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Effectiveness of whole course fine nursing combined with insulin pump blood glucose management on patients with diabetes mellitus combined with ischemic cerebral infarction

Xiaobin Wu[1,4], Yayuan Yang[2,4], Xiufeng Huang[1,4] and Liwen Chen[3]✉

OBJECTIVE: To probe the effectiveness of whole course fine nursing combined with insulin pump blood glucose management on patients with diabetes mellitus (DM) combined with ischemic cerebral infarction (ICI).
METHODS: The control group (conventional nursing plus insulin subcutaneous injection) and observation group (whole course fine nursing plus insulin pump blood glucose management) were established. General characteristics, glucose control effects, recovery of neurological and motor functions, self-care ability, health behaviors, quality of life, satisfaction, and adverse event incidence were compared in both groups.
RESULTS: Serum FBG, 2hPG, and HbA1c levels and NIHSS scores reduced and FMA, ESCA, 2-DSCS, and SF-36 scores increased after the intervention in both groups, and all significantly improved in the observation group. The observation group had higher satisfaction with blood glucose monitoring and feedback, health knowledge education, disposal of unexpected situations, treatment effect and comprehensive evaluation, and lower total adverse event incidence rate during hospitalization than the control group.
CONCLUSION: Whole course fine nursing combined with insulin pump glucose management can enhance the glucose control effect, and improve the neurological and motor functions, self-care ability, health behaviors and quality of life in patients with DM plus ICI, with high satisfaction and reduced adverse event incidence.

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INTRODUCTION

Diabetes mellitus (DM) is known as a pivotal independent risk element for cerebral infarction (CI). Meanwhile, DM is the cerebrovascular risk factor related to elevated in-hospital mortality in CI patients [1]. There are several treatments for patients with DM combined with CI, and these interventions consist of mecobalamin, α-Lipoic acid, as well as Chinese herbal medicine [2]. The patients suffering from CI in the presence of DM often have poor clinical outcomes in comparison to those in the absence of DM [3]. In clinical, the neurological deficit in DM combined with CI patients is featured with a significant motor deficit, chiefly including numbness, weakness, limitation of unilateral limb, motion, dyslalia, as well as alalia [4]. In terms of the pathogenesis of DM combined with CI, chronic high blood glucose concentrations are often thought to result in blood vessel wall damage, increased blood viscosity and hardening of the blood vessels, ultimately leading to vascular infarction [5, 6].

Due to the long-term high blood glucose levels in patients with DM combined with CI, it may lead to metabolic disorders and reduce clinical treatment effectiveness [7]. This situation will affect the daily lives of these individuals in their personal, family, and community environments, and they may experience serious physical and emotional limitations [8]. Nowadays, how to make patients actively and rationally accept professional and systematic treatment for DM combined with CI is the most essential issue to be solved in nursing work, and if nursing intervention is not performed in a timely manner, it is easy to trigger other complications and contribute to incalculable consequences [9, 10]. Following the traits of the patient's condition and their exact situation, better nursing interventions can be provided in terms of psychology, diet, medication, complications, physical and language function exercise, etc. [11]. Whole course fine nursing is a nursing model that consists of the preoperative, intraoperative, as well as postoperative nursing care [12]. Insulin pump therapy is an ongoing form of insulin delivery that has been revealed to be highly effective in keeping normal blood glucose and offering patients with flexibility in their lives [13]. The application of insulin pumps can be replenished by information obtained from continuous glucose monitoring in the sensor-augmented pump therapy, which could improve glycaemic control [14]. Many patients wish to continue using insulin pumps during hospitalization, so nurses should know how to care for those hospitalized patients wearing insulin pumps [15]. Herein, this paper aimed to probe the effectiveness of whole course fine nursing combined

[1]Department of Endocrinology, Zhongshan Hospital, Xiamen University, Xiamen, Fujian, China. [2]Department of Ultrasound Medicine, Zhongshan Hospital, Xiamen University, Xiamen, Fujian, China. [3]Department of Neurology, Zhongshan Hospital, Xiamen University, Xiamen, Fujian, China. [4]These authors contributed equally: Xiaobin Wu, Yayuan Yang, Xiufeng Huang. ✉email: ChenLiwen4848@163.com

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with insulin pump blood glucose management on patients with DM combined with ischemic cerebral infarction (ICI).

