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Original Article

Analysis of postoperative quality of life and prognosis of patients with intracranial aneurysm after nursing based on concept of time

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Abstract: Objective: To assess the postoperative quality of life and prognosis of patients with intracranial aneurysm (IA) after nursing based on a time-based concept. Methods: Data of 84 patients with IA who underwent treatment at the Shengjing Hospital Affiliated to China Medical University from February 2019 to February 2021 were analyzed retrospectively. Among them, the control group (n=41) received conventional nursing. On this basis, the observation group (n=43) received nursing based on the concept of time. Patients' limb motor function and quality of life before and after treatment, postoperative complications and prognosis, and nursing satisfaction were evaluated. Also, risk factors for poor prognosis were analyzed through multifactorial analysis. Results: One month after surgery, the scores of Fugl-Meyer Assessment (FMA) and Quality-of-Life Questionnaire Core in both groups were higher than those before nursing, and both scores were dramatically higher in the observation group than in the control group (P<0.05). The overall postoperative complication rate was markedly higher in the control group than in the observation group (P<0.05). Patients in the observation group were more satisfied with the nursing than those in the control group (P<0.05). The postoperative prognosis in the observation group was dramatically better than that in the control group (P<0.05). There were statistical differences in age, timing of intervention, hypertension, aneurysm diameter, Hunt-Hess classification, Fisher grade, FMA score and nursing regimen at one month postoperatively between the good prognosis group and the poor prognosis group (P<0.05). Older age, delayed timing of intervention, aneurysm ≥15 mm and Fisher grade ≥3 were independent risk factors for poor prognosis. Conclusion: In summary, a nursing model based on the concept of time can effectively improve the rehabilitation outcome, improve the prognosis, and enhance the quality of life in IA patients.

Keywords: Nursing based on concept of time, intracranial aneurysm, interventional therapy, quality of life, prognosis

Introduction

Intracranial aneurysm (IA) is an acute cerebrovascular disease and a common intracranial vascular disease with high disability and mortality rates [1, 2]. It has a high prevalence in the elderly population and therefore often has a poor prognosis [3]. The cause of this disease is the weakness of the intracranial arterial blood vessel wall, and an abnormal dilatation of the inner lumen of the vessel towards the outer wall [4]. The vessel wall may dramatically weaken then rupture, with subsequent subarachnoid hemorrhage that may lead to severe hemorrhagic stroke [5]. The prevalence of IA in the general population is approximately 2-6%, with an estimated annual risk of rupture of 0.7% [6].

Craniotomy for IA is gradually decreasing due to the disadvantages of high trauma, long operation time, slow recovery and high psychological stress in patients [7]. With breakthroughs in aneurysm embolization materials and continuous improvement in neurointerventional techniques, interventional spring-ring embolization has emerged as the preferred treatment for IA due to its minimal surgical trauma, rapidity and high success rate [8, 9].

Despite the obvious advantages of interventional procedures, some patients undergo a

long recovery period or require lifelong care due to individual differences, which requires targeted nursing programs to reduce the risk of complications and improve the prognosis [10]. The current traditional routine care in the clinic generally has shortcomings such as lack of systematization, so the intervention effect is not significant, which makes it difficult to meet the physical and mental needs of IA patients [11]. Time-based nursing is a new nursing model, and the implementation of targeted nursing interventions are done according to the regular changes of the body rhythms, which can minimize unnecessary stimulation to patients and shorten the recovery process [12]. Previous studies have shown that a care model based on the concept of time, both enhanced patients' disease perceptions and reduced negative emotions in both spinal cord injury patients and survivors of stroke [13, 14]. Jones et al. [15] also reported that a nursing model based on the concept of time improved the quality of nursing for patients in the emergency room, with high compliance to treatment. Therefore, this study investigated the effect of nursing based on the concept of time for IA patients.

