

Long-term training in diabetes-related knowledge, attitudes, and self-reported practice among diabetes liaison nurses

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Abstract

Objective: We aimed to investigate whether long-term regular training of diabetes liaison nurses (DLNs) could improve their diabetes-related knowledge, attitudes, and self-reported practice.

Methods: We enrolled 45 diabetes liaison nurses (DLNs) and 45 non-specialist nurses (controls). DLNs received 11 days of qualifying training, followed by regular theory classes and practice sessions for 4 years. All nurses were administered a questionnaire assessing demographic characteristics, knowledge about diabetes mellitus (DM), attitudes toward DM, and DM management practices, before and after the 4-year DLN training period.

Results: At baseline, there were no significant differences between the DLN and control groups for sex, age, educational level, nurse title/grade, work experience, hospital department, or questionnaire scores. At 4 years, the DLN group had a higher overall questionnaire score and higher scores for knowledge about DM, attitudes toward DM, and DM management practices, as compared with baseline scores.

Conclusion: Long-term regular training provided by a multidisciplinary diabetes care team can improve the knowledge, attitudes, and self-reported practice levels of DLNs.

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Keywords

Diabetes liaison nurse, multidisciplinary diabetes care team, training, questionnaire, knowledge, practice

Date received: 10 April 2019; accepted: 25 September 2019

Introduction

Diabetes mellitus (DM) is a metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both.¹ The prevalence of type 2 DM (T2DM) has shown an increasing trend owing to population aging and lifestyle changes.^{2,3} DM is becoming an epidemic in China, where the age-standardized prevalence of diabetes and pre-diabetes has been estimated at 9.7% to 11.6%.⁴ Over 30% of patients hospitalized owing to complications of diabetes are admitted to non-endocrinology departments for specialized management of their condition.^{5,6} Optimal glycemic control in patients admitted to the hospital is essential to curbing and delaying the onset of other severe complications.^{7,8} Therefore, non-endocrinology departments play an important role in the delivery of diabetes care.⁹ Although nurses in non-endocrinology departments have nursing experience relevant to their specialty, they may lack knowledge regarding diabetes nursing.

Studies have found that nurses demonstrate some knowledge deficits in clinical and theoretical diabetes-related topics, such as the initial treatment of hypoglycemia, insulin storage, and preparation, meal planning, the duration of action of hypoglycemic agents,¹⁰ and risk factors for cardiovascular complications.¹¹ Notably, a 1-year training program failed to improve nurses' motivational interviewing skills in routine diabetes care.¹² The use of a multidisciplinary diabetes care team (MDCT) that

provides patients with highly individualized care can improve patient outcomes and reduce overall costs.^{13,14} An MDCT represents a clinical program of excellence that improves the processes of care.¹⁵

Inadequate provision of nursing has been perceived to be an important barrier limiting health promotion in clinical practice.¹⁶ Knowledge deficiencies limit nurses' capability to coordinate with doctors and to communicate effectively with patients, to help improve diabetes management.¹⁷ If a patient with T2DM is admitted to a non-endocrinology hospital department for the diagnosis and treatment of a medical condition, the nurses may find it difficult to control the patient's blood glucose and to advise on diet, exercise, oral antidiabetic drug use, or insulin injection methods without the help of an MDCT.¹⁸

An MDCT was set up at The Second Xiangya Hospital of Central South University in August 2011 because many patients with T2DM were being admitted to non-endocrinology wards that lacked specific support for the management of DM. An MDCT is a patient-centered care group that includes endocrinologists, DM-specialized nurses, and nutritionists as its core members, as well as other doctors, psychological consultants, statisticians, and information managers, when required. Additional members of the MDCT are diabetes liaison nurses (DLN), who are non-endocrinology or non-diabetes nurses who receive a qualification certificate after completing an intensive course that includes

theoretical and practical training. DLNs are expected to have basic knowledge and skills in caring for patients with DM and evaluating diabetes-related nursing problems. Thus, DLNs have an important role in the management of patients with DM and act as a bridge between non-endocrinology and non-diabetes nurses, specialist diabetes nurses, and diabetes education nurses, who are all important members of the MDCT.

