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Glucose fluctuation during insulin therapy in diabetic patients with nasal feeding analysis of influencing factors

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Abstract: **To explore the factors related to blood sugar fluctuation in diabetic patients with continuous nasal feeding during insulin pump therapy, and to provide clinical reference for the adjustment of insulin therapy. Forty diabetic patients with continuous nasal feeding treated with insulin from January 2016 to June 2019 in our hospital were selected. The blood sugar fluctuation was observed by 7-8 fingertip blood monitoring every day. The blood sugar fluctuation of patients with continuous nasal feeding was observed by analyzing the clinical data. In addition, the related factors affecting blood sugar fluctuation were summarized. Using LAGE and SDBG as the evaluation indexes of blood sugar fluctuation, logistic multiple regression analysis of single and multiple factors was carried out for the possible related factors affecting blood sugar fluctuation.The blood sugar levels of different sex, age, course of disease, glycosylated hemoglobin, body mass index (BMI) and other indicators of patients were compared, and no statistical difference was found in the blood sugar fluctuation levels of gender, age and BMI groups (p>0.05). With the increasing of diabetes course, the blood sugar fluctuation amplitude increased (P < 0.05). Carbohydrate content and total protein during the period also lead to blood sugar fluctuation (P < 0.05). Unconditional multivariate logistic regression analysis showed that duration (OR = 1.201, P = 0.016), carbohydrate (OR = 1.029, P = 0.016), total protein (OR = 1.134, P = 0.046) were the factors of blood sugar fluctuation in diabetic nasal feeding patients. For diabetic patients with continuous nasal feeding, the fluctuation of blood sugar is related to the course of disease, carbohydrate content, total protein and other factors. For those patients with risk factors, we should take relevant measures and pay attention to the fluctuation of blood sugar.**

Keywords: Diabetic patients with nasal feeding; Insulin therapy; Fingertip blood sugar monitoring; Blood sugar fluctuation; Influencing factors

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1. Introduction

The American Endocrinological Society's Clinical Practice Guidelines for Hyperglycemia in Non-emergency Inpatients[1] recommends that insulin therapy be the first choice for controlling blood sugar in all hospitalized hyperglycemic patients. Enteral nutrition (EN) has become the most ideal nutritional support for severe patients. Hyperglycemia is a common complication of nutritional support regardless of diabetes history. Therefore, during EN support, attention should be paid to blood sugar and appropriate blood sugar control should be given. Some patients with diabetes in our hospital are often admitted to non-endocrine specialty for the first time because of the need of disease. Some patients need insulin treatment because of the nutritional support of continuous nasal feeding. During the treatment period, more attention is paid to the hyperglycemia and hypoglycemia and their treatment. There are few studies on the fluctuation of blood sugar. The fluctuation of blood sugar is one of the important indexes to evaluate the control of blood sugar. The fluctuation of blood sugar is one of the important indexes to evaluate the control of blood sugar. Glucose fluctuation refers to the unstable state in which blood sugar level changes between its peak and valley. It includes not only short-term blood sugar fluctuation (intraday blood sugar fluctuation and intraday blood sugar fluctuation), but also long-term blood sugar fluctuation (HbA 1C variability)[2]. In the long-term process of blood sugar control, blood sugar fluctuation has always been a difficult problem to solve. Blood sugar fluctuation causes vascular endothelial damage by activating oxidative stress and inflammation. The greater the blood sugar fluctuation, the greater the damage. If the blood sugar control is not good, serious complications will occur[3]. At present, clinical blood glucose monitoring methods are divided into continuous glucose monitoring (CGM) and self-monitoring of blood glucose (SMBG), which can effectively assess the degree of blood glucose fluctuation. CGM can accurately and comprehensively reflect the characteristics of blood sugar fluctuation, but the cost of monitoring is relatively high and the operation is relatively complex, so it is not easy to popularize in

diabetic population. SMBG is flexible, easy to operate, relatively economical and feasible. The daily blood sugar fluctuation in type 2 diabetes can be accurately estimated by SMBG values 7-8 times a day, and it has a good correlation with CMG[4,5]. Therefore, this study monitored the blood glucose of diabetic patients with continuous nasal feeding in our hospital 7-8 times, in order to explore the factors related to blood glucose fluctuation during insulin pump treatment of diabetic patients with continuous nasal feeding, and to provide clinical reference for the adjustment of blood glucose regimen.