Methods

General data

Data of 84 IA patients treated at the Shengjing Hospital Affiliated to China Medical University from February 2019 to February 2021 were retrospectively analyzed. The patients who received conventional nursing were included in a control group (n=41), with 22 males and 19 females, and an average age of (54.29±5.15) years. The patients who received additional nursing measures based on the concept of time were enrolled in the observation group (n=43), with 26 males and 17 females, and an average age of (53.40±6.07) years. This study was approved by the Ethics Committee of Shengjing Hospital Affiliated to China Medical University (Lot No. 20190218).

Inclusion and exclusion criteria

Inclusion criteria: Patients who were diagnosed with IA, and the diagnosis was confirmed by imaging; patients who underwent interventional embolization; patients older than 18 years; patients who were conscious before treatment and were tested by the scale used in this study.

Exclusion criteria: Patients who were unable to receive anti-platelet medication before or after surgery; patients with other brain diseases such as those combined with brain tumors and cerebral arteritis; patient with a history of mental illness; patients with organic diseases of heart, liver or kidney.

Nursing programs

Patients in the control group received the conventional postoperative care program. The patients were placed in a supine position with the head raised at an angle of less than 30°, and their vital signs were monitored regularly. In addition, they were instructed to have reasonable diet and exercise, and the postoperative precautions were explained to patients and their families.

The observation group received nursing interventions based on the concept of time, namely, time-based nursing according to patients' conditions. First, patients' vital signs and consciousness were understood, and their state after eating was observed. Patients' postoperative conditions were monitored and assessed comprehensively. Then, a reasonable nursing plan was adopted, and intervention measures were taken in a timely manner if abnormal conditions appeared. (1) Patients were observed for blood circulation in both lower extremities every half hour after surgery, and the puncture sites were checked for blood leakage or subcutaneous hematoma. Patients' vital signs were measured twice daily at 7:00 am and 15:00 pm. (2) Patients were instructed to have breakfast, lunch and dinner at 7:30-8:00, 11:30-12:00 and 17:00-17:30, respectively. (3) For sleep care, patients were instructed to fall asleep before 21:00 because sleep plays an important role in brain nerve recovery. Most patients with brain surgery will have postoperative sleep disorders. So, if their sleep quality was seriously affected, appropriate amount of sleep aids were prescribed by the doctor. A quiet and comfortable recuperation environment was created for patients to avoid external disturbances. (4) In terms of medication care, a detailed medication schedule and medication list were developed to help patients take their medications on time and in the right amount, so as to ensure the effectiveness of treatment. (5) As to postoperative functional training care, rehabilitation exercise was conducted from

10:00-10:30 and 15:00-15:30 daily. A training plan was formulated according to patients' recovery and living habits, and the nurses guided the patients to carry out rehabilitation training. The nursing interventions began when the patients returned to the ward after surgery and continued until discharge. (6) Regarding health education, between 19:00-21:00, 30-60 min of health education was given in a quiet environment by means of mini-lectures and games, including life health guidance, disease related knowledge and medication knowledge.

Outcome measures

(1) Patients' anterior and posterior limb motor functions were assessed by Fugl-Meyer Assessment (FMA) before surgery and 1 month after surgery, with a total score of 100. The score of upper limb motor function assessment was 66 with 34 items, and that of lower limb motor function was 34 with 17 items, with higher scores representing better motor function [16].

(2) The quality of life of patients before surgery and 1 month after surgery was assessed by the Quality-of-Life Questionnaire Core 30 (QLQ-C30), which has a total score of 45 points and contains 5 aspects, physical function (15 points), cognitive function (6 points), emotional function (12 points), role function (6 points) and social function (6 points), with higher scores representing better quality of life [17].

(3) Patient satisfaction was assessed by a self-designed nursing satisfaction questionnaire on the day before discharge. The questionnaire covered nurses' professional skills, attitude and operation level. The total score was 100, and a score of 90 points or above was seen as very satisfied, 80 to 90 as satisfied, less than 80 as unsatisfied, total satisfaction rate = (very satisfied + satisfied) cases/total number of cases ×100%.

