Am J Transl Res 2022;14(2):1084-1091
www.ajtr.org /ISSN:1943-8141/AJTR0139303

Original Article

Clinical effects of neuroendoscopic hematoma evacuation for hypertensive intracerebral hemorrhage

Rile Wu, Jin'gang Bao, Jianping Zhang, Zhong Wang, Xiaojun Zhang, Qiang Yun

Department of Neurosurgery, Inner Mongolia People's Hospital, Hohhot 010017, Inner Mongolia Autonomous Region, China

Received September 22, 2021; Accepted December 29, 2021; Epub February 15, 2022; Published February 28, 2022

Abstract: Objective: To analyze the clinical effects of neuroendoscopic hematoma evacuation for the treatment of hypertensive intracerebral hemorrhage (ICH). Methods: A total of 80 patients with hypertensive ICH who were admitted to our hospital were included as the subjects of this retrospective study. The patients were assigned into a neuroendoscopic hematoma evacuation group (n=35) and a small bone window craniotomy group (n=45). The postoperative hematoma residues and the clearance rate of the hematoma were compared between the two groups. The intraoperative blood loss, duration of the surgery, and Glasgow Coma Scale (GSC) scores before and after surgery were compared between the two groups. The operation time, intraoperative blood loss, the time consumed to stop bleeding, clearance rate of hematoma, manifestation of complications, and the prognosis 6 months after surgery were analyzed statistically. Self-made questionnaires were used to evaluate the satisfaction degree of patients with their lives and to assess the quality of life after surgery. Results: The operation time, blood loss, and the time consumed to stop bleeding were less in the neuroendoscopic hematoma evacuation group than those in the small bone window craniotomy group (all P<0.05). The GCS scores in the neuroendoscopic hematoma evacuation group were significantly higher than those in the small bone window craniotomy group (P<0.05). The clearance rate of hematoma was higher in the neuroendoscopic hematoma evacuation group than that in the small bone window craniotomy group (P<0.05). Conclusion: As compared with small bone window craniotomy for removing hematoma, neuroendoscopic hematoma evacuation showed a better outcome in treating patients with hypertensive ICH. It could improve patients' clinical indications, which is worthy of being widely applied in clinical settings.

Keywords: Neuroendoscopic hematoma evacuation, small bone window craniotomy group, hypertensive ICH, treatment outcome

Introduction

Intracerebral hemorrhage (ICH) is a cerebrovascular disease, with high mortality and disability rates. There are 10% to 20% of patients who have stroke attacks caused by ICH [1]. ICH is also a disease contributed by many pathogenic factors. Among them hypertension is the most dominant cause, with a ratio of nearly 70% in all cases of ICH [2]. ICH usually occurs at the basal ganglia. There are data showing that people aged between 46 and 64 are most likely to have ICH, with a 50% survival rate in the first year and a 29% survival rate in the fifth year after its onset [3, 4]. People who have survived ICH are manifested with significant neurological dysfunctions. This results in permanent assistance from others in their daily lives, which is a huge burden for the family and for society [5].

ICH is often treated conservatively. Conservative treatment can lead to over 90% mortality rate when the hematoma is more than 60 mL in volume [6]. In recent years, a series of studies on ICH have been conducted. We still do not know about the exact pathophysiological mechanism of ICH. Patients who suffered an ICH attack produce hematoma that acts on peripheral tissues to mechanically destroy the formation of mass effects. This results in more complications and injuries, including edema in surrounding brain tissue, coagulation cascade, inflammation, formation of free radicals, blood degradation products, or a secondary injury caused by blood clots [7-10]. Some studies have shown that the size of hematoma largely determines patients' prognosis, eliminating hematoma not only reduces the mass effects, improves cerebral perfusion, and decreases intracranial pressure, but also effectively reduces the toxicity of hematoma degradation products, reducing damage to brain tissues [11-14].