MATERIALS AND METHODS

Ethical approval

The study was under the approval of the Ethics Committee of Zhongshan Hospital, Xiamen University and followed the tenets of the Declaration of Helsinki. Written informed consent was acquired from all subjects.

Study participants

Using convenience sampling, 100 patients with DM combined with ICI admitted to Zhongshan Hospital, Xiamen University from February 2022 to April 2023 were selected as study participants.

Inclusion criteria

(i) All patients met the diagnostic criteria of type II diabetes mellitus [16]; (ii) All patients were diagnosed with combined mild to moderate ICI after admission to the hospital by routine imaging examination combined with clinical manifestations; (iii) After treatment, the patients were in stable condition, clear consciousness, with certain self-care ability, and able to cooperate with the medical staff to complete self-management education, diet and exercise treatment, regular blood glucose monitoring and related program evaluation; (iv) The patients' clinical data were complete; (v) After the ethical approval of the hospital, the patients and their family members agreed to the use of insulin pump treatment, were informed of the study, and signed the informed consent form.

Exclusion criteria

These patients were excluded: (i) type I diabetes mellitus; (ii) combined with other brain diseases such as cerebral hemorrhage, brain tumor, encephalitis, etc.; (iii) complicated by systemic infectious diseases; (iv) complicated by multiple organ dysfunction, liver and kidney diseases or other autoimmune diseases; (v) combined with other critical illnesses such as diabetic ketoacidosis, etc.; (vi) combined with impaired consciousness, mental retardation, communication disorders or psychiatric illnesses; (vii) poor compliance or reasons for not being able to cooperate with nursing intervention or insulin pump blood glucose management workers.

Randomization process and blinding method

Patients were randomly divided into a control group and an observation group, with 50 patients in each group, using the random number table method. Specifically, the 100 patients who met the inclusion and exclusion criteria were numbered in the order of admission from 1 to 100. Starting from the fifth column of the second row of the random number table, three-digit numbers were sequentially read and recorded below the corresponding patient numbers. All selected random numbers were then numbered from smallest to largest, with numbers 1–50 designated as the control group and 51–100 as the observation group.

This study adopted a single-blind method, meaning that after recruiting patients, their enrollment information was kept by the researchers. Neither the patients nor the result assessors were aware of the group assignments to avoid contamination and bias. However, members of the nursing intervention team were aware of the patients' information.

