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Research Article

Determinants of insulin-related knowledge among healthcare providers at a county referral hospital in Kenya

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Background: Insulin is a high alert medication with potential to cause hypoglycaemia if used incorrectly. Inadequate healthcare provider knowledge regarding insulin contributes to errors in its use that may cause patient harm.

Objective: To identify the determinants of healthcare provider knowledge regarding insulin use in type 2 diabetes.

Methodology: A cross-sectional study was conducted at Thika Level V Hospital in March 2015. A 20-item questionnaire was used to assess insulin knowledge in pharmaceutical, nursing and medical staff working in the outpatient department and the medical wards. The outcomes of interest were the scores on types, prescribing, administration and monitoring of insulin. Descriptive and regression data analyses were performed using IBM SPSS Statistics Version 20.

Results: The participants' mean (±SD) age was 32.6±10.2 years. The mean (±SD) duration of clinical practice was 8.3±9.03 years. Nurses formed the largest (36, 40%) cadre in the study. Determinants of the overall score in the insulin knowledge test were professional cadre ($p<0.0001$), in-patient care ($p=0.044$) and reading of journals ($p=0.005$). Insulin pharmacology scores were correlated with younger age (21-30 years, ($p=0.02$), clinical experience of <5 years, ($p=0.013$), use of information from drug representatives ($p=0.023$) and being a pharmacist intern or medical officer ($p=0.002$). Good prescribing scores were found among the medical officers, consultants and the clinical pharmacist ($p=0.035$).

Conclusion: Several factors account for the differences in insulin-related knowledge among the healthcare providers evaluated in this study. Interventions are required to address these variations and equip the health workers with knowledge on all areas related to insulin use. Such interventions should include development of a curriculum on certified diabetes education, improved access to journals, collaboration with pharmaceutical companies in provision of drug-related information, continuing medical education and staff duty rotation to ensure that the healthcare providers gain experience in in-patient diabetes care.

Keywords: diabetes, healthcare provider, insulin-related knowledge

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1. Introduction

Insulin is the most effective glucose lowering agent and its use in type 2 diabetes has been associated with a reduction in microvascular and macrovascular complications (David et al, 2009; Ohkubo et al, 1995). On the other hand, insulin is a high alert medication commonly implicated in medication errors that have the potential to cause harm and death (The Joint Commission, 1999). Medication errors related to insulin are associated with knowledge deficits regarding the various insulin formulations, concentrations, monitoring and devices for insulin administration (ISMP, 2011). To prevent such medication errors, insulin therapy should be restricted to healthcare workers who have demonstrated competency on prescription, storage, dispensing, administration and monitoring of insulin therapy.

Studies evaluating insulin-related knowledge in healthcare professionals have demonstrated deficiencies and differences in insulin knowledge in the various professional groups involved in provision of insulin therapy. A study assessing insulin knowledge in nursing and medical staff in four hospitals in Baltimore, USA showed that healthcare workers performed better in areas related to their role in the management of hospitalized patients with diabetes (Derr et al, 2007). Another study at a tertiary hospital in Singapore demonstrated that increasing years of clinical experience were associated with poor scores on knowledge related to new types of insulin analogues (Melvin et al, 2013). This observation was attributed to lack of encounter of older physicians with these insulin types during their formal training and also lack of frequent updates on the new types of insulin analogues introduced in the drug market.

A study in Switzerland reported low insulin-related related knowledge in medical and nursing staff involved in in-patient diabetes management (Trepp et al, 2010).The study also identified the determinants of diabetes and insulin knowledge as the professional background and the clinical area of duty.

Identification of determinants of insulin knowledge among healthcare workers is critical in developing focused interventions to promote safe and effective use of insulin in type 2 diabetes. No studies have been conducted to evaluate the level of knowledge of health care practitioners in Kenya. A study was therefore carried out in the largest public hospital in Kiambu County, Kenya, that aimed at evaluating whether the health care practitioners had adequate knowledge on the safe use of insulin and determinants of the levels of knowledge. The findings of the study would be used to advocate for the development of a national curriculum for training health care workers on diabetes.