Limited information is available regarding whether the provision of long-term regular training would improve the knowledge and skills of DLNs involved in the management of DM. Therefore, the aim of this study was to investigate whether long-term regular training of DLNs could improve their diabetes-related knowledge, attitudes, and practice (KAP). To achieve this objective, DLNs received 4 years of centralized theoretical training (2–4 hours per quarter) and practical training (1–2 times per year); changes in their knowledge, attitudes, and self-reported practice of diabetes care were subsequently evaluated.

Methods

Study design

This matched cohort study was conducted at XXX Hospital during the period August 2011 to October 2015. DLNs (the DLN group) were enrolled based on the following inclusion criteria: 1) registered nurses not working in the endocrinology department; 2) educational background of junior college and engaged in clinical nursing care for over 5 years, or educational background of college and engaged in clinical nursing care for over 3 years, or educational background of postgraduate training and engaged in clinical nursing care for over 2 years; 3) has agreed to participate in the study and enthusiastic about DLN work and diabetes-related nursing and education;

4) superior professional skills and solid theoretical levels, and committed to professional development; 5) good communication skills and capabilities of organization and teaching; 6) at least one published article or formal publication; 7) in good health; and 8) has passed the MDCT screening and tests after training, as well as meets all DLN qualifications. Only one DLN was included from each nursing unit.

In addition, nurses not specialized in diabetes care (control group) were enrolled based on the following inclusion criteria: 1) non-DLNs matched to DLNs based on ward, age, educational background, and years of work; and 2) provided their informed consent agreeing to participate in this study.

Nurses were excluded from the final analysis if they met any of the following criteria: 1) having received advanced training; 2) currently on rotation; or 3) training was interrupted for >6 months or discontinued before the end of the 4-year study period for whatever reason (including maternity leave, prolonged illness, or a change in employment).

The ethics committee of our hospital granted approval for this study (No. 2019019). All nurses involved in the study provided their written informed consent.

DLN training

The responsibilities of DLNs in the hospital are as follows: 1) to have adequate knowledge and skills in diabetes nursing; 2) to provide appropriate nursing care to hospitalized patients with DM, including nursing assessment of the patient, identification of nursing problems, and provision of guidance on various aspects of diabetes management such as diet, exercise, use of antidiabetic drugs, insulin injection techniques, self-monitoring of blood glucose, relevance of psychological stress, and implementation of strategies to facilitate

behavioral changes; and 3) to act as the liaison with the MDCT as necessary, including diabetes specialist nurses, to ensure that high-quality nursing is provided to patients with DM.

DLNs received training based on a plan developed by the management team of the MDCT; diabetes-related training was not provided to the control group in this study. First, DLNs underwent an 11-day period of qualifying training consisting of 4 days of theory (centralized teaching) followed by 7 days of one-to-one practical training at the

bedside (Table 1). The training program was based on the *Chinese Diabetes Care and Education Guidelines* written by the Nursing and Diabetes Education Group of the Chinese Medical Association. Theory was taught by experts with rich experience in diabetes clinical care, nursing, education, and management practice, including senior nurses-in-charge, nursing specialists, nursing managers, and medical specialists of a higher grade than associate chief physician. Nurse practitioners or higher-grade nurses with clinical teaching experience were responsible

Table 1. Qualifying training given to diabetes liaison nurses during the first 11 days.