(4) The incidence of postoperative complications was compared between the two groups.

(5) The prognosis of patients was assessed at 6 months postoperatively using the Glasgow Outcome Scale and classified into 5 grades, with grade 1 meaning death and grade 5 meaning a basic return to normal life with mild impairment, and grades 4 to 5 were seen as good prognosis [18]. Patients were followed up prognostically using outpatient review and telephone.

Statistical methods

The collected data were statistically analyzed using SPSS 20.0 (SPSS Ltd., Chicago, USA), and the figures were plotted using GraphPad Prism 7 (GraphPad Software Co., San Diego, USA). The counting data were expressed as rate (%) and analyzed using Chi-square test (marked by χ^2). The measurement data were represented as mean ± standard deviation (mean ± SD), and the data conforming to a normal distribution were compared between the two groups using independent samples t-test. Independent risk factors for poor prognosis were assessed by multiple logistic regression. $P<0.05$ was considered statistically significant.

Results

General data

There was no statistical difference between the two groups in terms of age, sex, intervention time, hypertension, aneurysm diameter, Hunt-Hess classification, Fisher grade and smoking history ($P>0.05$) (**Table 1**).

Improvement in exercise capacity and quality of life

There was no statistical difference the two groups in preoperative FMA scores and QLQ-C30 scores ($P>0.05$). The FMA scores and QLQ-C30 scores of both groups were dramatically higher one month after surgery compared with those before surgery ($P<0.05$), and the two scores in the observation group were higher than those of the control group one month after surgery ($P<0.05$) (**Figure 1**).

Comparison of nursing satisfaction

The total satisfaction rate of patients in the observation group was dramatically higher than that of the control group ($P<0.05$) (**Table 2**).

Comparison of complications

The total complication rate of the observation group was dramatically lower than that of the control group ($P<0.05$) (**Table 3**).

Table 1. General data

	Observation group (n=43)	Control group (n=41)	X^2/t	P
Age	53.40±6.07	54.29±5.15	0.723	0.472
Sex			0.397	0.529
Male	26 (60.47)	22 (53.66)		
Female	17 (39.53)	19 (46.34)		
Intervention time			0.178	0.673
Early stage	19 (44.19)	20 (48.78)		
Delay	24 (55.81)	21 (51.22)		
Hypertension			0.171	0.679
Yes	18 (41.86)	19 (46.34)		
No	25 (58.14)	22 (53.66)		
Aneurysm diameter (mm)			0.119	0.730
≥15	13 (30.23)	11 (26.83)		
<15	30 (69.77)	30 (73.17)		
Hunt-Hess classification			0.397	0.529
Grade ≥III	12 (27.91)	9 (21.95)		
Grade <III	31 (72.09)	32 (78.05)		
Fisher grade			0.043	0.835
Grade ≥3	7 (16.28)	6 (14.63)		
Grade <3	36 (83.72)	35 (85.37)		
Smoking history			0.186	0.666
Yes	23 (53.49)	20 (48.78)		
No	20 (46.51)	21 (51.22)		

Comparison of prognosis of both groups

There was no death in either group during the 6-month follow up, but the good prognosis rate in the observation group was dramatically higher than that in the control group (P<0.05) (**Table 4**).

Univariate analysis of factors affecting prognosis

All patients were regrouped according to their 6-month prognosis, with 53 in a good prognosis group and 31 in a poor prognosis group. Statistical differences were found between these two groups in age, timing of intervention, hypertension, aneurysm diameter, Hunt-Hess classification, Fisher grade, FMA score and nursing regimen at one month postoperatively (P<0.05) (**Table 5**).

Multivariate analysis of factors affecting prognosis

We performed a multifactorial logistic regression analysis of the indicators that differed in the univariate analysis and found that older age, delayed timing of intervention, aneurysm ≥15 mm and Fisher grade ≥3 were independent risk factors of poor prognosis (**Table 6**).