Intervention methods

The control group received routine nursing combined with insulin subcutaneous injection treatment. Routine nursing content mainly includes routine blood glucose, vital signs and neurological function monitoring; medication guidance and adverse reaction supervision; diet, exercise and early rehabilitation training guidance; and completing routine nursing operations in accordance with the doctor's instructions. Insulin subcutaneous injection treatment is to implement the subcutaneous injection of insulin aspart injection, within 15 min before three meals, 3 times/d, the specific dosage is decided by the doctor according to the individual blood glucose level and dietary arrangements. The observation group received the whole course fine nursing combined with insulin pump blood glucose management. The whole course fine nursing includes: (i) establishment of a whole course fine nursing team: The head nurse of the department served as the team leader, and nurses with strong responsibility and rich experience were selected as team members. All members jointly studied relevant knowledge on cerebral infarction and diabetes, consulted relevant domestic and international literature, and formulated refined nursing intervention plans based on the actual situation of the patients, ensuring the high quality and scientific nature of the nursing content. (ii) admission assessment and individualized care plan development: patients are admitted to the hospital for a detailed and comprehensive assessment, including blood glucose level, neurological function, motor function, dietary habits, psychological state, etc., and individualized care plans are developed. At the same time, the patient's comorbidities and underlying diseases are assessed to provide the basis for subsequent nursing interventions. (iii) Health education: health education on knowledge related to DM and cerebrovascular disease is provided to patients and their families through various forms, such as verbal notification and distribution of publicity brochures. Nursing staff instructs patients on the use of insulin pump, operation precautions and risks, and also instructs them to keep a blood glucose monitoring diary to understand and control their diet, exercise and insulin treatment, diet management and daily care, as well as the importance of diet control, regular exercise, and mood stabilization in blood glucose control. (iv) Glucose management: nursing staff use insulin pumps to record patients' daily blood glucose, insulin use and diet, analyze the data to identify problems and make adjustments, and optimize the settings on a regular basis, among other things. Setting blood glucose control goals and adjusting insulin or glucose-lowering drug dosage according to the patient's condition to avoid hypoglycemia. Nursing staff instructs patients to learn to operate the pump and adjust basal rates in advance based on exercise intensity, sleep, etc., and to master carbohydrate content calculation and insulin dose matching to ensure that the patient's insulin dose remains reasonable with the change of condition or lifestyle adjustment. (v) Neurological function nursing: Nursing staff regularly monitors the patient's consciousness state, speech ability, limb activity, and other neurological function indices, and observe the progress of the condition. Combined with the treatment of rehabilitation department, they carry out the rehabilitation training of limbs, speech and swallowing function to prevent functional degradation. (vi) Dietary care: Nursing staff formulates a scientific and reasonable dietary plan, control the total energy intake, and choose a diet with low sugar, low salt, low fat, and high fiber. According to the principles of dietary management, combine with patients' tastes and dietary habits, they rationally arrange the number of meals and food types. (vii) Complication prevention: nursing staff instructs patients and family members to do a good job of pump protection, avoid collision damage, and avoid going to places with large magnetic fields. A strict handover system is implemented, the handover includes insulin pump operation status, battery power, the skin condition of the patient's infusion site, whether the dressing is loose, and whether the needle cannula is dislodged. They instructs patients to keep the skin of the puncture site clean to avoid infection and inform patients and families about the necessity and time of blood glucose monitoring. In addition, nursing staff instructs patients how to recognize and deal with complications such as hypoglycemia, hypoglycemic coma, ketoacidosis, etc., and take emergency countermeasures immediately to deal with them if they occur. Nursing staff also need to instruct patients to turn over regularly, use anti-pressure sore pads, and keep skin clean and dry to prevent pressure sores, also, strengthen oral care, keep the respiratory tract open, and prevent lung infection. Moreover, they should pay attention to urinary tract infection, and encourage patients to move around early, perform passive lower limb exercises and massage to prevent deep vein thrombosis, etc. (viii) Psychological care: Nursing staff should pay attention to the patient's psychological state, help relieve anxiety and depression, and give emotional support. Meanwhile, they should communicate with patients and their families on a regular basis to understand the psychological needs and provide psychological counseling when necessary. (ix) Rehabilitation training and functional maintenance: Nursing staff should formulate different training programs according to the patient's rehabilitation stage, including passive activities, active exercise, daily life activities training, and gradually improve self-care ability. They should also regularly assess the progress of rehabilitation and adjust the rehabilitation program to help patients gradually restore their ability to live. Note that the fixation of puncture needles and catheters should be checked before and after rehabilitation training. Insulin pump (Medtronic MiniMed 712E) blood glucose management includes: (i) Setting up the insulin pump: personal parameters such as target glucose range and insulin sensitivity coefficient are entered according to the physician's recommendations, and the basal rate is set for 24-h continuous infusion to simulate basal pancreatic secretion, with the preprandial dose adjusted according to blood glucose and carbohydrate intake. (ii) Blood glucose monitoring and adjustment: Blood glucose monitoring are conducted several times a day. Combined with Continuous Glucose Monitoring (CGM) system, real-time monitoring and insulin adjustment are performed, followed by flexible adjustment of

basal rate and preprandial dosage based on factors such as activity, diet, sleep and stress. (iii) Handling of high and low blood glucose: automatic insulin supplementation by correction factor in case of high blood glucose, automatic suspension of infusion in case of low blood glucose. (iv) Treatment goal: Fasting blood glucose (FBG) 4.4–7.0 mmol/L and 2-h postprandial blood glucose (2hPG) < 10.0 mmol/L are considered to be achieved. (v) Device maintenance: the sensor and infusion device are replaced every 3 ~ 7 d. The CGM is regularly calibrated according to the device prompts to ensure the accuracy of blood glucose data. The effect is assessed after 2 weeks of continuous intervention in both groups. The nursing interventions in both groups were carried out by experienced nurses.