Type of training	Duration	Training content	Training methods
Full-time, continuous, centralized teaching of theory	4 days	Training overview	Multimedia classroom instruction
		Patient education techniques	Case analysis and discussion
		Basic knowledge about DM	Videos
		Diet and exercise guidance	Written examination
		Oral hypoglycemic drugs	
		Insulin types and insulin injections	
		Self-monitoring and management of blood glucose	
		Prevention and treatment of complications	
		Nursing in special populations or under special conditions	
One-to-one clinical practice training delivered by a specialist	1 week	Bedside individualized diabetes education	On-site instruction
		Group education of patients with DM	Operational demonstration
		Oral glucose tolerance test	Operational re-demonstration
		Use and maintenance of a portable blood glucose meter	Class observation and practice
		Blood glucose detection with a portable blood glucose meter	Live talks
		Use of an insulin pen	On-site assessment
		Use of an insulin pump	
		Detection and treatment of hypoglycemia	
		Calorie calculation in a diet for patients with DM	
		Exercise guidance for patients with DM	
		Nursing evaluation of patients with DM	
		Risk assessment of the diabetic foot	

DM: diabetes mellitus.

for one-to-one practical training at the bedside, which was provided under the supervision of endocrinology specialists. All clinical teaching staff were trained by the MDCT to be fully aware of the aims, importance, and requirements of the assessment. To receive a DLN qualification certificate issued by the hospital, trainee DLNs were required to pass a written examination assessing their theoretical knowledge and a practical test.

During the 4 years following qualification, DLNs received on-the-job training, provided by members of the MDCT, to update their diabetes nursing-related knowledge, attitudes, and self-reported practice. Centralized classes in theory (2–4 hours) were taught quarterly, and practical training (bedside or classroom) was provided 1 to 2 times per year (Table 2).

Questionnaire to assess diabetes-related knowledge, attitudes, and practice (KAP)

A questionnaire assessing diabetes KAP was administered to all nurses (i.e., both DLN and control groups) in August 2011 (before any nurses in the DLN group had initiated their DLN training) and again 4 years later,

in October 2015, after DLNs had completed their 4-year training program. The questionnaire was designed by the authors and had a content validity of 0.875 and test–retest reliability of 0.711.¹⁹ The questionnaire was completed under the supervision of an investigator who was blinded to the grouping. An investigator ensured that all questions were answered, and the same investigator scored the questionnaires.

The questionnaire consisted of two parts.¹⁹ The first part collected demographic data such as sex, age, educational background, nurse title/grade, clinical experience, and department of work. This information enabled us to perform analyses to determine whether between-group demographic variations contributed to any differences in the scores obtained on the second part of the questionnaire. This latter part of the questionnaire comprised three sections assessing knowledge about diabetes, attitudes toward diabetes, and practical aspects of diabetes management, respectively. The section assessing knowledge about diabetes contained 29 questions (21 single-response questions and 8 multiple-choice questions, with 1

Table 2. Four-year on-the-job training program delivered to diabetes liaison nurses.

Type of training	Duration	Training content	Training methods
Centralized teaching of theory	One session (2–4 hours) per quarter	Knowledge/practice development within the hospital: Nursing patients with DM Treatment of patients with DM Education and management of DM Case study External training or symposia attendance	Multimedia classroom instruction Video demonstration Case analysis and discussion
Clinical practice training at the bedside and in a classroom	One or two sessions per year	Bedside ward round and consultation In-hospital case analysis and discussion Demonstration of new techniques for treating DM Exposure to new technologies	Site instruction Operational demonstration Operational re-demonstration Classroom demonstration and practice

DM: diabetes mellitus.

point scored for each correct answer) testing basic knowledge (seven items) and knowledge about dietary therapy (three items), exercise therapy (three items), oral antidiabetic drugs (three items), insulin injection (six items), and long-term complications (seven items). The total score for this section ranged from 0 to 29 points, with a higher score indicating a higher level of diabetes knowledge. The section assessing attitudes toward diabetes comprised eight items; responses to the first seven items were given according to a five-point scale where 1 indicated strongly agree and 5 indicated strongly disagree; the eighth item was a multiple-choice question. The total score for this section ranged from 7 to 35 points, with a higher score indicating a better attitude. The section pertaining to practical aspects of diabetes management contained eight items with responses given using a four-point scale (1 = never, 2 = occasionally, 3 = often, and 4 = always). The total score for this section ranged from 8 to 32 points, and a higher score indicated a higher level of practice. The overall questionnaire score was obtained by summing the scores for the three sections. The scoring rate was calculated as (actual score/highest possible score) \times 100%. The performance of each nurse on each section of the questionnaire was rated as poor (score \leq 60%), moderate (60%–80%), or good ($>$ 80%).¹⁹