Discussion

IA is a common disease in neurosurgery. It is a saccular aneurysm formed by the outward expansion of the arterial vessel wall due to damage or aging, and the predisposing factors include traumatic brain injury, atherosclerosis, congenital factors and infection. The tumor is prone to rupture during overexertion and extreme stress, causing cerebral hemorrhage, and the rupture has a high incidence in middle-aged and elderly groups with high lethality and disability rates [19, 20]. Interventional embolization is currently a reliable treatment option for this disease, but aneurysm re-rupture, puncture site hematoma and vasospasms are prone to occur during the postoperative period, placing higher demands on postoperative care [21].

Conventional care often uses a uniform management model for all patients, making it difficult to provide precise and individualized care. The nursing model based on the concept of time, on the other hand, starts from the individual patient, formulates targeted nursing interventions according to their conditions and physiological indicators, and provides scientific and quality services by regulating patients' diet, sleep, medication and recovery exercises, therefore reducing postoperative adverse reactions and benefiting recovery and long-term prognosis. Our study found that the FMA score and QLQ-C30 score were markedly higher in both groups one month after surgery compared to those preoperatively, and both scores were higher in the observation group than in the control group one month after surgery. This suggests that the time-based care concept is better than conventional care for patients in terms of motor function rehabilitation outcomes and

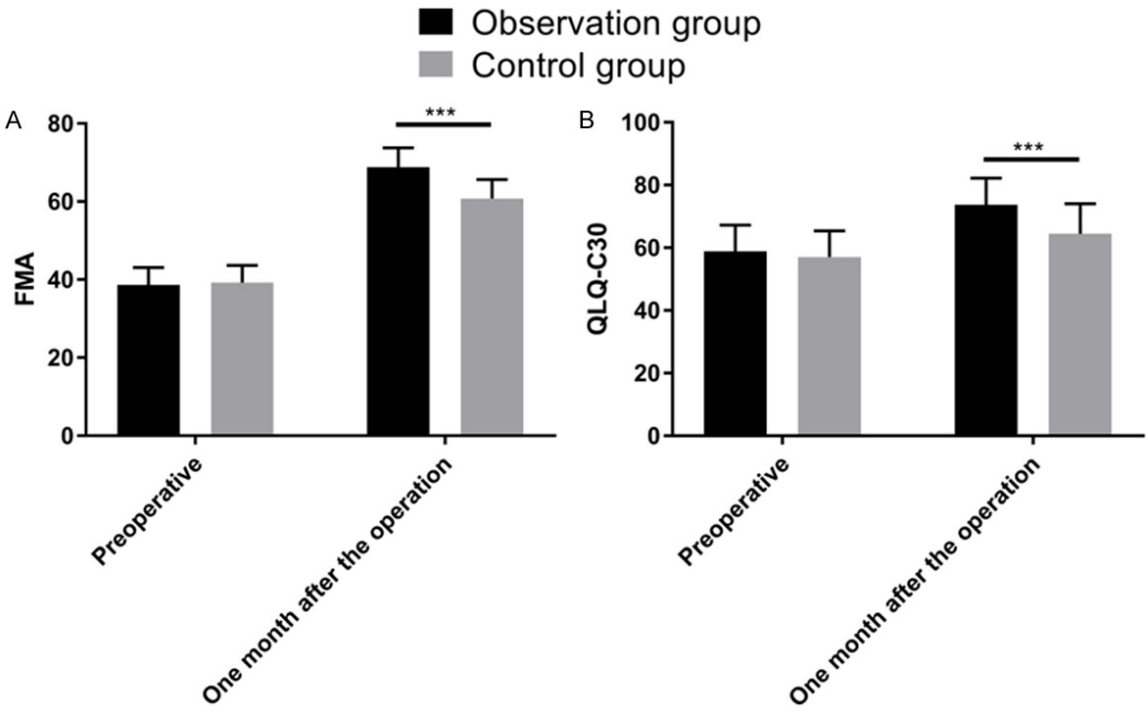

Figure 1. Improvement in exercise capacity and quality of life. A. The FMA score was dramatically higher in the observation group than in the control group one month after surgery (P<0.001). B. The QLQ-C30 score was dramatically higher in the observation group than in the control group one month after surgery (P<0.001). Note: *** denotes P<0.001; FMA: Fugl-Meyer Assessment; QLQ-C30: Quality-of-Life Questionnaire Core 30.

