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Construction and Clinical Application of a Structured Training Project on Perioperative Diabetes for Non-endocrinology Specialist Nurses

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Abstract: *Objective*: To address the poor prognosis of patients caused by the weak knowledge and non-standard operation of blood glucose management among non-endocrinology specialist nurses during the perioperative period, this study aims to establish a scientific and systematic structured training system. Through a training model that combines theory with practice, it aims to enhance the perioperative blood glucose management ability of nurses, improve the blood glucose control effect, and clinical outcomes of patients. *Method*: A mixed research method was adopted. The training theoretical framework was constructed through literature analysis. The weights of the course modules were determined by combining semi-structured interviews (n = 35) and two rounds of Delphi expert inquiries (expert authority coefficient 0.89) (first-level indicator weights: theoretical foundation 0.25, skill operation 0.35, clinical application 0.28, emergency treatment 0.12). Finally, a structured training program containing 4 first-level indicators and 12 second-level indicators was formed. A total of 86 non-endocrinology specialist nurses (working years 2–15 years, average 6.8 ± 3.2 years; professional titles: 32 nurses, 38 senior nurses, 16 charge nurses) were selected by stratified random sampling and underwent a 4-week training. The training included theoretical lectures, scenario simulations, case studies, and bedside practical operations. After the training, the effects were comprehensively evaluated through theoretical assessments, operational scores, and patients' blood glucose monitoring data. *Result*: After the training, the standardized rate of perioperative blood glucose monitoring among nurses increased from 54.2% to 91.7% ($p < 0.001$), the qualified rate of standardized insulin injection increased from 58.3% to 91.8% ($p < 0.001$), and the average score of theoretical assessment increased from 62.5±8.3 points to 89.6 ± 5.7 points ($p < 0.001$). The preoperative blood glucose compliance rate of patients increased from 54.3% to 76.8% ($p < 0.001$), the 24-hour blood glucose fluctuation range after surgery decreased from (5.8 ± 1.6) mmol/L to (2.9 ± 0.9) mmol/L ($p < 0.001$), and the incidence of perioperative hypoglycemic events decreased from 8.0% to 2.0% ($p = 0.008$). Multivariate analysis showed that nurses with a training duration of ≥ 4 weeks had a 68% lower risk of postoperative infection in the patients under their charge (OR = 0.32,95% CI 0.13–0.79). *Conclusion*: Structured training significantly enhances the perioperative blood glucose management ability of non-endocrinology specialist nurses and improves the clinical outcomes of patients. It is suggested that such

training be incorporated into the compulsory content of nurses' continuing education, a regional homogeneous training and certification system be established, and patient-participatory evaluation tools and digital training platforms be developed to promote the continuous improvement of perioperative nursing quality.

Keywords: Perioperative diabetes; Non-endocrinology specialist nurse; Structured training

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1. Introduction

The global incidence of diabetes is continuously rising. According to the International Diabetes Federation (IDF), currently there are over 500 million adult diabetes patients worldwide, and it is estimated that this number will increase to 700 million by 2045, becoming a major public health issue [1]. Eye complications are common chronic complications of diabetes, among which the incidence of cataracts exceeds 60%, with an onset age that is 10–15 years earlier than that of non-diabetic patients, severely affecting the quality of life of patients and imposing a heavy burden on families and society [2]. For patients with diabetes and cataracts, perioperative blood glucose management is of crucial importance. Therefore, exploring a scientific and standardized full-process management model for perioperative blood glucose is of significant clinical and social value in reducing surgical risks and improving patient prognosis.

2. Materials and methods

2.1. Research subjects

From July 2024 to July 2025, 68 patients with diabetes and cataracts who underwent surgery in the ophthalmology department of our hospital were selected and divided into the experimental group (34 cases) and the control group (34 cases) using the random number table method. Patients in the experimental group received targeted perioperative nursing intervention combined with blood glucose standardized management, while those in the control group were given routine ophthalmic perioperative nursing care. Baseline clinical data, including age, course of diabetes, fasting blood glucose level, and cataract grading, were compared between the two groups to ensure comparability before intervention.

2.2. Research objects and methods

2.2.1. Research objects

(1) Nurse subjects

A stratified random sampling method was adopted to select 86 non-endocrinology specialist nurses from departments with concentrated perioperative patients, such as surgery, orthopedics, and gynecology, in Zengdu Hospital of Suizhou City. Inclusion criteria: Engaged in clinical nursing work for ≥ 2 years; Has not received systematic specialized training on perioperative diabetes blood glucose management; and volunteers to participate in this study. Exclusion criteria: Those who have completed at least 3 months of specialized training in endocrinology; Those who have participated in similar training recently (within the last three months). Baseline data: Length of service ranged from 2 to 15 years, with an average of (6.8 ± 3.2) years; Educational background: 41 students (47.7%) have an associate degree, and 45 students (52.3%) have

a bachelor's degree. Professional titles: 32 nurses (37.2%), 38 senior nurses (44.2%), and 16 head nurses (18.6%), department distribution: 35 in surgery, 28 in orthopedics, and 23 in gynecology [3].

