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Logistic regression analysis of risk factors for hematoma after autologous arteriovenous fistula in hemodialysis patients

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Abstract

To determine the risk factors and nursing countermeasures for post-operative hematoma in hemodialysis patients with autogenous arteriovenous fistula by logistic regression analysis. A retrospective analysis of 240 chronic hemodialysis patients admitted to our hospital from January 2019 to October 2022 was performed. Physical and vascular examinations of the patients were performed by surgeons. Continuous care measures were implemented for all patients. The patient serum creatinine (Scr) and blood urea nitrogen (BUN) were measured on the day of inclusion and after the implementation of care measures. Self-management scales were used to analyze patients' self-management. Fatigue symptoms were assessed using the Fatigue Scale 14. The WHO Quality of Life Scale (WHOQOL-BREF score) was used to assess patients' quality of life. Self-Rating Depression Scale and Self-Rating Anxiety Scale (SAS) were used to assess negative affect. Treatment compliance was assessed according to 3 levels: complete compliance, compliance, and noncompliance. In all, 240 patients underwent 240 initial and 48 repeat procedures; 18 of the 240 patients experienced fistula failure, with an overall success rate of 92.5% (222/240). There were no significant differences in renal function, self-management, General Self-Efficacy Scale, fatigue symptom scores, and WHOQOL-BREF scores between the postoperative hematoma group and no-hematoma group before the continuous care. After continuous care, renal function, self-management, General Self-Efficacy Scale, fatigue symptom scores, and WHOQOL-BREF scores were better in the postoperative no-hematoma group than in the hematoma group, and the difference was statistically significant ($P < .05$). Logistic regression analysis of risk factors for postoperative hematoma showed that elevated Scr and BUN levels, decreased self-management and SAS scores and poor treatment compliance were independent risk factors for postoperative hematoma in hemodialysis patients with autologous arteriovenous fistulas ($P < .05$). Elevated Scr levels, elevated BUN levels, decreased self-management scores, decreased SAS scores, and poor treatment compliance were independent risk factors for postoperative hematoma in hemodialysis patients with autogenous arteriovenous fistulas. By providing continuous care to hemodialysis patients based on timing theory, the negative emotions can be alleviated and the self-efficacy, quality of life, and treatment compliance of the patients can be improved.

Abbreviations: BUN = blood urea nitrogen, FS-14 = Fatigue Scale 14, GSES = General Self-Efficacy Scale, MHD = maintenance hemodialysis, SAS = Self-Rating Anxiety Scale, Scr = serum creatinine, SDS = Self-Rating Depression Scale, WHOQOL-BREF = WHO Quality of Life Scale.

Keywords: autologous arteriovenous fistula, continuous care, hemodialysis, logistic regression analysis, postoperative hematoma, risk factors

1. Introduction

Patients with chronic renal failure mainly rely on maintenance hemodialysis (MHD) therapy to prolong survival.[1] MHD can effectively replace the kidney function in patients with renal failure as well as remove residual toxins and edema fluid.[2] Some patients with chronic renal failure need long-term MHD to prolong their lives and wait for the opportunity of kidney transplantation, and establishing high patency vascular access is a prerequisite for dialysis.[3] Improving hemodialysis patency is still a significant clinical issue that must be addressed. The Renal Disease Dialysis Guidelines recommend autologous arteriovenous fistulas or human-made vascular fistulas as vascular access for hemodialysis expected to be performed for more than 1 year.[4] As vascular and microsurgical techniques continue to advance, previously challenging small blood vessels are no longer formidable obstacles, and clinical practice has progressively

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embraced arteriovenous fistula procedures to fulfill the needs of hemodialysis patients. Chronic renal failure requires long-term treatment, but the lack of supervision, unclear understanding, and poor attention to the disease in some patients during the home rehabilitation process leads to thrombotic arteriovenous endovascular fistula events that make them lose their function, affecting the prognosis of patients. Therefore, it is particularly important to implement a comprehensive and effective scientific care program for patients with chronic renal failure on MHD. The aim of this study was to analyze the risk factors and nursing countermeasures for post-operative hematoma in hemodialysis patients with autologous arteriovenous fistulae using logistic regression methods.