Questionnaires were distributed to the nurses at their workplace by the MDCT and were accompanied by an information sheet stating the objectives of the questionnaire. Quality control was achieved based on standardized training of the investigators, standardized methods of data collection, with rechecking of all responses and data collection.

Statistical analysis

According to a previous study using the same questionnaire,¹⁹ based on improvement of at

least 10 points in diabetes-related knowledge after the intervention, a sample size of at least 30 participants per group provided 80% power with an α value of 0.05. Descriptive statistical analysis of quantitative data was conducted using IBM SPSS 21.0 (IBM Corp., Armonk, NY, USA). Data with a normal distribution are expressed as mean \pm standard deviation, and non-normally-distributed data are expressed as median (range or interquartile range). Categorical data are expressed as n (%). We performed a factor analysis (repeated measures analysis of variance with Greenhouse–Geisser correction for violation of symmetry) on the results of the questionnaire to assess any interactions between training (yes vs. no) and time (0 vs. 4 years) in their effects on questionnaire scores. For the DLN group, differences in questionnaire scores before and after completion of the 4-year training program were analyzed using the paired *t*-test (normally distributed data) or Pearson's chi-squared test (non-normally-distributed data). A *P*-value $<$ 0.05 was considered to indicate statistical significance.

Results

Baseline characteristics of nurses enrolled in the study

Among the 90 nurses initially enrolled in the study, 10 of the 45 nurses in the DLN group (changed department, $n = 5$; maternity leave, $n = 5$) and 11 of the 45 nurses in the control group (maternity leave, $n = 5$; changed department, $n = 4$; missed more than one training session, $n = 2$) did not complete the study protocol. Therefore, 69 nurses (35 in the DLN group and 34 in the control group) completed the 4-year training program and were included in the final analysis.

The baseline characteristics of nurses are presented in Table 3. There were no significant differences between the DLN and control groups with regard to sex, age,

Table 3. Baseline demographic characteristics of nurses included in the final analysis.

Characteristics		DLN group (n = 35)	Control group (n = 34)	P
Sex	Male	0 (0%)	1 (2.9%)	0.493
	Female	35 (100%)	33 (97.1%)	
Age (years)	25–29	12 (34.3%)	18 (52.9%)	0.437
	30–34	11 (31.4%)	9 (26.5%)	
	35–39	10 (28.6%)	6 (17.6%)	
	≥40	2 (5.7%)	1 (2.9%)	
Educational background	College	2 (5.7%)	4 (11.8%)	0.591
	Bachelor	31 (88.6%)	29 (85.3%)	
	Master	2 (5.7%)	1 (2.9%)	
Title	Senior nurse	20 (57.1%)	25 (73.5%)	0.208
	Supervisor nurse	15 (42.9%)	9 (26.5%)	
Work experience (years)	1–5	5 (14.3%)	13 (38.2%)	0.076
	6–10	15 (42.9%)	10 (29.4%)	
	≥10	15 (42.9%)	11 (32.4%)	
Department	Internal medicine	15 (42.9%)	14 (41.2%)	0.990
	Surgery	18 (51.4%)	18 (52.9%)	
	ICU	2 (5.7%)	2 (5.9%)	

Data are presented as n (%).

DLN: diabetes liaison nurse; ICU: intensive care unit.

educational level, nurse title/grade, work experience, or department in which nurses were employed (Table 3).

Comparison of baseline questionnaire scores between DLN and control groups

There were no significant differences in baseline questionnaire scores between nurses in the two groups (Table 4). Notably, 62 of the 69 nurses (89.9%) rated poorly (score $\leq 60\%$) in the knowledge section of the questionnaire, especially for knowledge relating to risk factors for DM, microvascular complications, and appropriate injection sites for insulin.