2. Objects and methods

2.1. Research subjects

Forty patients with type 2 diabetes who received continuous monitoring of nasal feeding blood sugar by insulin in the First Affiliated Hospital of Jinan University from January 2016 to January 2019 were collected. Among the 40 patients, 25 were males and 15 were females, aged from 30 to 88 years, with an average age of (65.85±12.36) years. The course of the disease ranged from 0 to 21 years, with an average of (6.93±7.04) years. Selection criteria: according to the 1997 WHO diagnostic criteria for type 2 diabetes[6], type 2 diabetes cases were diagnosed. Exclusion criteria: neurological and psychiatric diseases; liver and kidney dysfunction; recent surgery, trauma, infection and other stress state; recent hormone treatment and taking other drugs affecting glucose metabolism.

2.2. Methods

The clinical data of 40 patients with type 2 diabetes mellitus complicated with nasal feeding were retrospectively analyzed. Indicator information was obtained through electronic medical record system. Including: (1) General data: gender, age, course of diabetes, body mass index (BMI), blood pressure at admission. (2) Laboratory examination results: fasting blood glucose (FBG), glycosylated hemoglobin (HbA1c), total cholesterol (TC), triglyceride (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and other related metabolic indicators (3) Diabetic complications: diabetic nephropathy (DN), hypertension, coronary artery disease. Data were recorded by two researchers. The fingertip blood glucose monitoring data were 72 hours from 0:00 on the first day to 24:00 on the third day after the patients' blood glucose became normal. The fingertip blood glucose was monitored at 7 o'clock everyday day. The fixed time of nasal feeding for patients with continuous nasal feeding (starting at 8:00), and the fingertip blood glucose was measured by Q2h-Q3h machine. The fingertip blood was monitored by Johnson-Johnson Glucose Meter. Attention measurement for monitoring blood sugar was to avoid limbs undergoing infusion.

2.3. Self-monitoringof blood glucose

2.3.1. Monitoring System

At present, continuous glucose monitoring (CGM) and self-monitoring of blood glucose (SMBG) can effectively assess the blood glucose fluctuation. CGM can accurately and comprehensively show the characteristics of blood sugar fluctuation, but the valuable monitoring is relatively high and the operation is relatively complex. Therefore, it is not easy to popularize in diabetic population. SMBG is flexible, easy to operate, economical and feasible. The daily blood sugar fluctuation in type 2 diabetes mellitus can be accurately estimated by SMBG values 7 to 8 times one day. It has a good correlation with CMG. Therefore, this study used this method to collect the relevant indicators of blood sugar fluctuation.

2.3.2. Glucose fluctuation index

Standard deviation of blood sugar level (SDBG): Standard deviation of times sugar in one day, normal reference value of blood sugar fluctuation according to the consensus of experts on blood sugar fluctuation management of diabetic patients in 2017 [7]. SDGE<1.4 mmol/L is the normal range of blood sugar fluctuation.

2.4. The abnormal range of blood sugar fluctuation

Maximum glycemic fluctuation amplitude (LAGE): The difference between maximum and minimum glycemic values within a day (LAGE < 4.4 mmol/L) is the normal range of glycemic fluctuation. LAGE > 1.4 mmol/L is the abnormal range of blood sugar fluctuation.

2.5. Statistical analysis

SPSS 16.0 software was used for statistical analysis. The measurement data of normal distribution are expressed by $\bar{x} \pm s$, the measurement data of two independent samples are expressed by t test, and the counting data are expressed by rate and x^2 test. The data were analyzed by single factor linear correlation and logistic regression. The difference was statistically significant when $P < 0.05$.