Observation indicators

(1) Glucose control effect: Before and after the intervention, 3 mL of fasting venous blood was acquired from patients in the two groups who had fasted for at least 8 h (usually overnight fasting) for the measurement of serum FBG and glycosylated hemoglobin (HbA1c), and 2 mL of venous blood from patients who had timed out for 2 h after drinking a solution containing 75 g of glucose, respectively, for the evaluation of serum 2hPG. After routine anticoagulation, the blood was centrifuged at about 3000 rpm for 10 min, and the supernatant was extracted. The serum FBG and 2hPG levels were determined by glucose oxidase test kits purchased from Fuyu Biotechnology Co., Ltd. (Shanghai, China). Serum HbA1c levels were tested by high performance liquid chromatography, and the kits were available from Telesis Medical Technology Co., Ltd. (Shandong, China).
(2) Neurologic function: Before and after the intervention, the degree of neurologic recovery in both groups was quantified by the National Institutes of Health Stroke Scale (NIHSS), which consists of 11 items including visual fields, upper extremity movements, and lower extremity movements, with scores ranging from 0 (no impairment) to 42 (most severe).
(3) Motor function: Before and after the intervention, the degree of recovery of upper and lower limb motor function was assessed by Fugl-Meyer Assessment (FMA) in both groups, and the scores ranged from 0 to 49, 50 to 84, 85 to 95, and 96 to 100 to represent severe, obvious, moderate, and mild motor dysfunction, respectively.
(4) Self-care ability: Before and after the intervention, the ability of the two groups of patients to care for themselves in daily life was evaluated by the Exercise of Self-Care Agency Scale (ESCA), which includes four dimensions: self-concept, self-care responsibility, health knowledge level, and self-care skills, with a total score of 0–172, and the higher the score, the stronger the self-care ability.
(5) Health behavior: Before and after the intervention, the self-management behaviors of patients in both groups were evaluated by the 2-Diabetes Self-Care Scale (2-DSCS), which includes six dimensions, including dietary control, regular exercise, medication compliance, and blood glucose monitoring, with a total score of 26–130, and the higher the score, the better the self-management was performed.
(6) Quality of life: Before and after the intervention, the quality of life of patients in both groups was evaluated by the health questionnaire (SF-36) in four dimensions: physical function, emotional function, general health, and energy, and the scores of the single dimensions were 100 points, and the higher the score, the higher the quality of life.
(7) Satisfaction: 1d before the discharge of the two groups of patients, the hospital's own satisfaction questionnaire was adopted to assess the content of the survey, including the nurse's service attitude, glucose monitoring and feedback, insulin injection, insulin precautions tutorials, health knowledge education, rehabilitation guidance, skin observation, the disposal of unforeseen circumstances, treatment effect, and comprehensive evaluation of a total of 10 entries, each item using a very satisfied (5 points), satisfied (4 points), general (3 points), dissatisfied (2 points), very dissatisfied (1 point) for evaluation. The total score is 50 points, and each item ≥ 4 is the satisfaction of the project.
(8) Incidence of adverse events: the incidence of adverse events during hospitalization was counted in both groups.

Statistical analysis

Statistical analysis was implemented using SPSS 26.0 software. Qualitative data were described by [*n* (%)] and analyzed by the χ^2 test. Normal distribution quantitative data were described by $\bar{x} \pm s$ and independent or paired samples *t*-test was performed, and skewed distribution quantitative data were described by M (P25, P75) and Mann–Whitney *U*-test was performed. $P < 0.05$ was considered as statistically significant difference.

RESULTS

General characteristics

There were no statistically significant differences in general characteristics such as age, gender, body mass index, history of underlying diseases, smoking history, and education level between the two groups ($P > 0.05$), indicating that the groups were balanced and comparable (Table 1).