Factor analysis of the interaction between training and time in effects on overall and subsection questionnaire scores

Training and time showed a significant difference between the DLN and control

groups; there was a correlation between training and time ($P < 0.05$). The DLN group had a total KAP score of 18 after the training, a 12-point increase: 6 points in the knowledge section, 7.46 in attitude, and 4.66 in the practice section (Table 5).

Changes in questionnaire scores for knowledge about DM among DLNs after 4 years of on-the-job training

The effects of the 4-year training program on knowledge about DM are depicted in Table 6. The proportion of nurses who gave correct responses was significantly increased at 4 years (compared with baseline) for items regarding chronic complications of DM, typical symptoms of DM, appropriate time to take acarbose, proportion of carbohydrates in a diet for DM, comprehensive treatment of DM, the most common side effects of metformin,

Table 4. Baseline questionnaire scores of nurses included in the final analysis.

Characteristics	DLN group (n = 35)	Control group (n = 34)	P
Knowledge about diabetes mellitus	12.83 ± 3.92	12.88 ± 3.24	0.951
General	3.91 ± 1.17	3.71 ± 1.49	0.520
Diet	1.17 ± 0.82	1.18 ± 0.90	0.980
Exercise	1.20 ± 0.87	1.26 ± 0.75	0.742
Oral antidiabetic drugs	1.34 ± 0.91	1.79 ± 0.98	0.051
Insulin	2.06 ± 1.35	1.59 ± 1.08	0.116
Complications	3.14 ± 1.52	3.35 ± 1.35	0.545
Attitudes toward diabetes mellitus	34.80 ± 5.28	35.12 ± 4.12	0.783
Diabetes mellitus management practices	25.94 ± 4.74	26.21 ± 3.78	0.800
Overall score	73.57 ± 10.01	74.21 ± 7.15	0.763

Data are presented as mean ± standard deviation.

DLN: diabetes liaison nurse.

principles of foot protection in patients with DM, appropriate time to take gliquidone, blood glucose monitoring frequency in patients receiving insulin injections, principles of dietary therapy for DM, assessment of exercise levels using heart rate in patients with DM, diabetic microangiopathy, diabetic exercise therapy, symptoms of hypoglycemia, and risk factors for DM (all $P < 0.05$; Table 6).

Changes in scores for attitudes toward DM among DLNs after 4 years of on-the-job training

The 4-year training program improved the scores obtained by DLNs in the attitudes toward DM section of the questionnaire (Table 7). Significant improvements in scores at 4 years (vs. baseline) were observed for the following items: “How severe is DM?”, “Can patients with DM live and work normally?”, “Can DM be cured?”, “Are patients with DM passive during treatment?”, “How important is knowledge about DM?”, “Willing to provide training in DM?”, and “DM training topics” (all $P < 0.05$; Table 7).

Changes in scores for DM management practices among DLNs after 4 years of on-the-job training

The 4-year training program resulted in significant improvements in scores obtained by DLNs on all items in the DM management practices section of the questionnaire ($P < 0.05$; Table 8).

Discussion

A notable finding of this study was that, in the absence of any training, nurses in both the DLN and control groups had only limited knowledge about DM, with around 90% of nurses rated as “poor” on the knowledge section of the questionnaire. Importantly, DLNs who completed the training program (including 11 days of initial qualifying training and additional on-the-job training over 4 years) demonstrated significant improvements in their scores for knowledge about DM, attitudes toward DM, and DM management practices. By contrast, nurses in the control group showed no such improvements over the same 4-year period. These findings indicate that long-term regular training, provided by

Table 5. Factor analysis of the interaction between training and time in their effects on overall and subsection questionnaire scores.