3. Results

3.1. General information

There were 25 males and 15 females in 40 patients,

aged from 30 to 88 years, with an average age of (65.85±12.36) years. The course of disease ranged from 0 to 21 years, with an average age of (6.93±7.04) years. BMI values ranged from 15.80 to 37.5, with an average of (22.57±3.54), and the standard-meeting days ranged from 1 to 10 days, with an average of (3.03±1.87) days.

3.2. Univariate analysis of LAGE of blood sugar fluctuation

40 patients with diabetes mellitus during nasal feeding showed that 24 patients had blood sugar fluctuation in the maximum amplitude of blood sugar fluctuation (60.0%) and 16 patients had no blood sugar fluctuation (40.0%). There were 16 males and 8 females in the blood sugar fluctuation group, aged 67.50±12.54 years, with a course of 9.50±6.86 years. In the blood sugar fluctuation group, 9 males and 7 females, aged 63.38±12.05 years, had a course of 3.94±4.97 years. The course of disease, carbohydrate and total protein were significantly different between the two groups ($P < 0.05$), as shown in Table 1.

Table 1. Single factor analysis of basic indicators for blood glucose fluctuation (LAGE)

Risk factor	Maximum fluctuation of blood sugar LAGE		t/ x^2	p
	Normal group	Abnormal group		
Age	67.5±12.54	63.38±12.05	1.035	0.307
Diabetic (Y)	9.50±6.86	3.94±4.97	2.787	0.008
Nasal feeding volume(ml)	1039.17±283.36	983.75±307.61	0.586	0.562
BMI (kg/m2)	21.85±2.38	23.65±4.68	1.600	0.118
Carbon and water (g)	170.38±49.60	138.00±27.92	2.367	0.023
Hemoglobin mmol/L	8.15±1.62	9.056±2.17	1.208	0.234
WBC(mmol/L)	12.76±5.37	11.72±3.64	0.677	0.502
Uric acid (mmol/L)	304.26±121.55	311.94±165.68	0.169	0.867
Cholesterol (mmol/L)	4.28±1.12	4.69±1.33	1.061	0.295
TG (mmol/L)	1.67±0.93	2.30±2.46	1.321	0.194
HDL(mmol/L)	0.90±0.46	1.18±0.77	1.427	0.162
LDL (mmol/L)	2.57±0.87	2.56±0.85	0.050	0.960
Creatinine(mmol/L)	92.68±60.18	73.94±58.74	0.974	0.336
Urea (mmol/L)	11.21±8.37	3.39±23.35	10.421	0.676
Albumin (g/L)	33.82±4.66	33.12±4.50	0.473	0.639
Total protein (g/L)	65.81±6.99	58.91±9.94	2.58	0.014
ALT(mmol/L)	36.00±35.10	23.38±18.47	1.32	0.20
AST(mmol/L)	43.19±51.82	21.44±10.78	1.65	0.11
Systolic blood pressure (mmHg)	147.75±22.50	148.63±28.59	0.11	0.91
Diastolic blood pressure	78.21±11.98	78.06±17.04	0.03	0.98
Gender				
Male (n)	16(66.67)	9(56.25)	/0.44	0.51△
Female (n)	8 (33.33)	7(43.75)		
Coronary heart disease	1 (4.17)	2(12.50)	/0.14	0.71△
Hypertension	17(70.83)	9(56.25)	/0.90	0.34△
Nephropathy	1 (4.17)	2(12.50)	/0.135	0.71△

△ Chi-square value

3.3. Univariate analysis of blood sugar fluctuation SDBG

40 patients with diabetes mellitus during nasal feeding: 20 patients had blood sugar fluctuation in standard deviation of blood sugar level (SDBG), the incidence rate was 50.0%, 20 patients had no blood sugar fluctuation, the incidence rate was 50.0%.