2. Methodology

2.1 Study design and Study site

This was a hospital based cross-sectional descriptive study. This study was carried out in the outpatient diabetic clinics and inpatient medical wards at Thika Level V Hospital. This is a 300-bed referral county hospital located in Thika Town, Kiambu County. This hospital is located in the former central province which has the highest diabetes prevalence (29.4%) in Kenya according to the Diabetes Management Institute (Karekezi et al, 2011).

2.2 Study population and eligibility criteria

The participants were the medical, nursing and pharmaceutical staff involved in prescribing, administration and dispensing of subcutaneous insulin. Medical staff in outpatient diabetes clinics and in-patient wards who gave a written consent to participate were included in the study. Healthcare workers who declined to give consent and staff who were not involved in direct patient care were excluded from the study.

2.3 Sampling considerations and participants recruitment

A list of all the healthcare workers who work in the pharmacy, medical wards and outpatient clinics was used as the sampling frame. The calculated minimum sample size was 70 healthcare workers. This was calculated using the Fisher Formula for finite populations (Fisher, 1925) with the assumption that 60% of the participants had adequate insulin knowledge (Derr et al, 2007) and a critical value of a standard normal distribution which at 95% confidence level was 1.96 and a level of precision of 5%.

The minimum sample size, adjusted by 10% to cater for non-responses, was a minimum of 77 healthcare workers. Since the number of all the healthcare workers was not expected to exceed 100, universal sampling was attempted.

2.4 Data collection

A 20-item single-best answer questionnaire was generated from a validated questionnaire by Derr et al (2007). It was adapted to conform to Kenya's standard insulin preparations and practice for diabetic care.

The questionnaire had five questions for each step in the insulin use process namely; identification of insulin types, preparation and administration, prescribing and safety monitoring. Each of the 20 items got a score of 1 if answered correctly. Unanswered items were considered as incorrect. A total score (out of 20) and sub-scores of the various domains of insulin use (out of 5) were obtained by adding up the respective points and expressed as percentages of the relevant maximum score between 0% (lowest) and 100% (highest).

A link log using staff identification numbers as unique identifiers and study numbers, was used to ensure that the questionnaire was not administered more than once to the same person. The questionnaire was reviewed after completion to confirm that one best answer per question had been accomplished.

2.5 Data management and quality assurance

Data was entered into a password protected Access® database accessible only to the principal investigator, the statistician and the designated data clerk. The final copy of the dataset was exported to the IBM SPSS Statistics V20 software and recorded for analysis.

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2.6 Data analysis

Descriptive and exploratory data analysis was carried out to summarize all variables related to knowledge regarding the formulations, prescription, storage, administration and monitoring of insulin. Cross tabulations with chi-squared tests were used to compare knowledge based on participant characteristics such as age, gender, cadre, years of practice and specialization. Inferential data analysis was conducted using the unpaired t-test and the chi-square test. The main outcome variable was the total score attained by each healthcare worker and the sub-scores in the specific domains of insulin knowledge which included knowledge on types of insulin and their characteristics, prescribing, preparation and administration and safety of insulin. To identify the key variables that determined the overall score, linear regression analysis was conducted. A manual forward stepwise model building approach was used. Variables that were statistically significant on bivariable analysis were used for multivariable analysis. P-values ≤ 0.05 were considered significant.

2.7 Ethical considerations

Ethical approval for this study was obtained from the University of Nairobi/Kenyatta National Hospital (UoN/ KNH) Ethics and Research Committee (Ref: **P639/10/2014**). Additional clearance was obtained from Thika Level V Hospital Research and Ethics committee. Participation in the study was through a written informed consent. Hard copies of the completed questionnaires were stored in a lockable cabinet to prevent unauthorized access. To maintain confidentiality, only the participant study numbers were used in the questionnaire and during data entry.

3. Results

3.1 Socio-demographic characteristics of the study participants

A total of 100 questionnaires were distributed to healthcare workers out of which 90 questionnaires were completed and analysed. This gave an overall response rate of 90%. More than half of the participants (49, 54.4%) were aged between 21 and 30 years. The age distribution pattern was mirrored by the duration of clinical practice where the bulk of the participants (51, 56.7%) had a clinical experience of between 1-5 years. Management of type 2 diabetes was mainly done by the nurses (36, 40%) and clinical officers (28, 31.1%) with only three (3.3%) medical specialists involved in handling insulin therapy. The hospital has only one certified diabetes educator. Only two participants indicated that they had received in-service training on insulin use. The baseline characteristics of the study participants are described in **Table 1**.