Table 2. Comparison of nursing satisfaction

	Very satisfied	Satisfied	Dissatisfied	Total satisfaction
Observation group (n=43)	16 (37.21)	21 (48.84)	6 (13.95)	37 (86.05)
Control group (n=41)	11 (26.83)	15 (36.58)	15 (36.59)	26 (63.41)
t				5.733
P				0.017

Table 3. Comparison of complications

	Cerebrovascular spasm	Puncture site hematoma	Thrombus	Total complications
Observation group (n=43)	0 (0.00)	2 (4.65)	1 (2.33)	3 (6.98)
Control group (n=41)	3 (7.32)	5 (12.20)	2 (4.88)	10 (24.39)
t				4.865
P				0.027

quality of life. The main thrust of the rehabilitation training approach, as the primary recognized treatment, is based on the theory of central nervous system plasticity, which aims to stimulate nerve cells through different pathways to achieve neurological reconstruction and facilitate the restoration of the motor system [22, 23]. A care model based on the concept of time can better help patients regain motor function through regular rehabilitation. Meanwhile, psychological interventions for patients were emphasized in goal-oriented care based on the concept of time. Appropriate emotional guidance was provided to encourage active communication, and together with detailed interventions in diet and rehabilitation

Table 4. Comparison of prognosis (Glasgow Outcome Scale)

	Grade 2	Grade 3	Grade 4	Grade 5	Good prognosis
Observation group (n=43)	2 (4.65)	9 (20.93)	22 (51.16)	10 (23.26)	32 (74.42)
Control group (n=41)	5 (12.20)	15 (36.59)	13 (31.71)	8 (19.51)	21 (51.22)
t					4.851
P					0.028

Table 5. Univariate analysis

	Poor prognosis group (n=31)	Good prognosis group (n=53)	X^2/t	P
Age	57.06±4.82	51.94±5.22	4.446	<0.001
Sex			0.345	0.557
Male	19 (61.29)	29 (54.72)		
Female	12 (38.71)	24 (45.28)		
Timing of intervention			3.967	0.046
Early stage	10 (32.26)	29 (54.72)		
Delay	21 (67.74)	24 (45.28)		
Hypertension			5.927	0.015
Yes	19 (61.29)	18 (33.96)		
No	12 (38.71)	35 (66.04)		
Aneurysm diameter (mm)			6.626	0.010
≥15	14 (45.16)	10 (18.87)		
<15	17 (54.84)	43 (81.13)		
Hunt-Hess classification			4.925	0.027
≥ Grade III	12 (38.71)	9 (16.98)		
< Grade III	19 (61.29)	44 (83.02)		
Fisher grade			10.578	0.001
≥ Grade 3	10 (32.26)	3 (5.66)		
< Grade 3	21 (67.74)	50 (94.34)		
Smoking history			0.929	0.335
Yes	18 (58.06)	25 (47.17)		
No	13 (41.94)	28 (52.83)		
One-month postoperative FMA score	62.19±5.47	66.51±6.30	3.170	0.002
One-month postoperative QLQ-C30	67.45±10.10	70.26±10.05	1.230	0.222
Nursing programs			4.851	0.028
Conventional care	20 (64.52)	21 (39.62)		
Nursing strategies based on the concept of time	11 (35.48)	32 (60.38)		

FMA: Fugl-Meyer Assessment; QLQ-C30: Quality-of-Life Questionnaire Core 30.

to enhance the physical fitness and immune function of patients, they could recover quickly in a good state of mind, which was an important reason for the better improvement in the quality of life in the observation group. Xie et al. [24] also mentioned that alleviating negative emotions through psychological interventions for patients with IA improved their compliance with rehabilitation, thereby a better rehabilitation outcome.