Group	Baseline	At 4 years	Change (%)	Intervention effect		Time effect		Interaction effect	
				F	P	F	P	F	P
Overall score				122.41	<0.001	47.857	<0.001	16.871	<0.001
DLN group (n = 35)	73.57 ± 10.01	91.69 ± 4.49	+24.6						
Control group (n = 34)	74.21 ± 7.15	78.38 ± 7.91	+5.7						
Knowledge about diabetes mellitus				87.070	<0.001	25.905	<0.001	6.531	0.013
DLN group (n = 35)	12.83 ± 3.92	18.83 ± 3.57	+46.9						
Control group (n = 34)	12.88 ± 3.24	14.65 ± 4.28	+14.0						
Attitudes toward diabetes mellitus				56.043	<0.001	32.670	<0.001	13.231	0.001
DLN group (n = 35)	34.80 ± 5.28	42.26 ± 2.39	+21.6						
Control group (n = 34)	35.12 ± 4.18	36.12 ± 3.89	+2.9						
Diabetes mellitus management practices				38.407	<0.001	10.983	0.001	4.387	0.04
DLN group (n = 35)	25.94 ± 4.74	30.60 ± 1.29	+18.2						
Control group (n = 34)	26.21 ± 3.78	27.62 ± 2.67	+5.3						

Data are presented as mean ± standard deviation.

DLN: diabetes liaison nurse.

Table 6. Number (proportion) of diabetes liaison nurses giving correct responses for each item on the knowledge about DM section of the questionnaire, before and after the 4-year training program.

Item	Baseline n (%)	At 4 years n (%)	P
Fasting plasma glucose range	32 (91.43)	34 (97.14)	0.307
Chronic complications of DM	29 (76.32)	34 (97.14)	0.048
Typical symptoms of DM	26 (82.86)	33 (94.29)	0.022
Optimal indicators of blood glucose control at 3 months	28 (80.00)	32 (91.43)	0.175
Optimal exercise duration	27 (77.14)	32 (91.43)	0.103
Appropriate time to take acarbose	21 (60.00)	32 (91.43)	0.002
Carbohydrate proportion in a diet for DM	14 (40.00)	30 (85.71)	<0.001
Five aspects regarding comprehensive treatment of DM	19 (54.29)	28 (80.00)	0.023
Monitoring of blood glucose frequency during treatment of diabetic ketoacidosis	23 (65.71)	28 (80.00)	0.182
Most common side effects of metformin	14 (40.00)	27 (77.14)	0.002
Main cause of death in patients with type 2 DM	19 (54.29)	26 (82.86)	0.083
Principles of foot protection in patients with DM	11 (31.43)	26 (82.86)	<0.001
Appropriate time to take gliquidone	12 (34.29)	25 (71.43)	0.002
Blood glucose monitoring frequency in patients receiving insulin injections	11 (31.43)	22 (62.86)	0.009
Correct carbohydrate:protein:fat ratio in patients with DM	17 (48.57)	21 (60.00)	0.341
Glucose monitoring during treatment of hypoglycemia	20 (57.14)	21 (60.00)	0.810
Diagnostic criteria for DM	13 (37.14)	20 (57.14)	0.096
Principles of dietary therapy for DM	10 (28.57)	20 (57.14)	0.016
Assessing exercise levels using heart rate in patients with DM	6 (17.15)	20 (57.14)	0.001
Side effects of insulin therapy	20 (57.14)	20 (57.14)	1.000
Distinction between rapid-acting and other insulins	14 (40.00)	19 (54.29)	0.235
Diabetic microangiopathy	6 (17.15)	18 (51.43)	0.003
Diabetic exercise therapy	9 (25.71)	17 (48.57)	0.049
Frequency of fundus examinations	14 (40.00)	16 (45.71)	0.632
Symptoms of hypoglycemia	7 (18.42)	16 (45.71)	0.023
Use of dynamic blood glucose monitoring	12 (34.29)	14 (40.00)	0.623
Appropriate sites for insulin injection	8 (22.86)	12 (34.29)	0.293
Insulin pump usage	7 (18.42)	10 (28.57)	0.406
Risk factors for DM	0 (0)	6 (17.15)	0.011

DM: diabetes mellitus.

an MDCT, can improve KAP levels among DLNs. As liaison nurse systems are believed to promote clinical effectiveness and the dissemination of research findings,²⁰ the improvement in DM-related knowledge and practice levels of DLNs after training would be expected to enhance the quality of care given to patients with DM who are admitted (for whatever reason) to non-endocrinology departments.