2. Materials and methods

2.1. Clinical data

In all, 240 chronic hemodialysis patients admitted to our hospital from January 2019 to October 2022 were included in this retrospective study and divided into the observation group (with hematoma, n = 66) and control group (without hematoma, n = 174) according to the presence or absence of postoperative hematoma. Informed consent was signed by all patients, and the study was approved by the ethics committee of Lianyungang Hospital of TCM.

2.2. Inclusion and exclusion criteria

Inclusion criteria were as follows: met the diagnostic criteria of chronic renal failure in Internal Medicine, confirmed by ultrasonography and renal function tests; clinical symptoms such as significant metabolic disorders; hemodialysis treatment 2 to 3 times/week; hemodialysis duration ≥ 6 months; and provision of signed informed consent form.

Exclusion criteria included individuals: with cardiac, pulmonary, and other organ dysfunction; with congenital renal disease; who have previously received renal transplantation; with malignancy, bone and joint disease, or systemic infectious disease; or with psychiatric abnormalities and/or language and cognitive dysfunction.

2.3. Surgical approach

The surgeon carried out the physical and vascular examinations of the patients and assessed the vascular and cardiac ultrasonography scans. For patients in a hypercoagulable state, preoperative low molecular weight heparin 50 U/kg was routinely injected subcutaneously for 1 week. For patients treated with temporary access dialysis, the procedure was usually performed the day after hemodialysis to avoid excessive heparinization and reduce wound bleeding before the next hemodialysis. Radial artery-cephalic vein anastomosis was performed under general anesthesia. When the distance between the cephalic vein and the radial artery was long and end-to-end anastomosis tended to cause stenosis of the vascular pulling anastomosis, the surgical approach was changed to end-to-end anastomosis. The patient received a diet 6 hours after surgery, with appropriate fluid supplementation to prevent dehydration and maintain adequate fluid levels. All hemostatic and coagulant medications were discontinued, wet dressings were changed, and the wound was observed for accumulation of blood and fluid. The limbs were elevated to 30 degrees to determine whether the edema had reduced, whether vascular murmurs were detected by auscultation, whether there was obvious fistula flutter by palpation, and whether the limb was pale or cold. Seven days after the postoperative vascular review by ultrasonography, ball-holding exercises were prescribed to promote fistula maturation.

2.4. Care measures

A continuum of care based on time theory was implemented for all patients in the following steps. Establishing a team: The team consisted of 6 people, including the deputy chief physician, deputy chief nurse, chief nurse, and general nurse, who underwent uniform professional training and assessment; formulation of the program: according to the treatment stages, the patients were divided into the diagnosis, treatment, preparation, adjustment, and adaptation stages. Different education manuals were formulated for each stage, the specific details are described below:

In the diagnosis stage, the medical staff took the initiative to communicate with patients and establish a good doctor–patient relationship; in the preparation stage, the staff instructed the patients to receive correct treatment during the treatment stage, provided psychological support and motivation, and issued health education manuals including emergency treatment and family care methods; in the adjustment stage, the staff examined the patient health status through home visits and telephone follow-up and gave targeted answers to patients and their families; in the adaptation stage, the staff helped the patients adopt disease prevention strategies, motivated them to participate in social activities, and built their confidence in recovery efforts.

2.5. Criteria for evaluation of arteriovenous fistulas

Maturation of endovascular fistula is a complex process that includes a dramatic increase in blood flow leading to vasodilation and reconstruction of the vessel wall. After surgery, we performed regular and continuous evaluation of patients by physical examination for significant tremor and noise and ultrasonography to check for blood flow of no <3 mL/min kg; hemodialysis without recirculation was performed for no more than 4 hours, as the criterion for endovascular fistula maturation. Initial failure was defined as failure to provide effective blood flow after fabrication or establishment, with interruption of blood flow occurring within 30 days after the procedure.

2.6. Duration of arteriovenous fistula application and follow-up

Patients who met the above criterion 6 to 8 weeks after routine procedures were selected for the first application. Puncture was routinely performed using a 24-G puncture needle, and MHD was initiated with a detailed physical examination each time and regular assessment of dialysis adequacy. Anastomotic diameter and blood flow were examined by ultrasonography before and after each hemodialysis session to assess for stenosis, injury, or thrombosis. By October 31, 2022, the patients were evaluated for medium- and long-term complications such as heart failure, distal limb ischemia, or venous reflux disorders during follow-up.