This study also found that after nursing interventions, the observation group had a lower rate of postoperative complications, less vasospasms and better prognosis compared to the control group. To analyze the reasons, the goal-oriented care based on the concept of time started from the individual patient, adopted time-oriented standardized measures according to the recovery of the disease, and strictly followed the concept of time in medication, diet

Table 6. Multivariate analysis

	B	S.E	Wald	Sig.	Exp (B)	95% C.I. of EXP (B)	
						Lower limit	Upper limit
Age	0.240	0.072	11.032	0.001	1.271	1.103	1.464
Timing of intervention	-1.449	0.686	4.462	0.035	0.235	0.061	0.901
Aneurysm diameter	1.558	0.744	4.382	0.036	4.748	1.104	20.417
Fisher grade	2.085	0.936	4.959	0.026	8.045	1.284	50.406

and rest. It improved the self-discipline of patients during treatment, avoided irregular medication and unscientific diet and rest, and helped patients to cooperate with functional training, so the patients in the observation group had better recovery and prognosis. At the end of the study, we found that older age, delayed timing of intervention, aneurysm ≥15 mm and Fisher grade ≥3 were independent risk factors for poor prognosis by performing a multifactorial analysis, suggesting that these factors should be given adequate attention in treatment planning and intervention measures. The timing of surgery is an important factor affecting the prognosis, and the time from onset to surgery shows an obvious negative correlation with the BI index, i.e., the later the surgery is performed, the worse the prognosis of patients. Because secondary brain damage caused by hematoma metabolites and toxic degradation products worsens with time, and early surgery also reduces the risk of rebleeding and vasospasm, so patients with surgery indicators should undergo surgery as early as possible [25]. Fisher grading is an objective indicator to assess the conditions and determine the prognosis by CT performance after aneurysm rupture and bleeding, while Fisher grading has been found to have a high predictive value for postoperative cerebral vasospasm in some studies [26]. Aneurysm size can affect aneurysm rupture, and Lu et al. [27] also reported that the size of the aneurysm could affect prognosis. A study by de Winkel et al. [28] similarly showed that older age and higher Fisher grade resulted in a poor prognosis for interventional patients, in addition to the presence of intracerebral hematoma on admission imaging being a risk factor for poor prognosis.

The current study also has some shortcomings. First, this study was conducted in IA patients after interventional therapy, so it is not clear whether the same effect can be achieved after other treatment modalities. Second, a diverse population is needed to explore the applicability of the interventions, in order to support our findings.

In conclusion, a care model based on the concept of time can effectively improve the rehabilitation outcome, improve the prognosis and enhance the quality of life of IA patients.

Disclosure of conflict of interest

None.

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References

[1] Piotin M, Biondi A, Sourour N, Mounayer C, Jaworski M, Mangiafico S, Andersson T, Soderman M, Goffette P, Anxionnat R and Blanc R. The LUNA aneurysm embolization system for intracranial aneurysm treatment: short-term, mid-term and long-term clinical and angiographic results. J Neurointerv Surg 2018; 10: e34.

[2] Chen CC, Yi-Chou Wang A, Chen CT and Hsieh PC. Coadjuvant treatment of vasospasm in ruptured unsecured cerebral aneurysms with aggressive angioplasty, intra-arterial nimodipine, and aneurysm embolization. World Neurosurg 2018; 116: e452-e459.

[3] Kim J, Kim JH, Lee HS, Suh SH and Lee KY. Association between longitudinal blood pressure and prognosis after treatment of cerebral aneurysm: a nationwide population-based cohort study. PLoS One 2021; 16: e0252042.

[4] Soldozy S, Norat P, Elsarrag M, Chatrath A, Costello JS, Sokolowski JD, Tvrdik P, Kalani MYS and Park MS. The biophysical role of hemodynamics in the pathogenesis of cerebral aneurysm formation and rupture. Neurosurg Focus 2019; 47: E11.