Table 1. Comparison of general characteristics between the two groups.

Indicator	Observation group ($n = 50$)	Control group ($n = 50$)	$t/Z/\chi^2$	*P*	Effect sizes (95%CI)
Age (years)	53.50 ± 10.80	54.46 ± 8.89	−0.485	0.629	0.097 (−4.887–2.967)
Body mass index (kg/m^2)	27.64 (24.50, 30.59)	26.78 (25.01, 30.13)	−0.314	0.754	0.073 (−1.105–1.604)
Male/female (cases)	29/21	34/16	1.073	0.300	0.650 (0.298–1.444)
Hypertension (cases)	32 (64.00)	36 (72.00)	0.735	0.391	0.691 (0.288–1.583)
Hyperlipidemia (case)	27 (54.00)	24 (48.00)	0.360	0.548	1.272 (0.571–2.881)
Smoking history (case)	16 (32.00)	18 (36.00)	0.178	0.673	0.837 (0.367–1.871)
Causes of cerebrovascular disease (case)			0.931	0.818	/
Large-artery atherosclerotic	32 (64.00)	35 (70.00)	–	–	
Aortic occlusive	8 (16.00)	6 (12.00)	–	–	
Cardiogenic embolic	6 (12.00)	4 (8.00)	–	–	
Other	4 (8.00)	5 (10.00)	–	–	
Education level (cases)			2.376	0.305	/
Primary school	9 (18.00)	4 (8.00)	–	–	
Middle school	36 (72.00)	39 (78.00)	–	–	
University	5 (10.00)	7 (14.00)	–	–	

Table 2. Comparison of glucose control effects between the two groups.

Time	Observation group ($n = 50$)	Control group ($n = 50$)	Z	P	Effect sizes (95%CI)
Before intervention					
FBG (mmol/L)	9.37 (8.03, 10.65)	9.16 (8.47, 10.56)	−0.400	0.689	0.058 (−0.700–0.522)
2hPG (mmol/L)	13.07 (11.80, 14.09)	13.24 (12.02, 14.20)	−0.634	0.526	0.106 (−0.663–0.383)
HbA1c (%)	9.98 (8.44, 11.30)	9.82 (8.12, 11.08)	−0.851	0.395	0.125 (−0.413–0.792)
After intervention					
FBG (mmol/L)	5.78 (5.07, 6.39)[a]	6.65 (5.76, 6.95)[a]	−4.240	<0.001	0.912 (−1.045 to −0.409)
2hPG (mmol/L)	7.65 (6.65, 8.60)[a]	8.57 (7.69, 9.80)[a]	−3.619	<0.001	0.834 (−1.599 to −0.569)
HbA1c (%)	6.82 (6.01, 7.56)[a]	7.63 (7.07, 8.06)[a]	−3.816	<0.001	0.904 (−1.094 to −0.425)

[a]$P < 0.05$ vs. Before intervention within the same group.

Table 3. Comparison of neurological and motor function recovery between the two groups (points).

Time	Observation group ($n = 50$)	Control group ($n = 50$)	Z	P	Effect sizes (95%CI)
Before intervention					
NIHSS	12.50 (10.75, 14.00)	13.00 (11.75, 14.00)	−1.069	0.285	0.284 (−1.388–0.228)
FMA	36.00 (31.75, 39.25)	36.00 (30.75, 40.00)	−0.283	0.777	0.065 (−1.632–2.272)
After intervention					
NIHSS	6.00 (4.00, 7.00)[a]	7.00 (5.75, 8.25)[a]	−4.176	<0.001	0.908 (−2.069 to −0.811)
FMA	67.00 (60.75, 72.00)[a]	58.50 (52.50, 64.25)[a]	−4.782	<0.001	1.125 (5.100–10.660)

[a]$P < 0.05$ vs. Before intervention within the same group.

Table 4. Comparison of self-care skills and health behaviors between the two groups (score).