2.7. Observation indicators

2.7.1. Assessment of renal function. On the day of enrollment and after completion of nursing measures, 3 mL of fasting peripheral venous blood was collected from the postoperative hematoma group and the no-hematoma group. Serum creatinine (Scr) and blood urea nitrogen (BUN) levels were measured by double-antibody sandwich ELISA.

2.7.2. Self-management and self-efficacy scores. The self-management scale, including 4 dimensions, 31 items, and a total score of 124, was used to analyze the patients' self-management; high scores reflected good self-management ability. The General Self-Efficacy Scale (GSES),[5] with a total of 10 items and a total score of 40, was used to analyze the patient self-efficacy. The higher the score, the stronger the patient self-efficacy.

2.7.3. Quality of life score. The WHO Quality of Life Scale (WHOQOL-BREF score)[6] was used to assess the quality of life of the patients. The scale includes 4 areas, with a total score of 100 points. The higher the score, the better the quality of life.

2.7.4. Fatigue symptom score. The Fatigue Scale 14 (FS-14),[7] including 2 dimensions with a total of 14 items and a total score of 14, was used to evaluate the patients' fatigue symptoms. The FS-14 score was inversely proportional to the patient fatigue level.

2.7.5. Negative emotion assessment. Self-Rating Depression Scale (SDS)[8] and Self-Rating Anxiety Scale (SAS),[9] both including 20 items with a total score of 100, were used to assess negative emotions in the postoperative hematoma and no-hematoma groups. The higher the scores, the more severe the symptoms of depression and anxiety.

2.7.6. Treatment compliance. Compliance with treatment was evaluated according to 3 levels: complete compliance—active MHD treatment with complete behavior change, compliance—completion of MHD treatment with some change of poor behavior, and noncompliance—non-cooperation with MHD treatment with no change of poor behavior. The total compliance rate was calculated as follows: Total compliance rate = (complete compliance + compliance)/100.

2.8. Statistical analysis

SPSS 19.0 software was used for analysis. The measurement data were described as mean ± standard deviation, and the independent sample *t* test was used for comparison between groups. The count data were expressed as n (%), and the chi-square test was used for comparison between groups. Logistic regression was used to analyze the risk factors for hematoma after autologous arteriovenous fistula in hemodialysis patients. $P < .05$ was considered statistically significant.

3. Results

3.1. General information

The causes of end-stage renal disease in 240 chronic hemodialysis patients were as follows: localized segmental glomerulosclerosis in 69 patients, renal and urinary tract malformations in 18, sclerosing glomerulonephritis in 42, hyperoxaluria in 72, and unknown causes in 39 patients. Of these patients, 144 and 96 started hemodialysis with a temporary central venous catheter and arteriovenous fistula as the initial vascular access, respectively. There was no significant difference between the 2 groups in terms of age, sex, smoking history, drinking history, BMI, comorbidities, and educational level ($P > .05$), as shown in Table 1.

3.2. Procedures

In all, 240 patients underwent 240 initial and 48 repeat procedures, of which 153 patients opted for left upper extremity fistula and 87, for right upper extremity fistula; 141 patients received radial artery-cephalic vein end-to-end anastomosis and 99 patients received end-to-end anastomosis. The mean internal diameter of the radial artery was 1.58 ± 0.29 mm and that of the cephalic vein was 1.94 ± 0.55 mm. Most of the patients who underwent reoperation experienced thrombus formation after postoperative wound hematoma compression anastomosis, and the fistula was successful after hematoma debridement + thrombectomy + revascularization. In addition, there were 2 cases of immature postoperative endovascular fistula without hemodialysis. Fistula failure occurred in 18 of 240 patients, with an overall success rate of 92.5% (222/240).