Surgery is a good way to remove hematoma. Despite some disputes, small bone window craniotomy is a conservative method which is widely used to remove hematoma by a lateral fissure-insular approach under a microscope [15]. According to a clinical trial, small bone window craniotomy does not benefit patients the most [16]. Another famous and classic trial on the exploration of treatment approach for ICH is a surgical trial in intracerebral hemorrhage (STICH). The results of STICH showed that early surgery failed to significantly improve a patient's prognosis as compared with early conservative treatments. Researchers conducted STICH II, a trial that confirmed that early surgery for ICH did not increase the disability and mortality rates, but slightly increased the rate of good prognosis of patients (41%) as compared with the conservative treatment (38%) [16-20]. It was concluded that surgery can mildly improve the prognosis of ICH patients, but shows no statistical significance compared with the conservative treatment. Traditional craniotomy removes hematoma in patients' brains at once. This can result in a large wound, which has a relatively huge impact on brain tissues. Neuroendoscopic surgery, a new surgery, has become popular over the recent year for the treatment of hypertensive ICH. It produces a smaller wound with higher safety and better prognosis as compared with traditional craniotomy. This study aimed to investigate the clinical efficacy of different surgeries on hypertensive ICH. In our research, the efficacy of neuroendoscopic surgery and small bone window craniotomy in removing hematoma in patients with hypertensive ICH were compared.

Materials and methods

General data

In this retrospective study, 80 patients who were admitted to our hospital during January 2020 and January 2021 for hypertensive ICH were included. They were assigned into a neuroendoscopic hematoma evacuation group (n=35) and a small bone window craniotomy group (n=45) according to the surgical approach.

The clinical and surgical data were obtained with the approval from the Ethics Committee of our hospital (Approval number: 202102611L). No significant differences in these data were found (P>0.05). All patients or families provided written informed consent.

Inclusion criteria: Patients with hypertension; patients with hypertensive hemorrhage; and patients without surgical contradictions.

Exclusion criteria: Patients who had complicated brainstem hemorrhage; patients with severe heart, liver, and lung dysfunction; patients with mental dysfunction; and patients with coagulation dysfunction.

Methods

Small bone window craniotomy: Patients took CT scans to locate the hematoma before the surgery. The hematoma was marked as large as possible for the selection of the best surgical approach. The scalp was incised 5 cm and separated by a periosteal detacher. A scalp clip was used to stop bleeding, making sure that the hematoma was in the center, to avoid deviation. A hole was drilled into the skull a diameter of 3.0 cm and a small bone window was created using a milling cutter. The dura mater was cut into a cross shape and suspended. Fistulization was performed in the hematoma cavity under a microscope, with cerebral cotton pads being used to protect the brain tissue and blood vessels around the passage. The hematoma was removed, after which the bleeding was stopped completely. Normal insulin was used to wash the operated site. The wall of the hematoma cavity was covered with medical instant hemostatic gauze. The dura mater was sutured tightly, and artificial dura mater was used when necessary. The skull bone flap was placed back and fixed, and the scalp was sutured layer by layer. During the surgery, the surgeon used the same urokinase approach as in the neuroendoscopic hematoma evacuation group. A drainage tube was placed if the hematoma had not been completely removed during the surgery. Urokinase was administered postoperatively to drain the remaining hematoma.

After surgery, patients were sent to ICU for monitoring and medical care.

Neuroendoscopic hematoma evacuation group: Conventional tools for neuroendoscopic surgery were selected. A surgical approach was designed according to the results of the CT scanning. Tracheal intubation under general anesthesia was performed in all the patients in accordance with the surgical approach, designed in advance. An incision was made at the site closest to the hematoma. The surrounding scalp was removed and a small bone flap about 3.0 cm in length was milled. The bleeding was stopped after electrocoagulation on dura mater, which was subsequently cut off for puncturing blood vessels and functional areas or locating the hematoma through the sulcus using a cerebral needle directly, instead of through the brain. Ultrasonic wave was used to locate the hematoma under necessary circumstances during the surgery. The cortex was punctured and the endoscopic drilling sheath was delivered into the hematoma. The puncture was completed after all the residual blood was sucked out. The sheath tube acted as a catheter for the endoscope, which was placed at an angle of 0° or 30° according to the needs of the surgery to remove the hematoma under endoscopic vision. While removing the central hematoma, the "collapse" of the peripheral hematoma continued to "collapse" inward. The swing of the cerebral tissue produced a constant pressure on the hematoma remaining in the catheter that had facilitated its removal process. The sheath tube was kept pulled backward during the process to clear most of the hematoma. Arterial bleeding was observed under a microscope, and bleeding spots were aspirated with an aspirator. Bipolar electrocoagulation was adopted to stop bleeding. Pulling with or without force was not recommended while removing the hematoma if blood clots were stuck in the cavity. Instead, the electrocoagulation was disconnected to separate the blood clots, which were washed immediately. Compression or scrubbing was performed to stop the superficial scalp bleeding. Compression was done with the use of liquid gelatin, instant sol, or a gelatin sponge. Frequent washing with normal saline was recommended during the scrubbing process. The dura mater was repaired and sutured after the removal of the hematoma. The bone flap was placed back and fixed, and the scalp and skull were sutured layer by layer. Patients were transferred to ICU for continued medical treatment.