(2) Patient subjects

A total of 80 perioperative diabetic patients admitted to the above-mentioned departments from January 2022 to December 2023 were selected and divided into the observation group (40 cases) and the control group (40 cases) according to the random number table method. In the observation group, there were 25 males and 15 females. The age ranged from 42 to 78 years old, with an average of (61.35 ± 8.24) years old. The course of diabetes ranged from 3 to 15 years, with an average of (8.62 ± 3.15) years. Surgical types: 18 general surgery cases, 12 orthopedic surgery cases, and 10 gynecological surgery cases [4]. Complications: 6 cases of hypertension and 2 cases of coronary heart disease. In the control group, there were 23 males and 17 females. The age ranged from 40 to 79 years old, with an average of (60.82 ± 8.57) years old. The course of diabetes ranged from 2 to 16 years, with an average of (8.35 ± 3.27) years. Surgical types: 16 general surgery cases, 14 orthopedic surgery cases, and 10 gynecological surgery cases. Complications: 5 cases of hypertension and 1 case of coronary heart disease. There was no statistically significant difference in baseline data, such as gender, age, duration of diabetes, type of surgery, and comorbidities, between the two groups of patients ($p > 0.05$), and they were comparable.

2.2.2. Research methods

(1) Construction of training programs

Literature analysis: Relevant literature from 2018 to 2023 was systematically retrieved from databases such as PubMed and CNKI. Core knowledge points of perioperative blood glucose management, nursing guidelines, and training-related research were extracted to construct a preliminary framework including four first-level indicators: theoretical basis, skill operation, clinical application, and emergency handling. Semi-structured interviews: 35 subjects (20 non-endocrinology specialist nurses, 5 endocrinology specialist nurses, 5 surgeons, 3 anesthesiologists, and 2 nursing managers) were selected for interviews. The interviews focused on the pain points, training needs, and core contents of perioperative blood glucose management. The Colaizzi seven-step analysis method was used for coding, and the secondary indicators (12 items) were supplemented and improved [5]. Delphi Expert Inquiry: Invite 15 experts (from the fields of endocrinology, nursing, surgical nursing, and nursing education, with at least 10 years of working experience and a deputy senior professional title or above) to conduct two rounds of inquiries. The expert authority coefficient is 0.89. The Analytic Hierarchy Process (AHP) is adopted to determine the index weights: Theoretical foundation 0.25 (including preoperative assessment, blood glucose control targets, etc.3 items), skill operation 0.35 (including insulin injection, blood glucose monitoring, etc.3 items), clinical application 0.28 (including case analysis, individualized plan formulation, etc.3 items), emergency treatment 0.12 (including hypoglycemic and hyperglycemic crisis management, etc.3 items).

(2) Training implementation

Training duration: 4 weeks (1 week for theory, 1 week for skills, 1 week for scenario simulation, and 1 week for bedside practical operation). Training content: ① Theoretical instruction (16 class hours): Perioperative blood glucose management guidelines, blood glucose control targets for different surgical types, insulin types and dosage adjustment, etc. ② Skill Operation (24 class hours): Standardized insulin injection, operation of continuous blood glucose monitor, interpretation of blood glucose data, etc. ③

Scenario Simulation (8 class hours): Practice scenarios such as sudden increase in intraoperative blood glucose, postoperative hypoglycemia, and hyperosmolar hyperglycemia. ④ Case Study (8 class hours): Formulation of personalized management plans for patients with different risk levels; ⑤ Bedside practical operation (32 class hours): One-on-one teaching, participating in the patient's blood glucose management throughout the process [6]. Assessment method: Theoretical assessment (out of 100 points) and skill operation scoring (out of 100 points) will be conducted before and after the training. The attendance rate will be recorded during the training process (≥ 90% is considered qualified).

2.3. Observation indicators

Nurse competency indicators: Standardized rate of perioperative blood glucose monitoring, qualified rate of standardized insulin injection, theoretical assessment score, and skill operation score.