3.3. Fistula follow-up and dialysis use

The mean maturation time of arteriovenous fistula from the establishment to the application was 7.31 ± 2.78 weeks, fistula blood flow was 4.72 ± 0.34 mL/(min kg), and dialysis adequacy was 1.28 ± 0.65 Kt/V. The urea reduction rate was 66.26% ± 6.50%. Five renal transplants were terminated, and the remaining normal endovascular fistulae had been in use for 18.93 ± 17.35 (5–46) months. Two patients developed heart failure during prolonged use. Dialysis was increased and diet was controlled. Two patients developed mild anastomotic intimal hyperplasia, but their fistula flow on ultrasonography was not significantly affected and no special treatment was done.

3.4. Comparison of renal function before and after care measures in both groups

Before the implementation of care measures, there was no statistically significant difference in renal function between the postoperative hematoma group and the no-hematoma group ($P > .05$). After the implementation of care measures, the Scr and BUN levels in both groups had reduced, and the Scr and BUN levels in the postoperative no-hematoma group were

Table 1

Comparison of general information between the 2 groups.

Variable	Observation group (n = 66)	Control group (n = 174)	χ^2/t	*P*
Age (yr)	47.23 ± 4.97	46.56 ± 4.83	0.896	.341
Gender (male/female)	30/36	74/100	0.167	.683
Smoking history			0.389	.533
Yes	40 (60.61)	113 (64.94)		
No	26 (39.39)	61 (35.06)		
Drinking history			0.325	.569
Yes	36 (54.55)	102 (58.62)		
No	30 (45.45)	72 (41.38)		
BMI (kg/m^2)	22.15 ± 2.94	22.77 ± 2.76	0.506	.673
Comorbidities				
Diabetes	22 (33.33)	49 (28.16)	0.615	.433
Hypertension	27 (40.91)	68 (39.08)	0.067	.796
Educational level			0.005	.944
>High school	30 (45.45)	80 (45.98)		
<High school	36 (54.55)	94 (54.02)		

lower than those in the postoperative hematoma group, and the differences were statistically significant ($P < .05$), as shown in Table 2.

3.5. Comparison of self-management, GSES, and fatigue symptom scores before and after care measures between the 2 groups

Before the implementation of care measures, the differences in self-management, GSES, and fatigue symptom scores between the 2 groups were not statistically significant ($P > .05$). After receiving the care measures, the self-management and GSES scores of both groups increased, while the FS-14 scores decreased. The postoperative no-hematoma group had higher self-management scores and GSES scores and lower FS-14 scores than the hematoma group. The differences were statistically significant ($P < .05$), as shown in Table 3.

3.6. Comparison of WHOQOL-BREF scores before and after care measures between the 2 groups

Before the implementation of the care measures, the difference in WHOQOL-BREF scores between the 2 groups was not statistically significant ($P > .05$). Before and after the implementation of care measures, the WHOQOL-BREF scores of both groups increased than were before the implementation care measure, and the WHOQOL-BREF scores of the postoperative no-hematoma group were higher than those of the postoperative hematoma group; with statistically significant difference ($P < .05$), as shown in Table 4.

3.7. Comparison of negative emotions before and after care measures between the 2 groups

Before the implementation of the care measures, there was no statistically significant difference in the negative emotion scores between the 2 groups ($P > .05$). After the implementation of the care measures, the SDS and SAS scores of both groups decreased, and the SDS and SAS scores of the postoperative no-hematoma group were lower than those of the postoperative hematoma group, with a statistically significant difference ($P < .05$), as shown in Table 5.

3.8. Comparison of treatment compliance between the 2 groups

The overall compliance rate of 94.83% in the group without hematoma after autologous arteriovenous fistula was statistically higher than that of 75.76% in the group with hematoma after autologous arteriovenous fistula ($P < .05$), as shown in Table 6.

3.9. Logistic regression analysis of risk factors for hematoma after autologous arteriovenous fistula in hemodialysis patients

Hematoma formation was set as a dependent variable after arteriovenous fistula creation in hemodialysis patients, and factors such as Scr and BUN levels; self-management, GSES, FS-14, WHOQOL-BREF, SDS, and SAS score; and treatment compliance were set as independent variables. Logistic regression analysis showed that increased Scr (OR = 0.336, $P < .001$) and BUN levels (OR = 0.302, $P < .001$), decreased self-management (OR = 3.562, $P < .001$) and SAS scores (OR = 3.892, $P < .001$), and poor treatment compliance (OR = 6.375, $P < .001$) were independent risk factors for hematoma after autologous arteriovenous fistula in hemodialysis patients ($P < .05$), as shown in Table 7.