The present study also included non-DLNs as controls, i.e., nurses who did not receive the diabetes training. The aim of comparing the two groups was to explore differences in diabetes-related knowledge and skills between DLNs and non-DLNs. Nurses in the DLN group received the intervention, i.e., long-term regular training in diabetes-related knowledge and skills (including 2–4 hours' theoretical training

Table 7. Scores for items in the attitudes toward diabetes mellitus section of the questionnaire completed by diabetes liaison nurses, before and after the 4-year training program.

Item	Baseline	At 4 years	P
How severe is DM?	2.80 ± 1.11	4.03 ± 0.38	<0.001
Can patients with DM live and work normally?	4.09 ± 0.78	4.46 ± 0.51	0.021
Can DM be cured?	2.60 ± 1.04	4.09 ± 0.66	<0.001
Are patients with DM passive during treatment?	3.89 ± 1.13	4.43 ± 0.78	0.022
How important is knowledge about DM?	4.29 ± 0.89	4.86 ± 0.36	0.001
Willing to attend DM training?	4.51 ± 0.70	4.77 ± 0.423	0.069
Willing to provide DM training?	4.34 ± 0.68	4.83 ± 0.38	0.001
DM training topics	8.29 ± 3.72	10.80 ± 1.37	0.001

Table 8. Scores for items in the diabetes mellitus management practices section of the questionnaire completed by diabetes liaison nurses, before and after the 4-year training program.

Item	Baseline	At 4 years	P
Change needle for each injection	2.86 ± 0.94	4.00 ± 0.00	<0.001
Change site of each injection	3.17 ± 0.89	3.86 ± 0.36	<0.001
Pinch the skin as needed during each injection	3.14 ± 0.88	3.57 ± 0.50	0.015
Take a blood sample from the side of the finger to test blood glucose	3.31 ± 0.83	3.80 ± 0.47	0.004
Sterilize with alcohol before taking blood to test blood glucose	3.71 ± 0.67	4.00 ± 0.00	0.016
Inform patient of the right time to take oral antidiabetic drugs	3.49 ± 0.78	3.83 ± 0.38	0.024
Detect and treat hypoglycemia	3.34 ± 0.73	3.80 ± 0.41	0.002
Actively perform patient education	2.91 ± 0.82	3.74 ± 0.44	<0.001

and 1–2 practical training sessions); no special diabetes-related training was provided for nurses in the control group. Age, years' working, educational background, and nurses' title at inclusion were generally comparable between the two groups; the only difference between the groups was with respect to receiving diabetes training. Therefore, differences between the two groups should mainly arise as a result this training. Importantly, the results showed improvements in the skills and knowledge of DLNs after the intervention whereas the control group showed no improvement.

Nurses are a potentially important barrier to patient education and counseling in

practice.¹⁶ Any deficiency in knowledge and/or communication skills would limit the ability of a nurse to coordinate with other medical staff (including doctors) and to provide clear and convincing guidance to patients.¹⁷ When a patient with DM is admitted to a non-endocrinology ward (e.g., to receive specialized treatment for another condition), nurses on that ward may find it challenging to manage the patient's DM (including blood glucose control, advice on diet or exercise, oral antidiabetic drug administration, or insulin injection) without the help of an MDCT.¹⁸ Furthermore, the optimal management of DM requires patients to actively participate

in their care, which occurs most effectively when an MDCT is involved.²¹ Building long-term relationships, integrating knowledge by means of an MDCT, and ensuring adequate documentation is important in the provision of consistent diabetes-related information to the patient.²² An MDCT can provide patients with highly individualized care, including medical care, diabetes education, nutritional advice, exercise and lifestyle coaching, counseling, and monitoring of drug effects; this individualized care can improve patient outcomes and reduce overall costs. The involvement of an MDCT can also help minimize the risk of DM-related complications and improve the treatment of any complications²³ through a coordinated approach that facilitates timely communication and intervention. DLNs are important members of an MDCT, providing a link between specialist teams and nurses working in the clinical area.²⁰

