

## Original Article

# Establishment of emergency-nursing pathway of interventional thrombectomy in acute ischemic stroke

Ting Zhang<sup>1</sup>, Xiaolu Li<sup>2</sup>, Guiguan Sun<sup>2</sup>, Juan Wang<sup>1</sup>, Huimin Chen<sup>3</sup>

<sup>1</sup>Department of Thoracic Surgery, Tianjin First Central Hospital, Tianjin 300192, China; <sup>2</sup>Department of Encephalopathy, Shandong Qingdao Integrated Traditional Chinese and Western Medicine Hospital, Qingdao 266000, Shandong, China; <sup>3</sup>Department of Neurology, The No. 4 Hospital of Ji'nan, Ji'nan 250031, Shandong, China

Received February 20, 2021; Accepted June 2, 2021; Epub October 15, 2021; Published October 30, 2021

**Abstract:** Objective: To establish the emergency-nursing pathway of interventional thrombectomy on acute ischemic stroke (AIS). Methods: 113 AIS patients who received interventional thrombotomy in conventional emergency model from Aug. 2019 to Feb. 2020 were included as control-group, and 127 patients, who underwent interventional thrombotomy by pathway-based emergency nursing program from Mar. 2020 to Sep. 2020, were classified into observation-group. The time points from admission to recanalization of the two groups, the recanalization rate, and the changes in the neurological impairment scale (NIHSS) scores of the two groups in pre- and post-treatment were compared; Meanwhile, the therapeutic efficacy rate between the two groups was evaluated and compared by modified Rankin Score (mRS) 90 days after discharge. Results: The average time from hospital arrival to femoral artery puncture, the average time of successful femoral artery puncture, and the average time from admission to recanalization in observation-group were remarkably shorter than that of control-group ( $P<0.05$ ). The recanalization rate of endovascular therapy in observation-group was 92.13%, which was higher than that in control-group (80.53%,  $P<0.05$ ); The NIHSS score of observation-group after treatment was obviously lower than that of control-group ( $P<0.05$ ); The curative rate in observation-group was 90.55%, which was higher than that of 79.65% in control group ( $P<0.05$ ); The satisfaction of observation-group patients with nursing care was 90.55%, which was higher than that of 73.45% in control-group ( $P<0.05$ ). Conclusion: Establishment of emergency-nursing pathway can reduce the time-consuming from admission to vascular recanalization for AIS patients undergoing interventional thrombectomy, increase the recanalization rate, improve the patients' neurological function, and ameliorate the curative rate and nursing satisfaction.

**Keywords:** Emergency-nursing pathway, acute ischemic stroke, interventional thrombectomy

## Introduction

Acute ischemic stroke (AIS), also known as cerebral infarction, is a severe acute disease that generally occurs in clinical, and accounts for about 80% of the whole cases [1]. AIS is primarily due to the occlusion of cerebral arteries that caused by a variety of incentives, leading to the infarction of cerebral tissues [2]. According to literature reports, the mortality rate of AIS caused by occlusion of large intracranial vessels (>2 mm in diameter) reaches as high as 53%~90% [3]. As AIS is featured by high rates of morbidity, fatality, recurrence and disability, it has become one of the major diseases that threaten patients' life safety and quality [4, 5]. Interventional thrombectomy is one of the superior methods to treat AIS, but

it has a strong time dependence. Since the prognostic effect of AIS patients is positively related to recanalization time, prompt and effective recanalization of occluded vessels and the reduction of cerebral ischemia time in AIS patients are the "golden principles" of disease treatment [6-8]. However, the interventional thrombectomy performed under conventional emergency model often causes a prolonged time from admission to recanalization due to multiple reasons, and greatly reduces the effect of recanalization [9, 10]. In order to ensure the smooth operation and improve the cooperating efficiency and quality of nurses in interventional operating room, our hospital has actively established an emergency-nursing pathway, and applied it to patients underwent interventional thrombectomy for

## Nursing care of embolectomy in patients with acute stroke

AIS from March to September 2020, and achieved satisfactory results.

### Cases and methods

#### *Research objects*

AIS Patients who admitted in our hospital from Aug. 2019 to Sep. 2020 and undergoing interventional thrombectomy were chosen as the research objects. 113 AIS patients that received interventional thrombotomy in conventional emergency model from Aug. 2019 to Feb. 2020 were included as control-group, and the remaining 127 patients, who underwent interventional thrombotomy of emergency-nursing pathway from Mar. 2020 to Sep. 2020, were classified into observation-group. The study complies with the requirements of the Helsinki Declaration and is conducted after approval of the Ethics Committee of our hospital.