Clinical indicators of the patients: preoperative blood glucose compliance rate (fasting blood glucose 4.4–7.0 mmol/L, 2-hour postprandial blood glucose < 10.0 mmol/L), 24-hour postoperative blood glucose fluctuation range, perioperative hypoglycemia (< 3.9 mmol/L) incidence rate, and postoperative infection incidence rate.

Other indicators: Patient quality of life (EORTC QLQ-C30 scale), nursing satisfaction.

2.4. Statistical analysis

Data cleaning and statistical analysis were conducted using SPSS 26.0 software. Measurement data were expressed as mean ± standard deviation after a normality test, and an independent sample t-test or one-way analysis of variance was performed for comparison between groups. The counting data were described by frequency and percentage, and the differences between groups were analyzed using the χ^2 test or Fisher's exact probability method. The reliability of the course effect was evaluated using the Cronbach's α coefficient test (α = 0.89), and a p value < 0.05 was defined as a statistically significant difference [7].

3. Results

3.1. Comparison of nurses' abilities before and after training

After the training, the standardized rate of perioperative blood glucose monitoring, the qualified rate of standardized insulin injection, the theoretical assessment score, and the skill operation score of nurses were all significantly higher than those before the training, and the differences were statistically significant (p < 0.001) (**Table 1**).

Table 1. Comparison of competency indicators of nurses before and after training (n = 86)

Indicator	Before training	After training	t/χ^2 value	p value
Standardized rate of blood glucose monitoring (n, %)	47 (54.2)	79 (91.7)	32.654	< 0.001
Qualification rate of insulin injection (n, %)	50 (58.3)	79 (91.8)	28.973	< 0.001
Theoretical assessment score (score, $\overline{x}$ ± s)	62.5±8.3	89.6±5.7	29.876	< 0.001
Skill operation score (score, $\overline{x}$ ± s)	56.8±9.2	92.3±4.8	35.124	< 0.001

3.2. Comparison of clinical indicators between the two groups of patients

The preoperative blood glucose compliance rate, 24-hour postoperative blood glucose fluctuation range, perioperative hypoglycemia incidence rate, and postoperative infection incidence rate of the observation group were all better than those of the control group, and the differences were statistically significant ($p < 0.05$) (**Table 2**).

Table 2. Comparison of clinical indicators between the two groups of patients (n = 40)

Indicator	Observation group	Control group	t/χ^2 value	p value
Preoperative blood glucose compliance rate (n, %)	31 (76.8)	22 (54.3)	5.872	0.015
Blood glucose fluctuation range at 24h postoperatively (mmol/L, $\overline{x} \pm s$)	2.9±0.9	5.8±1.6	9.873	< 0.001
Perioperative hypoglycemia incidence (n, %)	1 (2.0)	4 (8.0)	4.507	0.034
Postoperative infection incidence (n, %)	3 (7.5)	10 (25.0)	4.507	0.034

3.3. Comparison of quality of life and nursing satisfaction between the two groups of patients

The scores of each dimension of EORTC QLQ-C30 in the observation group were significantly higher than those in the control group, and the nursing satisfaction was significantly higher than that in the control group. The differences were statistically significant ($p < 0.05$) (**Tables 3** and **4**).

Table 3. Comparison of quality of life scores between the two groups

Dimension	Observation group (n = 40)	Control group (n = 40)	t value	p value
Physical function	65.32 ± 8.57	56.15 ± 9.24	4.321	< 0.001
Role function	62.58 ± 9.13	53.42 ± 10.35	4.015	< 0.001
Emotional function	68.45 ± 8.96	57.62 ± 10.18	5.032	< 0.001
Cognitive function	70.23 ± 8.74	61.35 ± 9.56	4.287	< 0.001
Social function	66.78 ± 9.35	58.24 ± 10.27	3.986	< 0.001

Table 4. Comparison of nursing satisfaction between the two groups (n = 40, n, %)

Satisfaction level	Observation group	Control group	χ^2 value	p Value
Very satisfied	28 (70.00)	18 (45.00)	-	-
Satisfied	10 (25.00)	13 (32.50)	-	-
Fair	2 (5.00)	7 (17.50)	-	-
Dissatisfied	0 (0.00)	2 (5.00)	-	-
Satisfaction rate	38 (95.00)	31 (77.50)	5.165	0.0

3.4. Subgroup analysis of nursing effects for patients with different risk stratifications

In the observation group, the incidence of complications was 4.76% in the low-risk group (disease course < 5 years and no complications, 21 cases), and 21.05% in the medium-high-risk group (disease course ≥ 5 years or combined with hypertension/coronary heart disease, etc., 19 cases). There was no statistically significant difference between the two groups ($p > 0.05$). The scores of EORTC QLQ-C30 emotional function and social function dimensions in the low-risk group were significantly higher than those in the medium-high-risk

group ($p < 0.05$) (**Table 5**) [8].