There were 14 males and 6 females in the group of blood sugar fluctuation, the age was 65.83±12.73 years, the course of disease was 8.08+6.65 years. In the blood sugar fluctuation group, there were 11 males and 9 females, aged 65.88±12.19 years, with a course of 6.06 ± 6.81 years. There were no significant differences in age, course of disease, carbohydrate and other factors between the two groups (P < 0.05), as shown in Table 2.

Table 2. Single factor analysis of basic indicators for standard deviation of blood sugar level (SDBG)

Risk factor	SDBG		t/ x^2	p
	Normal group(20)	Abnormal(20)		
Age	66.0±13.02	65.70±12.00	0.08	0.94
Diabetic (Y)	8.10±6.44	6.45±7.01	0.78	0.44
Nasal feeding volume(ml)	1022.00±292.35	1012.00±296.53	0.11	0.92
BMI (kg/m2)	22.02±2.12	23.13±4.54	0.10	0.33
Carbon and water (g)	167.30+50.47	147.55+37.02	1.41	0.17
HbA1c(%)	8.04+1.42	8.99+2.18	1.63	0.11
Hemoglobin mmol/L	118.42+34.82	109.24+24.20	0.97	0.34
WBC(mmol/L)	13.22+5.58	11.46+3.62	1.18	0.24
Uric acid (mmol/L)	286.61+107.33	328.05+164.81	0.94	0.35
Cholesterol (mmol/L)	4.37+1.15	4.51+1.29	0.35	0.73
TG (mmol/L)	1.75+0.97	2.16+2.25	0.76	0.45
HDL(mmol/L)	0.90+0.46	1.18+0.77	1.18	0.25
LDL (mmol/L)	2.65+0.92	2.48+0.79	0.62	0.54
Creatinine(mmol/L)	93.02+63.90	77.36+55.43	0.83	0.41
Urea (mmol/L)	10.32+7.79	13.84+21.23	0.70	0.49
Albumin (g/L)	33.22+4.70	33.87+4.49	0.45	0.66
Total protein (g/L)	66.64+7.51	60.47+9.52	1.91	0.06
ALT(mmol/L)	38.20+37.82	23.70+17.33	1.56	0.13
AST(mmol/L)	45.48+56.56	23.05+11.30	1.70	0.10
Systolic blood pressure (mmHg)	146.00+20.87	150.20+28.53	0.53	0.60
Diastolic blood pressure (mmHg)	76.80+10.81	79.50+16.80	0.60	0.55
Gender				
Male (n)	14(70)	11(55)	/3.49	0.06△
Female (n)	6(30)	9(45)		
Coronary heart disease	0(0)	4(20)	/2.50	0.11△
Hypertension	15(75)	11(55)	/0.90	0.34△
Nephropathy	0(0)	1(5)	/0.53	0.47△

△ Chi-square value

3.4. Logistic multivariate analysis of blood glucose fluctuation

The occurrence of blood glucose fluctuation as dependent variable and three parameters with statistical significance are independent variables in Tables 1 and 2. Logistic multivariate regression analysis was carried out. After gradual selection, variables were screened by likelihood ratio advance method. The test level of introducing variables was a=0.10, and the data situation was 40 cases. Included in the analysis, there was no missing value. The score test results of step 0 of variable screening could be used as the result of univariate logistic regression analysis. For example, univariate regression analysis showed that at a=0.05 level, diabetes duration, carbohydrates and total protein entered the regression model with statistical significance. The results showed that the course of disease, carbohydrate and total protein were positively correlated with the

fluctuation of blood sugar (Table 3).

