 (95% confidence intervals [CI]: 9.51, 10.57; $p < .001$). However, the average increase in scores was just 7.36 (95% CI: 6.83, 7.89; $p < .001$) in the second post training observa-

tion. On an average, score changed by -0.15 (95% CI: -0.29, -0.02; $p = .03$) with each unit increase in age (years). We also found that with each unit increase in the year of experience, the average score changed by 0.17 (95% CI: -0.02, 0.36; $p = .08$); however, this change was not statistically significant. The average score in nurses with a degree was significantly higher compared with those who had a diploma (1.02, 95% CI: 0.28, 1.76; $p = .007$) (see Table 4).

Table 3. The insulin injection check-list practices in 80 nurses in Mumbai, India

Sr. No.	Parameters	Observation 1 n (%)	Observation 2 n (%)	p value
1	Blood sugar level monitoring done, 30 min. prior administration of insulin injection.	76 (95.0)	80 (100.0)	.12
2	Checked the consultant order and choosing of correct pen or syringe or injection.	80 (100.0)	80 (100.0)	-
3	Re- Suspension technique was done for insulin injection.	42 (52.5)	61 (76.3)	.003
4	Selection of accurate dose of insulin as per consultant order.	79 (98.8)	80 (100.0)	> .99
5	Proper selection of insulin injection administration site.	62 (77.5)	71 (88.8)	.06
6	Cleaning of injection site with alcohol swab before the injection.	60 (75.0)	75 (93.8)	.001
7	New needle was used for every insulin injection.	79 (98.8)	77 (96.3)	.31
8	Lump was assessed and avoided for insulin injection.	24 (30.0)	39 (48.8)	.02
9	Systemic site rotation was followed.	41 (51.9)	56 (70.0)	.02
10	Inserted the needle at 90 degree to the skin in quick smooth manner.	77 (96.3)	80 (100.0)	.25
11	Injected slowly ensuring plunger/thumb button is fully depressed.	74 (92.5)	80 (100.0)	.03
12	After administration of insulin dose leave needle in skin for about 10 seconds.	59 (73.8)	73 (91.3)	.004
13	Massaging of injection site and pinching of skin was avoided.	71 (88.8)	78 (97.5)	.06
14	Remove the needle from the pen device after injection and safe disposal.	68 (85.0)	68 (85.0)	1.00
15	Documentation done with counter signature.	78 (97.5)	80 (100.0)	.50

Table 4. Random effects regression models for Insulin knowledge scores in 80 nurses in Mumbai, India

Variable	Estimate	95% Confidence intervals	p value
Observation			
Pre-training scores	Reference		
Observation 1	10.04	9.51, 10.57	< .001
Observation 2	7.36	6.83, 7.89	< .001
Age			
Per year increase	-0.15	-0.29, -0.02	.03
Gender			
Female	Reference		
Male	-0.72	-2.00, 0.56	.27
Education qualification			
Diploma in nursing	Reference		
Degree in nursing	1.02	0.28, 1.76	.007
Experience			
Per year increase	0.17	-0.02, 0.36	.08
Constant	9.56	6.31, 12.80	< .001
Rho	0.26		

4. DISCUSSION

Thus, in the present study, we found that knowledge about appropriate insulin injection was low in nurses; but it increased significantly immediately after a structured training programme. These scores, however, reduced three months after the training even though they remained significantly higher compared with baseline scores. Some practices such as cleaning of injection site and systemic site rotation improved significantly over time. Though, there was a significant increase in the assessment of lumps and avoiding these sites for injection, the proportion of nurses practicing this was relatively low. Knowledge was significantly associated with age and qualification of nurses.