#### *Inclusion and exclusion criteria*

Inclusion criteria: (1) The included objects met the diagnostic criteria in Guidelines for Diagnosis and Treatment of Stroke in China in 2018 [11], and were confirmed as AIS by imaging examinations such as craniocerebral CT scan; (2) The age of patient >18 years old; (3) The onset time of anterior circulation ischemia was less than 8 hours, and that of posterior circulation ischemia (PCI) was less than 24 hours; and (4) The patients or their families gave informed consent to interventional thrombectomy, and signed the corresponding documents.

Exclusion criteria: (1) Patients diagnosed with intracranial hemorrhage by craniocerebral CT examination; (2) Patients with known bleeding propensity or active bleeding; (3) Patients who died in hospital after failure of rescue; (4) Patients who were not followed up for 90 days after discharge; (5) Patients with imaging changes of early large area infarction by craniocerebral CT examination; (6) Patients with contraindications to interventional thrombectomy; or (7) Patients with severe dysfunction in crucial organs such as heart, liver or kidney.

#### *Methods*

The control-group was treated with routine emergency mode of interventional embolecto-

my, and the procedures are as follows: The nurse in emergency department pretests and triages patients according to their general clinical symptoms; The emergency stroke specialist performs NIHSS evaluation on patients transferred to the rescue room, and immediately notify the intervention room after excluding of cerebral hemorrhage by CT. After receiving the notice of emergency AIS interventional thrombotomy, the nursing staff in interventional room prepares the emergency program in accordance with the conventional emergency procedures.

The observation-group was treated with the interventional thrombectomy that based on the emergency-nursing pathway. (1) The establishment of emergency-nursing pathway. The responsible nurse of interventional department works as the group leader, and the team members with over 5 years of experience in stroke nursing and good organizational and coordination, communication, and strong problem-solving skills are chosen as the team members. The team members search the literature on emergency care for stroke, summarize the inquiring data [12-15], and formulate a standardized emergency-nursing pathway according to each procedure from hospital admission to entry into the interventional room for surgery. The team standardizes the corresponding processes, and receives training and passes assessment to ensure that the members of the team can master and apply proficiently. (2) Management of emergency supplies. The designated personnel are responsible for the management of the supplies, and the quantity and variety of drugs, the specification of stent and the quantity of catheter wire, etc. shall be checked regularly and supplemented in time. First-aid supplies are placed in designated places, and the lockers storing first-aid supplies are regularly cleaned and disinfected; The expensive medicines and consumables should be locked for management; The team members must be fully aware of the specifications, usage, and storage locations of the drugs and consumables. (3) The implementation of standardized nursing with emergency-nursing pathway. ① The management of pre-operative nursing pathway. To establish a 24-hour emergency standby policy, and the team members can arrive at the intervention room within 15 minutes after receiving the

emergency call, and prepare the consumables and drugs that used during the operation. The team keeps in touch with the emergency department to keep abreast of the patient's conditions. A specialized green channel handover form is established for stroke patients to record the patient's vital signs, pupils, consciousness, muscle strength, etc. in detail. The first aid kits are placed in the emergency room and intervention room to promote effective intravenous thrombolysis and endovascular treatment in the shortest possible time. The preparation of various channels before surgery, including intravenous channels, endotracheal intubation (for patients in critically ill or coma), indwelling catheters, etc. are well-completed. The team coordinates the arrangement of operation, keeps in touch with the medical office and each operating department, and flexibly arranges the operation according to the principle of emergency consultation as the priority. The staff members notify the emergency surgery to the corresponding departments 30 min in advance, complete preoperative communication and overall coordination of operating tables as soon as possible, and prepare for surgery to prevent the time window from being extended due to poor coordination or insufficient preparation of surgical supplies or medicines. ② Management of intraoperative nursing pathway. If the patient has symptoms such as palpitation, shortness of breath, chest tightness, heart-rate acceleration, flushed face, and skin itch after receiving radiography, beware of allergic reactions to the contrast agent, inform the doctor in time and give oxygen, volume expansion, and intravenous injection of dexamethasone as physician's prescribed. If necessary, the operation shall be terminated immediately. The interventional thrombectomy may cause vascular damage in patients, and antiplatelet and anticoagulant drugs used in operation may also cause vascular rupture and bleeding. Therefore, it is necessary to closely observe the patient's response during the operation. If nausea or emesis occur with sudden increase of blood pressure and heart rate, the team members should timely inform the possibility of cerebral vascular rupture and bleeding to the doctor. After a successful thrombectomy, the occluded blood vessels of patient may suddenly open, which can possibly lead to an overperfusion injury. Therefore, it is necessary to closely