Table 3. Logistic regression analysis of risk factors for blood sugar fluctuation in nasal feeding patients treated with insulin

Variable	*B*	SE	Wald x^2	*P*	OR	95% CI
Course of disease (year)	0.183	0.076	5.752	0.016	1.201	1.034-1.394
Carbohydrate gram number (g)	0.029	0.12	5.761	0.016	1.029	1.005-1.054
Total protein	0.109	0.055	3.908	0.048	1.115	1.001-1.241

4. Discussion

The prevalence of diabetes in China is increasing year by year. The study of diabetes control and complications (DCCT) and the UKPDS established the status of glycosylated hemoglobin A1c (HbA1c) as a predictor of chronic complications of diabetes. However, the study found that the fluctuation of blood sugar may be independent factor of HbA1c and other indicators of blood sugar control[8]. Large fluctuation of blood sugar can cause the occurrence and development of diabetic complications. This study found that the duration of disease, carbohydrate and total protein of nasal feeding patients can affect the level of blood sugar fluctuation.

In this study, duration was a risk factor for blood sugar fluctuation, and OR value was (1.034 1.394) respectively. The reasons are as follows: It is reported that 8% of patients with diabetes mellitus have peripheral vascular lesions at the time of diagnosis, which increase with age and course of disease. The longer the course of diabetes mellitus is, the more serious the vascular lesions are, and the fluctuation of blood sugar is gradually increasing. Woo Kefang[9] found that the course of elderly patients with type 2 diabetes mellitus was an independent risk factor for blood sugar fluctuation. The basic function of islets in young patients is better, and the decline rate of islet function is slower with the prolongation of the course of disease. Many studies have confirmed that fluctuating hyperglycemia can accelerate the occurrence and development of diabetic complications.

Carbohydrate and blood sugar fluctuation were also risk factors of blood sugar fluctuation in this study, OR values were (1.005 1.054) respectively. The reasons are as follows: At present, severe patients include patients with diabetes mellitus or nasal feeding patients with elevated blood sugar due to stress, who have a longer period of consciousness disturbance, can not eat normally, and patients with acute disease have a stronger stress response, leading to decomposition. Increased metabolism and elevated blood sugar affect wound healing. Intestinal tract is a central immune organ, and enteral nutrition plays an important role in maintaining intestinal mucosal barrier function and normal physiological function of gastrointestinal tract. Every day, 1000-2000 ml of enteral nutrition suspension (Ruidai, Nengquan, Ruinong, etc.) was pumped, and each bottle of nutrient solution contained different levels of carbohydrates (Ruidai 60g/500ml; can exert 61.5g/500ml; Jiawei 70g/500ml; Ansu 55.8g/6spoon + 300ml; etc.). Following the principle of "low-to-high concentration, small-to-large capacity, uniform and continuous" pumping, the nutritional status and metabolism of patients were assessed daily, reasonable calorie supply was given, and enteral nutrition solution could be used early. Help to restore gastrointestinal function as soon as possible. However, in the process of nasal feeding, due to the suspension of medication or examination during the interval, or the start speed of nasal feeding is too fast and the end of nasal feeding is too early, resulting in hypoglycemia at night, leading to greater fluctuations in blood sugar. Domestic research on carbohydrate and blood sugar fluctuation related literature is less, only Zhang Lei and others use carbohydrate counting method to manage normal eating diabetic patients, through teaching carbohydrate counting method, can effectively control blood sugar, can improve blood sugar monitoring level, and reduce HbA1c.

Total protein and blood sugar fluctuation were also risk factors of blood sugar fluctuation in this study, with OR values of 1.001 1.241, respectively. The reasons are as follows: most of the human proteins are synthesized by the liver. In a better nutritional state, the total protein and albumin content will increase relatively. Total proteins mainly include albumin and globulin, both of which are used to examine the synthetic function of the liver. There are several reasons for the high total protein. The first is that diabetic patients with nasogastric feeding stay in bed for a long time, which may lead to blood concentration, diarrhea, vomiting and other symptoms of intestinal adaptation of nasogastric nutrient solution, which are also related to the lack of water in the body. The second is that the decline of liver function leads to the nutritional list. First, imbalance. All of these will lead to high or low blood sugar, blood sugar fluctuation is larger.