[5] Shimamura N, Naraoka M, Matsuda N, Katayama K, Kakuta K, Katagai T, Fujiwara N,

Hasegawa S and Ohkuma H. Use of preprocedural, multiple antiplatelet medications for coil embolization of ruptured cerebral aneurysm in the acute stage improved clinical outcome and reduced thromboembolic complications without hemorrhagic complications. World Neurosurg 2020; 133: e751-e756.

[6] Gudelj M, Bruyere PJ, Tebache M, Collignon L and Lubicz B. Endovascular treatment of intracranial aneurysms: initial experience in a low-volume center. J Belg Soc Radiol 2020; 104: 19.

[7] Xu W, Xie Y, Zhang X and Li W. Cerebral angiography under artificial intelligence algorithm in the design of nursing cooperation plan for intracranial aneurysm patients in craniotomy clipping. Comput Math Methods Med 2022; 2022: 2182931.

[8] Li C, Liu AF, Qiu HC, Lv X, Zhou J, Zhang YQ, Lv J, Zhang YY, Hu S, Liu F, Liu YE, Jin M and Jiang WJ. Perforator preservation technologies (PPT) based on a new neuro-interventional classification in endovascular treatment of perforator involving aneurysms (piANs). Chin Neurosurg J 2021; 7: 26.

[9] Perhac J, Spaltenstein J, Pereira VM, Schaller K, Brina O, Cabrilo I and Ratib O. Improving workflows of neuro-interventional procedures with autostereoscopic 3D visualization of multi-modality imaging in hybrid interventional suites. Int J Comput Assist Radiol Surg 2016; 11: 189-196.

[10] Tang AM, Bakhsheshian J, Ding L, Jarvis CA, Yuan E, Strickland B, Giannotta SL, Amar A, Attenello FJ and Mack WJ. Nonindex readmission after ruptured brain aneurysm treatment is associated with higher morbidity and repeat readmission. World Neurosurg 2019; 130: e753-e759.

[11] Liu J, Zhang K, Wang B, Hu Q, Zhang Q, Wan L, Wang X and Xiong W. Analysis of clinical effects of comprehensive nursing based on enhanced recovery after surgery in patients with embolization for intracranial aneurysms. Comput Math Methods Med 2022; 2022: 3026680.

[12] Xu Y, Wang RY and Zhao YH. Effects of perioperative comprehensive nursing based on risk prevention for patients with intracranial aneurysm. Int J Clin Pract 2021; 75: e13761.

[13] Huijben-Schoenmakers M, Rademaker A, van Rooden P and Scherder E. The effects of increased therapy time on cognition and mood in frail patients with a stroke who rehabilitate on rehabilitation units of nursing homes in the Netherlands: a protocol of a comparative study. BMC Geriatr 2014; 14: 68.

[14] Rundquist J, Gassaway J, Bailey J, Lingefelt P, Reyes IA and Thomas J. The SCIRehab project: treatment time spent in SCI rehabilitation. Nursing bedside education and care management time during inpatient spinal cord injury rehabilitation. J Spinal Cord Med 2011; 34: 205-215.

[15] Jones P, Haustead D, Walker K, Honan B, Gangathimmaiah V, Mitchell R, Bissett I, Forero R, Martini E and Mountain D. Review article: has the implementation of time-based targets for emergency department length of stay influenced the quality of care for patients? A systematic review of quantitative literature. Emerg Med Australas 2021; [Epub ahead of print].

[16] Luo S, Xie Y, He S, Li J and He C. A study on the effect of nursing intervention based on health behavior change integration theory on patients with limb fracture and its effect on limb function and self-efficacy. Comput Math Methods Med 2022; 2022: 1621210.