observe the patient's emesis, cerebral edema and changes in vital signs, and remind the doctor immediately if there is any abnormality. ③ The management of postoperative nursing pathway. Postoperative vital signs should be monitored and observed, especially pupils and consciousness, and patients' chief complaints should be paid attention to. The patient's puncture point should be cared for, and the pressure of the puncture point should be managed to prevent bleeding. During the handover with the ward nurse, the contrast media and drugs used, indwelling of tubes, vital signs and other related information of patients should be handed over face to face in the form of a standardized handover form. The ward nurse should be informed actively if there is any doubt to achieve smooth and complete handover as far as possible.

### *Observation of indexes*

(1) The time points from hospital admission to recanalization, including the average time from admission to femoral artery puncture, the average time of successful femoral artery puncture and the average time from admission to recanalization, were compared between the two groups. (2) The recanalization rate of endovascular therapy was compared between the two groups. The patients underwent a cerebral CT examination after surgery, and were divided into non-recanalization, partial recanalization and complete recanalization according to the examination results of vascular recanalization. The vascular recanalization rate = complete recanalization/total number of cases  $\times$  100%. (3) The changes of neurological deficit scale (NIHSS) scores before and after treatment were compared between the two groups. (4) The therapeutic efficacy of the two groups were evaluated and compared by 90 d-modified Rankin score (mRS) after discharge of hospital for 90 days. The therapeutic efficacy rate = (superior + good)/total number of cases  $\times$  100. (5) The satisfaction rates of the two groups to nursing care were compared. The *Nursing Satisfaction Questionnaire* prepared by our hospital was distributed to patients for anonymously fill before discharge for evaluation. The score below 59 points was dissatisfied, 60-79 points referred as basically satisfied, and 80 points or above was satisfied. Total satisfaction rate = (satisfied + basically satisfied)/total number of cases  $\times$  100.

## Nursing care of embolectomy in patients with acute stroke

**Table 1.** Comparison of general information between the two groups

Item	Control-group (n=113)	Observation-group (n=127)	X <sup>2</sup> /t	P
Gender (M/F, cases)	62/51	68/59	0.0422	0.8372
Age ( $\bar{x} \pm s$ , yd)	61.38±5.23	62.52±5.66	1.6140	0.1079
Occlusion			0.1440	0.9305
Vertebrobasilar system	49	52		
Anterior circulation ischemia	34	40		
Posterior circulation ischemia	30	35		

**Table 2.** Comparison of the time points between the two groups from admission to revascularization ( $\bar{x} \pm s$ , min)

Group	Average time from admission to femoral artery puncture	Average time of successful femoral artery puncture	Average time from admission to recanalization
Control-group (n=113)	79.74±13.58	15.67±3.27	175.36±62.78
Observation-group (n=127)	51.96±8.67	7.23±1.19	128.44±42.52
t	19.0935	27.1426	6.8422
P	<0.0001	<0.0001	<0.0001

### Statistical analysis

The statistical analysis and processing of data was conducted by SPSS19.0. The measurement data were expressed as ( $\bar{x} \pm s$ ), the comparison between groups was by *t*-test of independent samples; the enumeration data were expressed by percentage, and the results were checked by  $\chi^2$ .  $P < 0.05$  referred to the statistically significant of the difference. The graphic software was by Graphpad prism 9.0.

### Results

#### Clinical data

The difference between the general information of the two groups was not statistically significant ( $P > 0.05$ ), and there was comparability between the two groups (**Table 1**).

#### Comparison of the time points from admission to recanalization between the two groups

In control group, the time from admission to femoral artery puncture was (79.74±13.58) min, the time to successful femoral artery puncture was (15.67±3.27), and the time from admission to recanalization was (175.36±62.78) min; In observation group, the time from admission to femoral artery puncture was (51.96±8.67) min, the time from successful femoral artery puncture was (7.23±

1.19), and the time from admission to vascular recanalization was (128.44±42.52) min. The time points from admission to recanalization of the observation-group patients were shorter than those in control-group ( $P < 0.05$ ), as shown in **Table 2**.