Improving the knowledge about diabetes and its management in health care providers is an important way to reduce morbidity and mortality in diabetes patients. It has been suggested that specialized nurses who manage diabetes patients may be useful to improve the health outcomes in these patients – such as good glycemic control and reduction of side effects.^[17,18] The importance of maintaining appropriate

insulin techniques for management of diabetes mellitus in patients has been discussed extensively in the literature.^[19,20] Furthermore, suggestions and guidelines (including updates) have been regularly published.^[21–23] Thus, education programmes that impart training on these guidelines and improve knowledge about insulin injection, will improve management practices and improve the overall quality of life of diabetes patients.^[24] Studies have shown mixed results on the effectiveness of educational intervention programmes. On one hand, Uding and colleagues found a significant increase in the post intervention scores on nurses' knowledge after training in peer-developed diabetes management.^[25] However, on the other hand, however, Eaton-Spiva and Day found no significant increase in knowledge and skills of nurses after a computer-based educational training programme.^[26] Finally, a study by Kaur and Walia^[27] reported a significant increase in knowledge scores immediately a workshop on diabetes care in nursing students. However, these scores reduced after three months of the workshop – a finding also observed in our study. Thus, even though training programmes may increase knowledge about diabetes management and care in the short term, these changes may not be sustainable in the long-term. Hence, regular training programmes in nurses will be useful for appropriate management and care of diabetes patients – including appropriate insulin injection practices. Furthermore there

Knowledge about certain injection practices may be low in these nurses who manage diabetes patients. Studies have found knowledge deficiency in insulin storage, preparation, and site rotation.^[28,29] Furthermore, knowledge about insulin practices was associated with years of experience and qualification of nurses.^[30] Chrysoula and colleagues^[31] found poor knowledge about various insulin injection practices – such as points in which insulin injection will lead to better absorption and glucose control. Educational interventions with pharmacists also has an important role in ensuring appropriate insulin practices.^[32] As seen in our study, certain practices such as use of re-suspension technique and systemic site rotation was practiced by only 50% of the nurses in the first observation period. Even though, there was a significant increase in these were practices, the proportion remained lower compared with other practices. We also found a relation between years of experience and change in scores. Thus, it is important to focus on the importance of injection techniques, and pre-injection and post-injection practices. in the educational programmes.

An important area of concern, however, was the relative low proportion of nurses that assessed and avoided lumps for injection even in the second observation in our study. It has been well documented that insulin-induced liperhypertrophy

is associated with type I Diabetes Mellitus, needle reuse, with abdomen being the most common site.^[33–35] Occurrence of lipo-hypertrophy is also associated with failure to systematically rotate of injection sites in insulin patients.^[35,36] We assessed both these practices – systematic rotation and assessing for lumps - in our study, and found a statistically significant association between these two practices in the third month observation. Thus, it is important to stress on the relation between these two practices in the training programme. Appropriate rotation of the needle injection sites and avoiding lumps will ensure adequate insulin absorption in patients with Diabetes mellitus.^[37]

The study was not without its limitations. We only observed the practices in this study and did not monitor the blood glucose levels. It has been shown that good injection techniques will improve glucose control on patients with diabetes mellitus.^[20] However, the main objective of our study was to assess the change in practices in nurses after a training programme. We do not have long term follow-up of practices in these nurses. Though, we used a structured knowledge questionnaire and practices, researchers have highlighted the need to develop and test new instruments to assess this knowledge.^[38] Our check list was based on the Forum for injection technique and therapy expert, India recommendations.^[11] After preparing the initial questionnaire we discussed the same with senior nurses for their expert opinion. However, as stated earlier, there is a need to develop instruments which assess the behaviours and practices. Furthermore, since the trainer was observing the practices, Hawthorne effect cannot be ruled out.^[39] However, as seen in our results, even though the practices improved, some of them did not improve as much as others. The mean age in our study was 25.9; hence there may be concerns that the population of nurses included in the study is relatively young. However, this is close to the median age of the Indian population (27.1 years).^[40]

Nonetheless, despite these limitations, we have presented useful data in the study. The findings can be used to develop training programmes for nurses and nursing students for diabetes management and insulin injection practices. The study demonstrated that insulin injection practices improve with adequate guidance and information. However, there is a need to have a continued programme to sustain these practices. Certain practices such as site rotation and assessing lipo-hypertrophy, and the relation between these two should be emphasized in these sessions. Nurses are important for diabetes management and insulin therapy in hospitalized patient. Thus, if they are updated with current guidelines and new recommendations, the clinical outcomes will be better in these patients. Well-developed training programmes that use multiple teaching tools (didactic presentations, on-site

clinical training, case discussions, and online updates) will help to improve the knowledge of nurses on issues related to DM—particularly insulin injection therapy.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest.

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