4. Discussion

With the development of hemodialysis technology, more and more patients with end-stage renal disease are receiving dialysis treatment.[10] The long-term hemodialysis outcome and survival quality of patients depend on the establishment of stable and reliable vascular access.[11] Autologous arteriovenous endovascular fistulas have the advantages of safety, adequate blood flow, low risk of infection, adequate dialysis, long access life, and no interference with the patient daily life; while the disadvantages are that they take 2 to 6 months to mature, are painful during puncture, and require fixation of the forearm during dialysis.[10,12–15]

Studies have pointed out that the complexity of the clinical hemodialysis process is highly likely to lead to cross-infection among patients, medical care, and machines, resulting in an

Table 2

Comparison of renal function between the 2 groups.

Group	Scr (μmol/L)		BUN (mmol/L)	
	Before nursing	After nursing	Before nursing	After nursing
Observation group (n = 66)	814.29 ± 65.11	511.12 ± 50.07	41.30 ± 4.19	33.40 ± 5.00
Control group (n = 174)	810.55 ± 63.59	412.35 ± 37.10	41.15 ± 4.07	19.23 ± 2.53
t	0.266	10.27	0.166	16.39
P	.791	<.001	.868	<.001

BUN = blood urea nitrogen, Scr = serum creatinine.

Table 3

Comparison of patients' self-management, GSES and fatigue symptom scores between the 2 groups.

Group	Self-management score		GSES score		FS-14 score	
	Before nursing	After nursing	Before nursing	After nursing	Before nursing	After nursing
Observation group (n = 66)	50.11 ± 6.43	68.02 ± 8.04	13.66 ± 4.17	25.96 ± 5.24	9.65 ± 3.78	7.39 ± 2.00
Control group (n = 174)	50.32 ± 6.51	84.18 ± 7.54	13.75 ± 4.19	32.51 ± 6.38	9.75 ± 3.80	5.01 ± 1.29
t	0.148	9.501	0.098	5.142	0.121	6.481
P	.882	<.001	.922	<.001	.904	<.001

FS-14 = Fatigue Scale 14, GSES, General Self-Efficacy Scale.

Table 4

Comparison of WHOQOL-BREF scores between the 2 groups.

	Social relation		Environmental field		Physiological field		Psychological field	
Group	Before nursing	After nursing	Before nursing	After nursing	Before nursing	After nursing	Before nursing	After nursing
Observation group (n = 66)	51.11 ± 5.64	62.39 ± 6.00	45.94 ± 3.91	63.52 ± 5.57	50.33 ± 6.47	63.85 ± 5.94	51.79 ± 6.64	64.59 ± 5.35
Control group (n = 174)	52.26 ± 5.76	77.54 ± 5.94	46.58 ± 4.11	72.86 ± 4.96	51.54 ± 6.55	77.34 ± 6.89	52.33 ± 6.78	77.81 ± 5.79
t	0.925	11.63	0.731	8.116	0.852	4.61	0.368	10.87
P	.358	<.001	.466	.009	.397	.015	.713	<.001

WHOQOL-BREF = WHO Quality of Life Scale.

Table 5

Comparison of negative emotions between the 2 groups.

	SDS		SAS	
Group	Before nursing	After nursing	Before nursing	After nursing
Observation group (n = 66)	56.61 ± 8.37	48.13 ± 6.00	55.79 ± 7.01	47.46 ± 5.33
Control group (n = 174)	56.36 ± 8.24	40.25 ± 5.36	55.51 ± 6.83	35.67 ± 4.85
t	0.138	6.347	0.185	10.6
P	.891	.002	.853	<.001

SAS = Self-Rating Anxiety Scale, SDS = Self-Rating Depression Scale.

Table 6

Comparison of treatment compliance between the 2 groups.