Table 1: Baseline characteristics of the study population

Characteristic	n	%
Gender		
Male	40	44.4
Female	50	55.6
Age (years)		
21-30	49	54.4
31-40	23	25.6
41-50	11	12.2
>50	7	2.8
Duration of practice years		
1-5	51	56.7
6-10	13	14.4
11-20	16	17.8
>20	10	11.1
Profession		
Pharmacist intern	2	2.2
Clinical officer intern	11	12.2
Medical officer intern	2	2.2
Clinical officer	17	18.9
Nurse	36	40.0
Clinical pharmacist	1	1.1
Pharmaceutical technologist	4	4.4
Pharmacist	8	8.9
Medical officer	6	6.7
Medical specialist	3	3.3
Clinical area of duty		
Outpatient	51	56.7
Inpatient	27	30.0
Outpatient and inpatient	12	13.3
Certified diabetes educator		
No	89	98.9
Yes	1	1.1
Had In -service training on insulin		
No	88	97.8
Yes	2	2.2

3.2 Determinants of insulin-related knowledge

Insulin scores across Age- groups

There was significant association between younger age (21-30 years) and knowledge on insulin types (2.38, p=0.02) and safety (2.60, p=0.015).

Healthcare workers aged > 50 years had the best scores on insulin prescribing although this was not statistically significant.

The youngest participants aged between 21 – 30 years obtained the highest overall score and scored highest in domains of knowledge that could be acquired by reading. These were types of insulin formulations and safety. In the domains of knowledge, that were mainly acquired by experience, namely, insulin administration and prescribing, the older age groups scored highest

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(**Table 2**). There was no statistically significant difference in the overall score across age groups.

Effect of professional category on insulin knowledge

Overall insulin-related knowledge was significantly influenced by the cadre of the healthcare provider with the professional cadres with a degree qualification obtaining higher scores than non-degree holders who had an overall mean score of less than 50%. Medical officers had the highest overall scores (mean score of 14 out of 20 (70%), p= <0.0001). Pharmacist interns and medical officers were significantly associated with higher scores on the types of insulin and their characteristics (4 out of 5, p=0.002). The medical officers, specialists and the clinical pharmacist had better knowledge regarding prescription (3 out of 5, p=0.035) of insulin. In addition, the medical officers demonstrated high knowledge regarding insulin safety (3 out of 5, p=0.003) (**Table 3**).

Duration of clinical practice

Participants with shorter durations of clinical practice (1-5 years) were found to have statistically significantly better knowledge in the pharmacology of insulin (p=0.013). Similar to the pattern observed with the effect of provider age-group on insulin knowledge, the more experienced colleagues demonstrated better scores on insulin prescribing although this was not significant (**Table 4**).

Table 2: Mean insulin knowledge scores across the age-groups

Age-group (years)	Insulin knowledge sub-scores out of 5 (mean [SD])				Total (out of 20) (mean [SD])
	Insulin types	Prescribing	Preparation and Administration	Safety	
21-30 years	2.38 [1.409]	1.48 [1.148]	2.15[1.13]	2.6 [1.144]	8.6 [3.234]
31-40 years	1.57 [1.308]	1.7 [0.876]	2.13 [1.18]	2.26 [1.137]	7.65 [2.424]
41-50 years	1.36 [1.12]	1.82 [1.079]	2.82 [1.168]	1.36 [1.027]	7.36 [3.325]
>50 years	1.43 [0.535]	2 [1.155]	2.14 [1.069]	2.43 [1.134]	8 [2.38]
P-value	**0.02**	0.539	0.342	**0.015**	0.478