[17] Proust F, Bracard S, Thines L, Pelissou-Guyotat I, Leclerc X, Penchet G, Berge J, Morandi X, Gauvrit JY, Mourier K, Ricolfi F, Lonjon M, Sedat J, Bataille B, Drouineau J, Civit T, Magro E, Cebula H, Chassagne P, David P, Emery E, Gaberel T, Vignes JR, Aghakani N, Troude L, Gay E, Roche PH, Irthum B and Lejeune JP; FASHE investigators. Functional outcome 1 year after aneurysmal subarachnoid hemorrhage due to ruptured intracranial aneurysm in elderly patients. Neurochirurgie 2020; 66: 1-8.

[18] Kho GS, Kandasamy R, Bujang MA, Swammy M, Mustapha M and Abdullah JM. Ratio of nitric oxide metabolite levels in cerebrospinal fluid and serum, and their correlation with severity and outcome in patients with subarachnoid haemorrhage. Malays J Med Sci 2021; 28: 42-54.

[19] Skotsimara G, Antonopoulos A, Oikonomou E, Papastamos C, Siasos G and Tousoulis D. Aortic wall inflammation in the pathogenesis, diagnosis and treatment of aortic aneurysms. Inflammation 2022; 45: 965-976.

[20] Fukuda M, Fukuda S, Ando J, Yamamoto K, Yonemoto N, Suzuki T, Niwa Y, Inoue T, Satoh-Asahara N, Hasegawa K, Shimatsu A and Tsukahara T. Disruption of P2X4 purinoceptor and suppression of the inflammation associated with cerebral aneurysm formation. J Neurosurg 2019; 1-13.

[21] Higashida RT, Lahue BJ, Torbey MT, Hopkins LN, Leip E and Hanley DF. Treatment of unruptured intracranial aneurysms: a nationwide assessment of effectiveness. AJNR Am J Neuroradiol 2007; 28: 146-151.

[22] Ehrman JK, Fernandez AB, Myers J, Oh P, Thompson PD and Keteyian SJ. Aortic aneurysm: diagnosis, management, exercise testing, and training. J Cardiopulm Rehabil Prev 2020; 40: 215-223.

[23] Kato M, Kubo A, Green FN and Takagi H. Meta-analysis of randomized controlled trials on safety and efficacy of exercise training in pa-

tients with abdominal aortic aneurysm. J Vasc Surg 2019; 69: 933-943.
[24] Xie YE, Huang WC, Li YP, Deng JH and Huang JT. Dynamic interaction nursing intervention on functional rehabilitation and self-care ability of patients after aneurysm surgery. World J Clin Cases 2022; 10: 4827-4835.
[25] D'Andrea G, Picotti V, Familiari P, Barbaranelli C, Frati A and Raco A. Impact of early surgery of ruptured cerebral aneurysms on vasospasm and hydrocephalus after SAH: our preliminary results. Clin Neurol Neurosurg 2020; 192: 105714.
[26] Vo HK, Le VT, Nguyen VL, Dao XC, Duong DH, Trinh TL, Nguyen VT, Vo HL, Nguyen CH, Tran VL, Nguyen AT, Hoang VT, Truong TA, Nguyen TB, Chu BC, Le TM, Dao TT, Duong TH, Ha HQ, Trinh TP, Truong TT, Phan VD, Pham TN, Phuong TH and Le QC. Diagnostic value of cerebral vasospasm by transcranial doppler ultrasound in Vietnamese patients with subarachnoid hemorrhage. Eur Rev Med Pharmacol Sci 2022; 26: 1939-1944.
[27] Lu J, Li M, Burkhardt JK, Zhao Y, Li Y, Chen X, Zhao Y and Zhao J. Unruptured giant intracranial aneurysms: risk factors for mortality and long-term outcome. Transl Stroke Res 2021; 12: 593-601.
[28] de Winkel J, Cras TY, Dammers R, van Doormaal PJ, van der Jagt M, Dippel DWJ, Lingsma HF and Roozenbeek B. Early predictors of functional outcome in poor-grade aneurysmal subarachnoid hemorrhage: a systematic review and meta-analysis. BMC Neurol 2022; 22: 239.