#### Comparison of recanalization rate of endovascular therapy between the two groups

The recanalization rate of endovascular therapy in observation-group was 92.13%, which was higher than that of 80.53% in control-group, and the difference was statistically significant ( $\chi^2 = 6.9570$ ,  $P = 0.0083$ ) (**Table 3**).

#### Comparison of NIHSS scores between the two groups before and after treatment

The difference of NIHSS score between the two groups before treatment was not statistically significant [(15.49±2.13) vs. (15.57±2.28),  $t = 0.2798$ ,  $P = 0.7798$ ]; The NIHSS scores of the two groups after treatment were substantially lower than those before treatment, and the difference was statistically significant [(15.49±2.13) vs. (7.33±1.34),  $t = 34.4700$ ,  $P < 0.001$ ; (15.57±2.28) points vs. (5.65±1.12) points,  $t = 44.0088$ ,  $P < 0.001$ ]; The post-treatment NIHSS score of observation group was remarkably lower than control group [(5.65±1.12), (7.33±1.34),  $t = 10.5752$ ,  $P < 0.001$ ]. Details listed in **Table 4** and **Figure 1**.

## Nursing care of embolectomy in patients with acute stroke

**Table 3.** Comparison of recanalization rate between the two groups [cases, (%)]

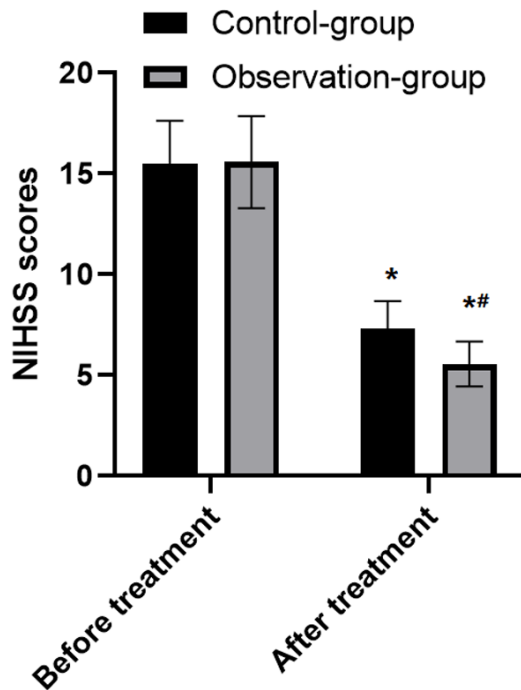
Group	Fail to recanalization	Partial recanalization	Complete recanalization	Recanalization rate
Control-group (n=113)	10 (8.85)	12 (10.62)	91 (80.53)	91 (80.53)
Observation-group (n=127)	4 (3.15)	6 (4.72)	117 (92.13)	117 (92.13)
$\chi^2$	-	-	-	6.9570
$P$	-	-	-	0.0083

**Table 4.** Comparison of NIHSS scores before and after treatment between the two groups ( $\bar{x} \pm s$ , points)

Group	Before treatment	After treatment	t	P
Control-group (n=113)	15.49±2.13	7.33±1.34	34.4700	<0.0001
Observation-group (n=127)	15.57±2.28	5.65±1.12	44.0088	<0.0001
t	0.2798	10.5752		
P	0.7798	<0.0001		

### Comparison of the satisfaction of two groups of patients with nursing

The satisfaction of observation-group patients with nursing care was 90.55%, which was higher than that of 73.45% in control-group, and the difference was statistically significant ( $\chi^2=12.1105$ ,  $P=0.0005$ ) (Table 6).



**Figure 1.** Comparison of NIHSS scores before and after treatment between the two groups. Note: compare with before treatment, \* $P<0.05$ ; compare with control-group, # $P<0.05$ .

### Comparison of curative rate between the two groups

The curative rate in observation-group was 90.55%, which was higher than that of 79.65% in control group with statistically significant difference ( $\chi^2 = 5.7087$ ,  $P=0.0169$ ) (Table 5).