Table 3: Effect of professional category on insulin knowledge

Professional category	Knowledge sub-score out of 5 (mean [SD])				Total out of 20 (mean [SD])
	Insulin types	Prescribing	Preparation and Administration	Safety	
Pharmacist intern	4 [1]	1 [0]	2 [0]	3 [0]	10 [1]
Clinical officer intern	2 [1]	1 [1]	1 [1]	2 [1]	7 [2]
Medical officer intern	2 [2]	2 [1]	3 [1]	2 [2]	8 [5]
Clinical officer	1 [1]	2 [1]	2 [1]	2 [1]	7 [3]
Nurse	2 [1]	2 [1]	2 [1]	2 [1]	7 [2]
Clinical pharmacist	1 [.]	3 [.]	4 [.]	3 [.]	11 [.]
Pharmaceutical technologist	2 [1]	2 [1]	2 [1]	2 [1]	8 [2]
Pharmacist	3 [2]	1 [0]	3 [1]	2 [1]	9 [3]
Medical officer	4 [1]	3 [2]	3 [1]	4 [1]	14 [5]
Medical specialist	2 [2]	3 [1]	2 [1]	4 [1]	11 [3]
P value	**0.002**	**0.035**	0.212	**0.003**	**<0.0001**

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Table 1: Effect of duration of practice on insulin knowledge

Duration of practice (years)	Knowledge sub-score out of 5 (mean [SD])				Total out of 20 (mean [SD])
	Insulin types	Prescribing	Preparation and Administration	Safety	
1-5 years	2.4 [1.455]	1.52 [1.148]	2.15 [1.13]	2.54 [1.202]	8.6 [3.234]
6-10 years	1.38 [1.261]	1.54 [0.967]	1.92 [1.256]	1.77 [1.013]	6.62 [2.694]
10-20 years	1.44 [1.263]	1.81 [0.911]	2.56 [1.263]	2.19 [1.276]	8 [3.011]
>20 years	1.5 [0.527]	2.1 [0.994]	2.6 [0.843]	2.1 [1.287]	8.3 [1.947]
p-value	**0.013**	0.399	0.319	0.161	0.216

Table 5: Variations in scores on insulin knowledge with clinical area of duty

Area of duty	Knowledge sub-scores out of 5 (mean [SD])				Total out of 20 (mean [SD])
	Insulin types	Prescribing	Preparation and Administration	Safety	
Outpatient	1.8 [1.4]	1.37 [0.848]	2.24 [1.069]	2.12 [1.07]	7.53 [2.461]
Inpatient	2.07 [1.357]	2.19 [1.272]	2.44 [1.219]	2.59 [1.338]	9.3 [3.821]
Outpatient and inpatient	2.25 [1.288]	1.42 [0.996]	1.67 [1.155]	2.58 [1.311]	7.92 [2.466]
p-value	**0.507**	**0.004**	**0.143**	**0.181**	**0.044**

Variation in scores on insulin related knowledge with Clinical area of duty

Working in the in-patient wards was significantly associated with better scores on insulin prescribing (mean score of 2.19 out of 5, p= 0.004) and overall insulin knowledge (mean score of 7.94 out of 20, p=0.044) (**Table 5**).

Sources of medical information

Participants who obtained medical information from journals had statistically significant higher scores on insulin safety (p=0.001) and overall insulin knowledge (p=0.005).In addition, obtaining medical information from pharmaceutical representatives was associated with better scores on types of insulin (p=0.023), insulin safety (3 out of 5, p=0.011) and overall insulin knowledge (10 out of 20, p=0.004).

4. Discussion

Overall insulin-related knowledge among the healthcare workers in this study was very low. In addition, the participants lacked in-service training on insulin use with only two participants indicating that they had attended training on diabetes during their practice. Only one participant was a certified diabetes educator.

This situation may be attributed to the fact that the Ministry of Health in Kenya does not have a curriculum for certified diabetes education. Currently, it is only the Diabetes Kenya Association, the local arm of the International Diabetes Federation that offers diabetes education to both the patients and healthcare professionals (IDF, 2015) A previous study on health information needs of healthcare workers in Kenya reported inadequate national guidelines as a cause of insufficient knowledge and practice (Obimbo et al, 1999). This raises the need for the Ministry of Health to develop standard guidelines for diabetes education and also strive for the incorporation of diabetes education in the National Health Policy. This will ensure that healthcare providers, and by extension, the patients receive regularly updated information on diabetes to avoid medication errors and maximize glycaemic outcomes.