Time	Observation group ($n = 50$)	Control group ($n = 50$)	Z	P	Effect sizes (95%CI)
Before intervention					
ESCA	55.00 (48.75, 60.00)	56.00 (50.00, 60.25)	−0.798	0.425	0.169 (−3.480–1.400)
2-DSCS	53.00 (46.75, 57.00)	54.00 (47.75, 57.00)	−0.401	0.689	0.098 (−2.926–1.766)
After intervention					
ESCA	103.00 (93.75, 110.00)[a]	89.00 (82.00, 94.25)[a]	−5.998	<0.001	1.524 (10.028–17.092)
2-DSCS	92.00 (85.50, 98.00)[a]	87.00 (80.00, 92.25)[a]	−3.179	0.001	0.673 (2.000–7.760)

[a]$P < 0.05$ vs. Before intervention within the same group.

Glucose control effect

The differences in serum FBG, 2hPG, and HbA1c levels between the two groups before the intervention were not significant ($P > 0.05$); reduced serum FBG, 2hPG, and HbA1c levels were detected in both groups after the intervention, and they were all lower in the observation group versus the control group ($P < 0.05$; Table 2).

Neurological and motor function recovery

The difference between the NIHSS and FMA scores of the two groups before the intervention was insignificant ($P > 0.05$); decreased NIHSS scores and increased FMA scores were observed in both groups after the intervention, and all of them improved significantly in the observation group in contrast to the control group ($P < 0.05$; Table 3).

Self-care skills and health behaviors

The ESCA and 2-DSCS scores exhibited no significance in the two groups before the intervention ($P > 0.05$); elevated ESCA and 2-DSCS scores were found in the two groups after the intervention, and they were all higher in the observation group relative to the control group ($P < 0.05$; Table 4).

Quality of life

The difference in SF-36 scores between the two groups before the intervention showed no difference ($P > 0.05$); SF-36 scores increased in both groups after the intervention, and they were all higher in the observation group than in the control group ($P < 0.05$; Table 5).

Satisfaction

The observation group's satisfaction with blood glucose monitoring and feedback, health knowledge education, disposal of unforeseen circumstances, treatment effect and comprehensive evaluation were higher versus the control group ($P < 0.05$; Table 6).

Incidence of adverse events

The total incidence of adverse events during hospitalization in the observation group was 14.00% (7/50), which was lower than 32.00% (16/50) in the control group ($P < 0.05$; Table 7).

DISCUSSION

DM has long been linked to vascular dysfunction and peripheral nerve degeneration and even directly injures the central nervous

Table 5. Comparison of quality of life between the two groups (score).

Time	Observation group ($n = 50$)	Control group ($n = 50$)	Z	P	Effect sizes (95%CI)
Before intervention					
Physical function	53.50 (48.00, 58.00)	52.50 (47.75, 57.00)	−0.701	0.483	0.127 (−1.578–3.058)
Emotional function	55.50 (48.75, 61.00)	54.50 (48.00, 60.00)	−0.480	0.631	0.075 (−2.253–3.293)
General health	50.00 (45.00, 55.00)	51.00 (45.00, 56.00)	−0.760	0.448	0.147 (−3.328–1.528)
Energy	53.50 (49.00, 59.00)	54.00 (48.00, 59.00)	−0.262	0.793	0.045 (−2.753–2.193)
After intervention					
Physical function	76.00 (69.00, 81.00)[a]	68.00 (61.75, 73.25)[a]	−4.834	<0.001	1.165 (5.314–10.806)
Emotional function	75.00 (68.00, 81.00)[a]	69.00 (62.00, 74.25)[a]	−3.646	<0.001	0.811 (3.158–9.202)
General health	74.00 (66.00, 81.00)[a]	67.00 (60.00, 73.00)[a]	−3.798	<0.001	0.846 (3.715–10.285)
Energy	72.00 (65.00, 78.00)[a]	65.50 (59.00, 71.00)[a]	−3.927	<0.001	0.890 (3.580–9.340)

[a]$P < 0.05$ vs. Before intervention within the same group.

Table 6. Comparison of satisfaction between the two groups [n (%)].