### Discussion

AIS is a common critical disease with high mortality rate in emergency department. According to statistics, there are up to 1.5 to 2 million cases of stroke in China every year, and the incidence has been increasing year by year with the change of people's lifestyle and dietary habits [16]. In the process of treatment, intravenous thrombolysis or interventional thrombus removal as soon as possible to reopen the blood vessels is a key factor in determining the survival of AIS patients. According to literature reports, for every 30 min of delay in rescue treatment, up to 12% of patients will lose the chance of recovery, and the mortality and disability rate will also increase remarkably [17, 18]. Therefore, it has currently become an important topic of clinical research on shortening the time from admission to recanalization of AIS patients. Although it is inevitable to miss the best treatment time due to delays outside the hospital, delays in inpatient treatment can be avoided easily. According to relevant literature, by optimizing the design of the treatment process and determining the key tasks in treatment process, the time from admission to recanalization of the patient's blood vessel was shortened by 60%, and the treatment effect of AIS has been improved [19].

The emergency-nursing pathway is a new type of emergency nursing scheme. With the theo-

## Nursing care of embolectomy in patients with acute stroke

**Table 5.** Comparison of curative rate of the two groups [cases, (%)]

Group	Excellent	Good	Acceptable	Effective rates
Control-group (n=113)	22 (19.47)	68 (60.18)	23 (20.35)	90 (79.65)
Observation-group (n=127)	43 (33.86)	72 (56.69)	12 (9.45)	115 (90.55)
$\chi^2$	-	-	-	5.7087
<i>P</i>	-	-	-	0.0169

**Table 6.** Comparison of nursing satisfaction between the two groups [cases, (%)]

Group	Satisfied	Basically satisfied	Unsatisfied	Satisfaction rate
Control-group (n=113)	42 (37.17)	41 (36.28)	30 (26.55)	83 (73.45)
Observation-group (n=127)	60 (47.24)	55 (43.31)	12 (9.45)	115 (90.55)
$\chi^2$	-	-	-	12.1105
<i>P</i>	-	-	-	0.0005

retical guidance of evidence-based nursing science, the emergency-nursing pathway integrates various nursing concepts such as humanized nursing and systematic management. It aims to strengthen the weak process in the traditional nursing process, and provides patients with targeted and integrated nursing measures. The core purpose of pathway-based emergency nursing program is to optimize each procedure in emergency process, and rationally use the medical resources, that to improve the rescue efficiency of critically ill patients [20, 21]. The success of AIS interventional thrombectomy is not only related to the time window, but also connect with the standard of the emergency program after admission, as well as the smooth teamwork [22, 23]. Therefore, the application of emergency-nursing pathway realizes the standard of nursing processes, which is conducive to the efficient operation of the emergency green channel in hospital and the improvement of the successful vascular recanalization rate. The establishment of emergency-nursing pathway in our hospital, which draws on the evidence-based nursing, has formulated a standard coordinative nursing pathway for emergency program and standard every procedure from the hospital arrival of patients to be admitted to the intervention room for recanalization. The team members perform their roles according to the requirements of the pathway, and the nursing points of each procedure are settled. This can avoid the randomness in routine emergency nursing work, facilitate the coordination and

cooperation between nurses and departments that involved [24, 25], and enable patients to receive surgical treatment in time after admission.

The results of this study showed that the average time from hospital arrival to vascular recanalization (average time from admission to femoral artery puncture, the average time of successful femoral artery puncture, and the average time from admission to vascular recanalization) in observation-group were all em-

arkably shorter than that of the control-group. This indicates that teamwork has exerted a crucial role in reducing time after the establishment of the emergency-nursing pathway, so that patients can receive more timely treatment. The NIHSS score primarily reflects the neurological function status of AIS patients, and the lower score refers to the better neurological function status of patients. In this study, the NIHSS score of the observation-group was lower than that of the control-group after treatment, suggesting that the construction of the emergency-nursing pathway can dramatically improve the neurological function of patients. In addition, the recanalization rate of endovascular therapy, curative rate and nursing satisfaction of observation-group were higher than those of control-group, indicating that the pathway can improve the treating effect and nursing satisfaction of patients.

In conclusion, the emergency-nursing pathway can reduce the time from admission to recanalization of AIS patients after interventional thrombectomy removal, increase the recanalization rate, improve the neurological function, and ameliorate the curative rate and nursing satisfaction.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Huimin Chen, Department of Neurology, The No. 4 Hospital of Ji'nan, No. 50 Shifan Road, Ji'nan 250031, Shandong, China.