The training protocol followed in this study led to an obvious improvement in DM-related knowledge, attitudes, and self-reported practice among DLNs, as compared with baseline levels. We suggest that training DLNs in DM-related knowledge and practices would improve the delivery of patient-centered diabetes care in non-endocrinology wards. The key role of a DLN is to provide knowledge and health education to patients with DM, as well as diabetes-related knowledge and guidance to other nurses in their department.²⁴ Because each trained DLN in our study worked in a different hospital department, they could help staff members within different departments to improve their understanding of DM and how it should be managed. Zwar et al.²⁵ found that the implementation of multidisciplinary care programs for patients with DM leads to significant decreases in HbA1c, blood pressure, and total cholesterol levels, improved metabolism, and a reduction in cardiovascular risk. Compared with untrained nurses, a DLN

is in a better position to provide patient education and improve patients' knowledge about diabetes, thereby improving self-management through better adherence to therapy and implementation of lifestyle modifications; this can be expected to yield benefits in terms of HbA1c and blood glucose levels.²⁶ Therefore, the inclusion of trained DLNs in non-endocrine departments can play a positive role in implementation of multidisciplinary nursing teams and management of blood glucose levels in patients with DM.

Several previous studies have reported that staff training can improve diabetes outcomes in hospitalized patients. For example, implementation of a 5-year stewardship intervention program (including organizational measures and quality improvement activities in drug storage, prescription, dispensing, administration, and monitoring) at a hospital in China resulted in a lower incidence of hypoglycemia in non-endocrinology wards, an increase in the proportion of nurses who correctly managed hypoglycemia (from 41.5% to 67.2%), and an increased proportion of outpatients receiving standardized insulin injection education (from 80% to 95.2%).²⁷ Furthermore, training nurses as diabetes management mentors can improve their clinical knowledge base and skill level and enhance their ability to resolve clinical issues.²⁸ In addition, educational interventions provided by clinical nurse specialists and nursing education specialists can lead to improved timing of bedtime glucose measurement and bedtime snack documentation.²⁹ A diabetes education program can also enhance the knowledge of nurses caring for hospitalized patients with DM.³⁰ Nevertheless, a recent study revealed that barriers remain in the implementation of DLN training and that measures must be taken.³¹ More importantly, the present study showed that some important knowledge items did not change after training.

Future studies should include multiple time points for assessing knowledge and skills, and the content of training should be adjusted to focus on these items.

This study has several limitations. One potential drawback is that KAP levels were only assessed theoretically through use of a questionnaire. In future studies, operational skills should be tested to demonstrate sustained improvement in skills. Second, the sample size in this study was relatively small, participating nurses were restricted to only one hospital, and some non-endocrinology departments may not have been represented. Third, the results focused only on nurses; inclusion of patients with DM in the analysis would have added value to assessment of the effectiveness of training. In addition, measurements were not taken of patient HbA1c and blood glucose levels, to evaluate whether participation in the training improved DM management among DLNs in non-endocrinology departments. Finally, the questionnaire was completed only once after the completion of training; therefore, the long-term sustainability of knowledge and skill improvement gained by the nurses could not be confirmed. A longitudinal study with multiple time points would be useful.

Conclusion

In the absence of any training, nurses had only limited knowledge about DM and its management. Long-term regular training provided by an MDCT improved KAP levels among DLNs. The inclusion of DLNs in non-endocrinology departments can potentially improve the quality of diabetes care provided to patients.

Acknowledgments

The authors would like to thank the nurses who volunteered to participate in this study.


Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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