Item	Observation group ($n = 50$)	Control group ($n = 50$)	χ^2	P	Effect sizes (95%CI)
Nurse's service attitude	49 (98.00)	46 (92.00)	1.895	0.169	4.261 (0.655–53.050)
Glucose monitoring and feedback	48 (96.00)	40 (80.00)	6.061	0.014	6.000 (1.464–28.230)
Insulin injection	49 (98.00)	45 (90.00)	2.837	0.092	5.444 (0.684–65.280)
Insulin precautions tutorials	47 (94.00)	42 (84.00)	2.554	0.110	2.984 (0.814–-10.830)
Health knowledge education	48 (96.00)	41 (82.00)	5.005	0.025	5.268 (1.228–25.060)
Rehabilitation guidance	47 (94.00)	44 (88.00)	1.099	0.295	2.136 (0.567–8.114)
Skin observation	49 (98.00)	44 (88.00)	3.840	0.050	6.682 (1.000–78.060)
Disposal of unforeseen circumstances	48 (96.00)	39 (78.00)	7.162	0.007	6.769 (1.436–31.550)
Treatment effect	49 (98.00)	41 (82.00)	7.111	0.008	10.760 (1.581–120.100)
Comprehensive evaluation	48 (96.00)	38 (76.00)	8.306	0.004	7.579 (1.666–35.050)

Table 7. Comparison of adverse event rates between the two groups [n (%)].

Complications	Observation group ($n = 50$)	Control group ($n = 50$)	$\chi2$	P	Effect sizes (95%CI)
Hypoglycemia	3 (6.00)	8 (16.00)	–	–	
Ketoacidosis	0 (0.00)	1 (2.00)	–	–	
Infection	2 (4.00)	4 (8.00)	–	–	
Thrombosis	2 (4.00)	3 (6.00)	–	–	
Total	7 (14.00)	16 (32.00)	4.574	0.032	0.346 (0.137–0.894)

system. DM combined with CI leads to poor functional prognosis and high incidence rates of and mortality [17, 18]. This statement should remind nurses who typically participate in reception, initial assessment, or triage activities in primary healthcare services to consider approaches for monitoring and performing effective care. Emphasizing the adoption of good self-care measures, such as developing a healthy diet plan, regular exercise, managing blood glucose levels, and adhering to medication treatment, is crucial for decreasing the long-term risk of chronic diseases, lowering treatment costs, and minimizing anxiety and other psychological distress [8]. This study probed the effect of whole course fine nursing combined with insulin pump blood glucose management on patients with DM combined with ICI.

In the past thirty years, insulin pump therapy has made significant progress, which can better control metabolism and reduce hypoglycemic events compared to multiple daily injections [19]. Insulin pump therapy can improve the potential pathophysiology of early DM, which may provide a therapeutic strategy for changing the natural history of DM [20]. In addition, compared with oral hypoglycemic drugs, insulin pump has a good effect on the recovery and maintenance of β cell function and long-term blood glucose relief in DM patients [21]. Insulin pump therapy requires continuous, dynamic, targeted, standardized and systematic management by diabetes specialists in five areas: education, diet, exercise, medication, and monitoring. The results of this study suggested that DM patients can be better educated about DM during their hospitalization in the surgical unit through insulin pump management, resulting in faster achievement of preoperative glycemic control in diabetic patients. This study also suggested that fine regulation through insulin pumps allows diabetic patients to have a high insulin dosage in stressful situations and a gradual reduction in dosage occurs during hospitalization, which will help the patients to safely get through stressful situations such as surgical trauma and maintain glycemic stability, thus avoiding large fluctuations in blood glucose.