## Nursing care of embolectomy in patients with acute stroke

Tel: +86-0531-81312681; E-mail: chm250031@163.com

### References

- [1] Cook AM, Morgan Jones G, Hawryluk GWJ, Mailloux P, McLaughlin D, Papangelou A, Samuel S, Tokumaru S, Venkatasubramanian C, Zacko C, Zimmermann LL, Hirsch K and Shutter L. Guidelines for the acute treatment of cerebral edema in neurocritical care patients. *Neurocrit Care* 2020; 32: 647-666.
- [2] Bahouth MN, Gottesman RF and Szanton SL. Primary 'dehydration' and acute stroke: a systematic research review. *J Neurol* 2018; 265: 2167-2181.
- [3] Umarova RM, Sperber C, Kaller CP, Schmidt CSM, Urbach H, Klöppel S, Weiller C and Karnath HO. Cognitive reserve impacts on disability and cognitive deficits in acute stroke. *J Neurol* 2019; 266: 2495-2504.
- [4] Bushnell C, Howard VJ, Lisabeth L, Caso V, Gall S, Kleindorfer D, Chaturvedi S, Madsen TE, Demel SL, Lee SJ and Reeves M. Sex differences in the evaluation and treatment of acute ischaemic stroke. *Lancet Neurol* 2018; 17: 641-650.
- [5] Ballarin B and Tymianski M. Discovery and development of NA-1 for the treatment of acute ischemic stroke. *Acta Pharmacol Sin* 2018; 39: 661-668.
- [6] Kelly KM, Holt KT, Neshewat GM and Skolarus LE. Community interventions to increase stroke preparedness and acute stroke treatment rates. *Curr Atheroscler Rep* 2017; 19: 64.
- [7] Bettencourt S and Ferro JM. Acute ischemic stroke treatment in infective endocarditis: systematic review. *J Stroke Cerebrovasc Dis* 2020; 29: 104598.
- [8] Ng JC, Churojana A, Pongpech S, Vu LD, Sadikin C, Mahadevan J, Subramaniam J, Jocson VE and Lee W. Current state of acute stroke care in Southeast Asian countries. *Interv Neuroradiol* 2019; 25: 291-296.
- [9] Li Z, Zhang X, Wang K and Wen J. Effects of early mobilization after acute stroke: a meta-analysis of randomized control trials. *J Stroke Cerebrovasc Dis* 2018; 27: 1326-1337.
- [10] Suzuki K, Kimura K, Takeuchi M, Morimoto M, Kanazawa R, Kamiya Y, Shigeta K, Ishii N, Takayama Y, Koguchi Y, Takigawa T, Hayakawa M, Ota T, Okubo S, Naito H, Akaji K, Kato N, Inoue M, Hirano T, Miki K, Ueda T, Iguchi Y, Fujimoto S, Otsuka T and Matsumaru Y. The randomized study of endovascular therapy with versus without intravenous tissue plasminogen activator in acute stroke with ICA and M1 occlusion (SKIP study). *Int J Stroke* 2019; 14: 752-755.
- [11] Morris DC, Zhang ZG and Chopp M. Thymosin beta4 for the treatment of acute stroke: neuro-restorative or neuroprotective? *Expert Opin Biol Ther* 2018; 18: 149-158.
- [12] Abubakar SA and Jamoh BY. Dysphagia following acute stroke and its effect on short-term outcome. *Niger Postgrad Med J* 2017; 24: 182-186.
- [13] Baatiema L, Chan CKY, Sav A and Somerset S. Interventions for acute stroke management in Africa: a systematic review of the evidence. *Syst Rev* 2017; 6: 213.
- [14] Liamis G, Barkas F, Megapanou E, Christopoulou E, Makri A, Makaritsis K, Ntaios G, Elisaf M and Milionis H. Hyponatremia in acute stroke patients: pathophysiology, clinical significance, and management options. *Eur Neurol* 2019; 82: 32-40.
- [15] Warnecke T, Im S, Kaiser C, Hamacher C, Oelenberg S and Dziewas R. Aspiration and dysphagia screening in acute stroke - the Gugging Swallowing Screen revisited. *Eur J Neurol* 2017; 24: 594-601.
- [16] Anderson CS, Arima H, Lavados P, Billot L, Hackett ML, Olavarria VV, Muñoz Venturelli P, Brunser A, Peng B, Cui L, Song L, Rogers K, Middleton S, Lim JY, Forshaw D, Lightbody CE, Woodward M, Pontes-Neto O, De Silva HA, Lin RT, Lee TH, Pandian JD, Mead GE, Robinson T and Watkins C; HeadPoST Investigators and Coordinators. Cluster-randomized, crossover trial of head positioning in acute stroke. *N Engl J Med* 2017; 376: 2437-2447.
- [17] Iwamoto Y, Imura T, Suzukawa T, Fukuyama H, Ishii T, Taki S, Imada N, Shibukawa M, Inagawa T, Araki H and Araki O. Combination of exoskeletal upper limb robot and occupational therapy improve activities of daily living function in acute stroke patients. *J Stroke Cerebrovasc Dis* 2019; 28: 2018-2025.
- [18] Chimatiro GL and Rhoda AJ. Scoping review of acute stroke care management and rehabilitation in low and middle-income countries. *BMC Health Serv Res* 2019; 19: 789.
- [19] Sun LR, Felling RJ and Pearl MS. Endovascular mechanical thrombectomy for acute stroke in young children. *J Neurointerv Surg* 2019; 11: 554-558.
- [20] Boulanger JM, Lindsay MP, Gubitz G, Smith EE, Stotts G, Foley N, Bhogal S, Boyle K, Braun L, Goddard T, Heran M, Kanya-Forster N, Lang E, Lavoie P, McClelland M, O'Kelly C, Pageau P, Pettersen J, Purvis H, Shamy M, Tampieri D, vanAdel B, Verbeek R, Blacquièrè D, Casaubon L, Ferguson D, Hegedus Y, Jacquin GJ, Kelly M, Kamal N, Linkewich B, Lum C, Mann B, Milot G, Newcommon N, Poirier P, Simpkin W, Snieder E, Trivedi A, Whelan R, Eustace M, Smitko E and Butcher K. Canadian stroke best practice recommendations for acute stroke manage-