Group	Complete compliance	Compliance	noncompliance	Overall compliance rate
Observation group (n = 66)	21 (31.82)	29 (43.94)	16 (24.24)	50 (75.76)
Control group (n = 174)	78 (44.83)	87 (50.00)	9 (5.17)	165 (94.83)
χ^2				18.648
P				<.001

Table 7

Logistic regression analysis of risk factors for hematoma after autologous arteriovenous fistula in hemodialysis patients.

Variable	β	SE	Wald χ2	OR	95% CI	*P* value
Scr	–0.643	0.746	35.654	0.336	0.159–0.913	<.001
BUN	–0.906	0.734	94.114	0.302	0.085–0.782	<.001
Self-management score	0.755	0.583	32.622	3.562	1.844–10.895	<.001
GSES score	0.251	0.613	13.982	3.631	2.375–8.951	.417
FS-14 score	0.533	0.729	16.493	5.326	4.114–9.877	.318
WHOQOL-BREF score	0.527	0.815	17.859	2.519	1.177–5.925	.725
SDS score	0.638	0.526	22.758	4.815	2.127–10.379	.811
SAS score	0.807	0.39	26.693	3.892	1.755–9.325	<.001
Treatment compliance	1.155	0.635	275.265	6.375	3.155–11.185	<.001

BUN = blood urea nitrogen, FS-14 = Fatigue Scale 14, GSES = General Self-Efficacy Scale, OR = odds ratio, SAS = Self-Rating Anxiety Scale, Scr = serum creatinine, SDS = Self-Rating Depression Scale, SE = Standard error, WHOQOL-BREF = WHO Quality of Life Scale.

increased risk of various diseases and affecting treatment outcomes.[16] Timing-based continuity of care provides information and educational support in line with the needs of each stage of the disease for line-specific guidance while providing effective linkage between in-hospital and out-of-hospital care for patients with chronic renal failure.[17] Most patients with chronic renal failure have misconceptions about the disease or dialysis treatment and may have inadequate information about self-care, eventually leading to irregular dialysis or abandonment of treatment that adversely affects disease control strategies and aggravates renal function damage.[18,19]

In this study, a comparison of the effect of continuing care measures in the groups with and without hematoma after autologous arteriovenous endovascular fistula showed that Scr and BUN levels were lower in the group without hematoma than in the group with hematoma after the implementation of continuing care. The self-management and GSES scores in the group without hematoma were significantly higher than those in the group with hematoma, and the FS-14 score was significantly lower than that of the group with hematoma. In their study of 90 end-stage renal disease patients requiring hemodialysis, Mai et al revealed that nursing guided by the timing theory can effectively enhance self-care capabilities in early-stage hemodialysis patients, reduce the incidence of complications, improve the quality of life of the patients, similar to the results of our current study.[20] The WHOQOL-BREF scores of patients in the group without postoperative hematoma after autologous arteriovenous endovascular fistula were higher than those in the group with postoperative hematoma, and the SDS and SAS scores were lower than those in the group with

postoperative hematoma after the implementation of continuous care measures. In their study of 95 hemodialysis patients, Jiang et al found that a nursing model based on the timing theory effectively ameliorated negative emotions in patients, similar to the results of our study.[21] In terms of compliance, the overall compliance rate of 94.83% was significantly higher in the postoperative no-hematoma group than that of 75.76% in the hematoma group. Logistic regression analysis in this study showed that elevated Scr and BUN levels, decreased self-management and SAS scores, and poor compliance with treatment were independent risk factors for postoperative hematoma after autologous arteriovenous fistula. Although the timing theory-oriented continuity of care is feasible for MHD in cases of chronic renal failure, there have been no before-and-after studies of this care response in clinical settings, and the sample size included in this paper was small; therefore, future studies with large sample sizes are needed to provide enhanced data for the benefit of patients.[22–25]

5. Conclusion

In conclusion, elevated Scr and BUN levels; decreased self-management and SAS scores, and poor treatment compliance were independent risk factors for hematoma in hemodialysis patients after autologous arteriovenous endovascular fistula surgery; continuous care based on timing theory for hemodialysis patients alleviated the patients' negative emotions and enhanced their self-efficacy, quality of life, and treatment compliance, indicating the good clinical value of continuous care.

Author contributions

Conceptualization: Kuanfan Shi.
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