Several factors were found to influence the healthcare providers overall and specific insulin knowledge. Professional cadre was an important determinant of overall insulin knowledge, insulin types, prescribing and insulin safety. This may be explained by the different training backgrounds and responsibilities of healthcare providers in the insulin use cycle. Medical officers and specialists are mainly involved in prescribing and monitoring of insulin therapy and this may have influenced their good scores in these domains. All the pharmacist interns and medical officers involved in this study had practiced for less than five years. The short duration of practice may have played a role in their good scores on insulin types and their characteristics due to recall of recent knowledge received in their undergraduate years.

However a study assessing insulin knowledge among primary healthcare providers in South Africa showed that the focus in undergraduate training may not provide the knowledge required in practical management of diabetes in healthcare settings (Haque et al, 2005). Another study evaluating insulin related knowledge among the nurses, pharmacists and medical

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staff showed some knowledge deficits among the physicians that may potentially lead to life-threatening insulin use errors (Melvin et al, 2013). This study also found that despite the nurses and the clinical officers forming the largest bulk of the participants, their overall and specific insulin knowledge was generally low. These observations highlight the need to provide induction and continuous medical training to healthcare workers to equip them with practical and updated information necessary for management of type 2 diabetes through standardized diabetes education for all cadres of health professionals. In addition to addressing variations in insulin knowledge, this intervention will create redundancy in the system by giving the different cadres of healthcare workers capacity to detect medication errors and alerting the concerned healthcare provider before patient harm occurs.

Lack of in-service training may account for the inverse relationship between knowledge on insulin pharmacology and increasing years of practice. This finding had also been reported in a study where poor knowledge regarding newer insulin formulations was observed among the physicians with ≥11 years of clinical practice compared to those with ≤ 5 years of practice (Melvin et al, 2013). Therefore opportunities to update the healthcare workers, including workshops and CMEs on new insulin formulations and their uses should be explored and utilized accordingly.

Working in the medical wards was associated with significantly better overall and prescribing scores. Clinicians in the in-patient departments manage patients with diabetes complications who require regular insulin dose adjustments to achieve glycaemic control. This frequent exposure to insulin therapy may have contributed to the better scores in this group of healthcare workers.

Use of medical journals and pharmaceutical representatives to obtain medical information was associated with better knowledge on overall, insulin types and safety. Studies conducted in the developing countries have shown that many health care workers have little or no access to basic, practical information (Pakenham et al, 1997; Macrorie, 1997; Sekikawa et al, 1997). These studies reported that many healthcare providers in developing countries rely on observation, advice from colleagues and building experience empirically through their own treatment successes and failures. Therefore facilities should adopt policies and initiatives to provide access to medical information sources to healthcare workers in all levels of healthcare. Such initiatives would include improved internet connectivity, journal subscriptions and collaboration with drug manufactures to provide continuous medical education.

Study limitations

The descriptive and bivariate analysis performed on data from this study did not identify any significant association between insulin preparation and administration knowledge and any of the factors evaluated in this study. Therefore further research may be required to identify the determinants of this aspect of insulin use processes.

5. Conclusion

Insulin-related knowledge among the healthcare workers evaluated in this study was influenced by several factors including the age, duration of practice, professional background, sources of medical information and the clinical area of duty. There was also a severe shortage of certified diabetes educators and the workers lacked continuous medical education on insulin use.

These observations highlight the areas that can be targeted to develop interventions aimed at improving insulin related knowledge among healthcare workers. Such strategies would include development of a curriculum for certified diabetes education, continuous medical education, subscription to medical journals, improved internet connectivity and collaborations with the pharmaceutical industries.

Other interventions would include improving the capacity of the higher cadres of healthcare providers such the pharmacists, medical officers and consultants to take leadership roles in diabetes training since they were found to have significantly better overall and specific insulin knowledge.

Finally, the knowledge strengths of each cadre should be harnessed to improve the possibility of detecting insulin prescription, dispensing or administration errors to prevent patient harm.

Conflict of Interest Declaration

The authors declare no conflict of interest.

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