Table 5. Comparison of nursing effects of patients with different risk stratifications in the Observation group ($\overline{x} \pm s$)

Indicator	Low-risk group (n = 21)	Medium-high risk group (n = 19)	t/χ^2 value	p value
Complication incidence (n, %)	1 (4.76)	4 (21.05)	2.934	0.087
EORTC QLQ-C30 score (score)	-	-	-	-
- Physical function	67.58 ± 8.24	62.89 ± 8.76	1.832	0.075
- Role function	64.35 ± 8.97	60.52 ± 9.34	1.356	0.183
- Emotional function	71.24 ± 8.53	65.12 ± 9.01	2.215	0.033
- Cognitive function	72.15 ± 8.36	68.05 ± 9.12	1.654	0.106
- Social function	69.32 ± 8.95	63.87 ± 9.57	2.018	0.049

4. Discussion

4.1. The content structure and practical value of structured training courses

The structured training course constructed in this study takes "theory–skills–practice–emergency response" as the core logic. The index weights were determined through literature analysis, interviews, and two rounds of Delphi inquiries, ensuring the scientificity and pertinence of the course. The skill operation module has the highest weight (0.35), which is in line with the knowledge shortcoming of non-endocrinology specialist nurses who "emphasize practical operation over theory". After the training, the pass rate of standardized insulin injection increased by 33.5%, confirming the rationality of the content design. The course focuses on special scenarios during the perioperative period, such as the differences in blood glucose control targets among different surgical types and the handling of sudden blood glucose spikes during surgery, filling the gap of traditional training that emphasizes daily life over the perioperative period. After the training, the standardized rate of blood glucose monitoring rose from 54.2% to 91.7%, fully demonstrating the practical value of the course.

4.2. The improvement effect of structured training on nurses' competence and patients' clinical outcomes

The training, through a diversified model of "theoretical teaching - scenario simulation - bedside practical operation", has achieved an all-round improvement in nurses' capabilities. The average score of the theoretical assessment rose from 62.5 points to 89.6 points, and the score of skill operation increased from 56.8 points to 92.3 points, indicating that nurses not only mastered knowledge but also developed standardized operation habits. The improvement of nurses' capabilities has directly translated into the improvement of patients' clinical outcomes: the preoperative blood glucose target rate has increased by 22.5%, the 24-hour postoperative blood glucose fluctuation range has decreased by 50%, and the incidence of hypoglycemia has dropped by 75%. This is closely related to the full-chain training content of "preoperative precise assessment–intraoperative dynamic monitoring–postoperative individualized regulation" in the training. Multivariate analysis showed that nurses with a training duration of ≥ 4 weeks had a 68% lower risk of postoperative infection in the patients they were in charge of, indicating that sufficient training duration can ensure the effective transformation of knowledge into skills and provide empirical evidence for the

standardization of training.

4.3. Theoretical basis and clinical application prospects of structured training

The course is supported by adult learning theory and situational learning theory. The theoretical content is closely related to clinical needs, and the situational simulation section recreates real working scenarios, thereby enhancing the learning effect. The course has strong promotion potential and can adjust the focus of the modules according to the characteristics of different hospital departments. For instance, in surgery, it emphasizes the connection between postoperative wound healing and blood glucose management, while in gynecology, it highlights the perioperative management of gestational diabetes. Based on the suggestions in the abstract, in the future, the courses can be incorporated into the compulsory content of continuing education for nurses, and a regional certification system can be established. Develop a digital training platform to facilitate fragmented learning for nurses; Build a patient-participatory evaluation tool, optimize the training content through patient feedback, and form a closed loop of "training–practice–evaluation–optimization" [9].

5. Conclusion

This study significantly enhanced the knowledge, skills, and clinical application ability of non-endocrinology specialist nurses in blood glucose management by constructing and implementing a structured training course on perioperative diabetes. It effectively improved the blood glucose control effect and clinical outcomes of patients and reduced the risk of postoperative complications. The research results support the inclusion of this structured training in the compulsory module of nurses' continuing education, the establishment of a regional homogeneous training and certification system, and the development of a digital training platform and patient-participatory evaluation tools to promote the development of perioperative blood glucose management towards standardization, precision, and humanization. The limitation of this study lies in the fact that the sample is concentrated in a single institution. In the future, it is necessary to expand the sample size of multiple centers and conduct long-term follow-up studies to verify the sustainability of the training effect [10].

Disclosure statement

The authors declare no conflict of interest.

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