Gimeno Orna[13] Studies found that HbA1c could only reflect the average level of blood sugar, but

could not show the fluctuation of blood sugar. Based on the characteristics of nasal feeding for diabetic patients, in order to evaluate the fluctuation of blood sugar more accurately and find out the factors causing the fluctuation. In this study, blood glucose was monitored by fingertips, LAGE and SDGE were analyzed. 25 indices including age, history of diabetes mellitus, BMI, fever, nasal feeding volume, systolic blood pressure and diastolic blood pressure were included to analyze the single factor of blood sugar fluctuation in diabetic nasal feeding patients. Finally, only three indices of course of disease, carbohydrate and total protein were included in the risk model. The other related factors were not statistically analyzed in this study. Learning Significance. It may be related to the small sample size, and the results need to be further verified by enlarging the sample size in the future. In order to better control the fluctuation of blood sugar, the blood sugar monitoring system and drug types are constantly improving, and the administration methods are also improving. Insulin pump can also be used to simulate physiological insulin secretion by setting the amount of insulin pumped in different periods, so that the insulin level in diabetic patients is closer to that of normal people. Hypoglycemia fluctuates.

References

[1] Umpierrez GE, Hellman R, Korytkowski MT, et al. Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guideline[J]. The Journal of Clinical Endocrinology & Metabolism, 2012, 97(1):16-38.

[2] Jan K, Jan S. Glucose variability, HbA1c and microvascular complications[J]. Reviews in Endocrine and Metabolic Disorders, 2016.

[3] Yang J, Li J, Zhou Lixin, et al. Analysis of blood sugar fluctuation level and influencing factors in patients with type 2 diabetes mellitus [J].Chinese Journal of Practical Nursing, 2018, 34(6):401-406.

[4] Hsu CR, Chen YT, Sheu WH. Glycemic variability and diabetes retinopathy: a missing link[J]. Journal of Diabetes & Its Complications, 2015, 29(2):302-306.

[5] Kusunoki Y, Katsuno T, Nakae R, et al. Evaluation of blood glucose fluctuation in Japanese patients with type 1 diabetes mellitus by self-monitoring of blood glucose and continuous glucose monitoring.[J]. Diabetes Research & Clinical Practice, 2015, 108(2):342-349.

[6] Diabetes Society of Chinese Medical Association. Guidelines for the Prevention and Treatment of Type 2 Diabetes in China[M]: Peking University Medical Publishing House, 2014.

[7] Society of Endocrinology, Chinese Medical Association. Expert consensus on the management of blood sugar fluctuation in diabetic patients[J].Drug evaluation, 2017,14(17): 5-8.

[8] Jia W. Clinical application guide of blood glucose monitoring in China (Edition 2011)[J]. Zhonghua Yi Xue Za Zhi, 2011, 91(10):656.

[9] Kusunoki Y, Katsuno T, Nakae R, et al. Evaluation of blood glucose fluctuation in Japanese patients with type 1 diabetes mellitus by self-monitoring of blood glucose and continuous glucose monitoring[J]. Diabetes Research & Clinical Practice, 2015, 108(2):342-349.

[10] Zheng TH, Wang SS, Chen ZL, et al. The effect of early enteral nutrition support on immunological function in patients with acute stroke[J]. Chinese Journal of Cerebrovascular Diseases, 2006, 3(8):356-360.

[11] Yu HM, Cheng WT, Wen MF, et al. Early Enteral Nutrition Versus Parenteral Nutrition After Resection of Esophageal Cancer: a Retrospective Analysis[J]. Indian Journal of Surgery, 2017, 79(1):13-18.

[12] Zhang HH. Nursing care of early enteral nutrition support for patients with hyperglycemia after neurosurgery. Modern Pharmaceutical Applications in China, 2018, 12(3):160-161.

[13] Minsky BD, Pajak TF, Ginsberg RJ, et al. INT 0123 (Radiation Therapy Oncology Group 94-05) phase III trial of combined-modality therapy for esophageal cancer: high-dose versus standard-dose radiation therapy[J]. Journal of Clinical Oncology, 2002, 20(5):1167-1174.