Outcome measures

Primary outcome measures: Blood loss during surgery was observed. The intraoperative blood loss was estimated according to the surgical records.

The amount of the remaining hematoma and its clearance rate after surgery were estimated. The amount of residual hematoma was calculated by Tada formula.

For patients who had received surgery, the amount of the residual hematoma was calculated according to the result of CT scanning in the routine re-examination after surgery. To calculate the clearance rate of hematoma after surgery, the amount of hematoma before surgery and after surgery was analyzed. Hematoma clearance rate = (preoperative hematoma volume - postoperative hematoma volume)/ preoperative hematoma volume *100%.

GSC scores before and 24 hours after surgery were compared between the two groups. Patient's GCS scores within 24 hours after surgery were recorded to assess the effects of the surgery. The scores were excluded if patients were conscious or anesthetized.

Secondary outcome measures: Patients' well-being was evaluated by a self-made questionnaire at discharge. Well-being = (number of patients felt happiness)/the total number of patients *100%.

Patients' quality of life (QOL) in the two groups was evaluated by a relevant scale at discharge, with higher scores indicating better quality of life.

Statistical analysis

All data were analyzed by SPSS 22.0 statistical software (IBM, USA). Measured data were tested for normality. Measured data conforming to normal distribution were expressed as mean ± standard deviation ($\bar{x}$ ± sd). The independent t test was used for inter-group comparison. The paired t test was used for intra-group comparison before and after surgery. Enumeration data were expressed as case number/percentage (n/%) and analyzed using the chi-square test. $P<0.05$ was considered as statistically significant.

Table 1. Comparison of general data of patients between the two groups ($\bar{x} \pm$ sd/n)

General data	Small bone window craniotomy group (n=45)	Neuroendoscopic hematoma evacuation group (n=35)	t/χ^2	P
Age (years old)	54.35±10.23	56.23±11.23	1.242	0.560
Gender (male/female)	30/15	23/12	0.675	0.543
Site (left/right)	24/21	17/18	0.987	0.354
Intraventricular hemorrhage (IVH)	16	15	1.012	0.543
GSC scores before surgery	9.24±2.45	9.67±3.42	1.433	0.085
Duration from the onset of ICH to the time of surgery (h)	12.45±3.45	11.67±2.78	0.764	0.354
The amount of hematoma before surgery (mL)	57.67±16.78	58.61±14.35	0.908	0.187

Note: GCS: Glasgow Coma Scale; IVH: Intraventricular hemorrhage; ICH: intracerebral hemorrhage.

Table 2. Comparison of surgical indicators of patients between the two groups ($\bar{x} \pm$ sd)

	Small bone window craniotomy group (n=45)	Neuroendoscopic hematoma evacuation group (n=35)	t/χ^2	P
Operation time (min)	121.45±45.32	46.57±9.78	3.564	0.022
Blood loss during surgery (mL)	131.54±67.34	66.20±16.78	3.687	0.034
Time consumed to stop bleeding (min)	30.34±10.31	22.34±7.56	3.123	0.027

Table 3. Comparison of the GSC scores of patients between the two groups ($\bar{x} \pm$ sd)

	Small bone window craniotomy group (n=45)	Neuroendoscopic hematoma evacuation group (n=35)	t/χ^2	P
GCS scoring before surgery	9.57±2.78	9.45±2.67	1.564	0.322
GCS scoring after surgery	1.12±0.46	1.56±1.23	3.045	0.016

Note: GCS: Glasgow Coma Scale.

Results

Comparison of general data between the two groups

There were no statistical differences in the general data of patients between the two groups (all P>0.05). See **Table 1**.

Comparison of patients' conditions in the two groups during and after surgery

The operation time, blood loss, and time consumed to stop bleeding were less in the neuroendoscopic hematoma evacuation group than those in the small bone window craniotomy group (all P<0.05). See **Table 2**.