## Nursing care of embolectomy in patients with acute stroke

- ment: prehospital, emergency department, and acute inpatient stroke care, 6th edition, update 2018. *Int J Stroke* 2018; 13: 949-984.
- [21] Ladhani NNN, Swartz RH, Foley N, Nerenberg K, Smith EE, Gubitz G, Dowlatshahi D, Potts J, Ray JG, Barrett J, Bushnell C, Bal S, Chan WS, Chari R, El Amrani M, Gandhi S, Hill MD, James A, Jeerakathil T, Jin A, Kirton A, Lanthier S, Lausman A, Leffert LR, Mandzia J, Menon B, Pikula A, Poppe A, Saposnik G, Sharma M, Bhogal S, Smitko E and Lindsay MP. Canadian stroke best practice consensus statement: acute stroke management during pregnancy. *Int J Stroke* 2018; 13: 743-758.
- [22] Antipova D, Eadie L, Macaden A and Wilson P. Diagnostic accuracy of clinical tools for assessment of acute stroke: a systematic review. *BMC Emerg Med* 2019; 19: 49.
- [23] Amarenco P, Lavallée PC, Monteiro Tavares L, Labreuche J, Albers GW, Abboud H, Anticoli S, Audebert H, Bornstein NM, Caplan LR, Correia M, Donnan GA, Ferro JM, Gongora-Rivera F, Heide W, Hennerici MG, Kelly PJ, Král M, Lin HF, Molina C, Park JM, Purroy F, Rothwell PM, Segura T, Školoudík D, Steg PG, Touboul PJ, Uchiyama S, Vicaute É, Wang Y and Wong LKS; TIAregistry.org Investigators. Five-year risk of stroke after TIA or minor ischemic stroke. *N Engl J Med* 2018; 378: 2182-2190.
- [24] Appleton JP, Woodhouse LJ, Adami A, Becker JL, Berge E, Cala LA, Casado AM, Caso V, Christensen HK, Dineen RA, Gommans J, Koumellis P, Szatmari S, Sprigg N, Bath PM and Wardlaw JM; ENOS Investigators. Imaging markers of small vessel disease and brain frailty, and outcomes in acute stroke. *Neurology* 2020; 94: e439-e452.
- [25] Vagal A, Wintermark M, Nael K, Bivard A, Parsons M, Grossman AW and Khatri P. Automated CT perfusion imaging for acute ischemic stroke: pearls and pitfalls for real-world use. *Neurology* 2019; 93: 888-898.