The concept of whole course fine nursing has gradually been emphasized by the nursing profession in recent years. Compared with the single, fragmented, and lack of precision characteristics of traditional nursing care, this nursing model has the characteristics of "comprehensiveness, precision, and systemicity". In the specific nursing process, based on evidence-based medicine, we analyze the risk factors and precautions for the occurrence of DM plus ICI in preoperative, intraoperative, and postoperative stages, without sparing or neglecting every detail in the clinic, and then formulate a strategy for the whole process of nursing intervention throughout the preoperative—postoperative period. The whole-course nursing for acute myocardial infarction patients improves their cardiac function, relieves their negative emotions, increases their quality of life, as well as reduce their incidences of complications [22, 23]. Abed et al. have pointed out that the whole-course nursing can help alleviate patients' negative emotions and has a more significant impact on patients with depression. Postoperative nursing for patients' psychological state and complications not only reduces the occurrence of complications, but also to some extent eliminates patients' negative emotions [24]. Wilgenhof et al. have also stated that whole-course nursing has a clearer impact on improving postoperative quality of life [25]. In our paper, we found that serum FBG, 2hPG, HbA1c levels and NIHSS scores were reduced and FMA, ESCA, 2-DSCS, SF-36 scores were increased after the intervention in both groups, and all of them were significantly improved in the observation group versus the control group. This implies that the intervention method combining whole course fine nursing combined with insulin pump blood glucose management can not only effectively control blood glucose levels but also promote neurological recovery, enhance patients' self-care abilities and quality of life, while reducing the incidence of adverse events and improving patient satisfaction.

It is noteworthy that inflammation plays a crucial role in the pathogenesis of ischemic neuronal injury. When cerebral ischemia occurs, the inflammatory response is activated, leading to further neuronal damage [26]. Relevant studies have shown [27–31] that hyperglycemia can exacerbate the inflammatory response after cerebral ischemia, whereas effective glycemic control may facilitate neurological recovery by mitigating the inflammatory response. Although this study achieved positive results, it did not directly monitor changes in inflammatory or vascular biomarkers to elucidate how improved glycemic control translates into better neurological recovery. Future research should focus on these physiological biomarker changes and attempt to establish a link between the inflammatory pathogenesis of ischemic stroke and favorable responses to glycemic control regimens.

Conclusion, limitations, and future directions

To conclude, this paper highlights that whole course fine nursing combined with insulin pump glucose management can notably enhance the glucose control effect, improve the neurological and motor functions, self-care ability, health behaviors and quality of life in patients with DM plus ICI, with high satisfaction and reduced incidence of adverse events. This study introduces a novel comprehensive intervention model that integrates whole course fine nursing combined with insulin pump blood glucose management. This model not only focuses on patients' glycemic control but also encompasses various aspects of nursing, such as health education, psychological support, and lifestyle adjustments. Furthermore, the study explores the application effects of this combined approach in a specific patient population with DM complicated by ICI, providing novel therapeutic insights for clinical practice. Healthcare providers can tailor individualized comprehensive meticulous nursing and insulin pump blood glucose management plans based on patients' specific conditions to achieve optimal treatment outcomes. However, this study has some limitations. For instance, it was conducted in a single hospital with a limited sample size, potentially restricting the generality of the results. Additionally, the study did not involve the monitoring of physiological biomarkers (such as inflammatory or vascular biomarkers), thus making it impossible to clearly explain how improved glycemic control translates into better neurological recovery. Moreover, the follow-up duration of our study was insufficient, potentially inadequate for assessing the long-term impact of the combined approach on disease progression, glycemic stability, or quality of life. Future research is recommended to expand the sample size and include multiple centers to encompass a broader patient population and healthcare settings. This will help validate and expand the study findings, enhancing their applicability in diverse contexts. Furthermore, extending the follow-up period to assess the sustained impact on glycemic control, functional recovery, and adverse events, while also focusing on cost-benefit analysis, will determine the economic feasibility of extending the intervention to larger populations. Notably, future studies could also delve deeper into the potential physiological or behavioral mechanisms driving improvements, such as reducing oxidative stress and enhancing patient capabilities, providing clues for improving treatment outcomes and facilitating the rehabilitation process for patients with DM complicated by ICI.

DATA AVAILABILITY

The experimental data used to support the findings of this study are available from the corresponding author upon request.

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AUTHOR CONTRIBUTIONS

Xiaobin Wu finished the study design. Yayuan Yang finished the experimental studies. Xiufeng Huang finished the data analysis. Liwen Chen finished the manuscript editing. All authors read and approved the final version of the manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

Correspondence and requests for materials should be addressed to Liwen Chen.

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