Comparison of GCS scores of patients in the two groups

The GCS scores were significantly higher in the neuroendoscopic hematoma evacuation group than those in the small bone window craniotomy group (all P<0.05). See **Table 3**.

Comparison of clinical efficacy in patients of the two groups

The clearance rate of the hematoma in patients was higher in the neuroendoscopic hematoma evacuation group than that in the small bone window craniotomy group (all P<0.05). See **Table 4**.

Comparison of the QOL of patients in the two groups

The scores of QOL of patients were significantly improved after surgery than those before surgery. The QOL of patients in the neuroendoscopic hematoma evacuation group was better than that in the small bone window craniotomy group (all P<0.05). See **Table 5**.

Comparison of complications between the two groups

Intracranial infection, pulmonary infection, and secondary bleeding were observed in 10, 20, and 6 patients of the small bone window crani-

Table 4. Comparison of hematoma clearance in patients between the two groups

	Small bone window craniotomy group (n=45)	Neuroendoscopic hematoma evacuation group (n=35)	t/χ²	P
The amount of hematoma before surgery (mL)	64.34±24.23	59.67±16.57	1.675	0.132
The amount of hematoma after surgery (mL)	13.24±5.46	11.78±3.45	3.123	0.034
Hematoma clearance rate (%)	81.23±23.45	89.11±6.16	3.242	0.023

Table 5. Comparison of the self-care ability of patients who had recovered from stroke between the two groups (point, $\overline{x}$ ± sd)

Group	Neuroendoscopic hematoma evacuation group (n=35)		Small bone window craniotomy group (n=45)	
	Before surgery	After surgery	Before surgery	After surgery
Self-care ability	15.61±2.41	33.48±5.46*	15.84±2.63	25.26±2.31*,#
Healthy notes	16.31±3.41	45.86±5.98*	16.87±3.57	38.47±3.64*,#
Self-responsibility	14.31±3.63	25.34±2.34*	14.67±3.67	15.35±2.04*,#
Self-consciousness	13.45±3.21	36.54±4.56*	13.42±3.36	23.56±4.12*,#

Note: *indicating that P<0.05 as compared with before surgery; #indicating P<0.05 as compared with the neuroendoscopic hematoma evacuation group.

Table 6. Comparison of complications and prognosis of patients between the two groups

	Small bone window craniotomy group (n=45)	Neuroendoscopic hematoma evacuation group (n=35)	t/χ²	P
Intracranial infection (yes/no)	10/45 (22.22%)	6/35 (17.14%)	3.564	0.030
Pulmonary infection (yes/no)	20/45 (44.44%)	10/35 (28.57)	3.687	0.023
Second bleeding	6/45 (13.33%)	3/35 (8.57%)	3.342	0.023
Dead	9/45 (20.00%)	3/35 (8.57%)	1.353	0.027

otomy group and 6, 10, and 3 of the neuroendoscopic hematoma evacuation group, respectively (P=0.030; P=0.023; P=0.023). The results indicated that patients who had small bone window craniotomy experienced higher infectious rates than patients who had neuroendoscopic hematoma evacuation. Nine patients in the small bone window craniotomy group and three in the neuroendoscopic hematoma evacuation group were dead (P=0.027). See **Table 6**.

Comparison of the well-being of patients in the two groups

The well-being index of patients was higher in the neuroendoscopic surgery group than that in the microsurgery group (92.50% vs. 75.00%). See **Figure 1**.

Discussion

It has been reported in many clinical studies that neuroendoscopic surgery for removing hematoma was more minimally invasive, with easier and more convenient operations, and less surgical preparations as compared with other traditional surgeries [21]. An incision shorter than 3 cm on the scalp and a bone hole less than 1.5 cm on the skull were made during the neuroendoscopic surgery. This saved time for opening and closing the skull, and provided a good surgical view shown on the endoscope. The aspirator was used for suction and for scrubbing. Several researches have been done on the treatment of hemorrhage. In a clinical trial on hypertensive ICH, after analyzing 121 patients who had neuroendoscopic surgery, it was found that the time for the surgery was 120 min in average [22]. These results were consistent with our findings, which revealed that the average time on neuroendoscopic surgery was less than that on small bone window craniotomy. It was concluded that neuroendoscopic surgery for hematoma evacuation was more efficient, less time-consuming, and presented less bleeding compared with small bone window craniotomy.

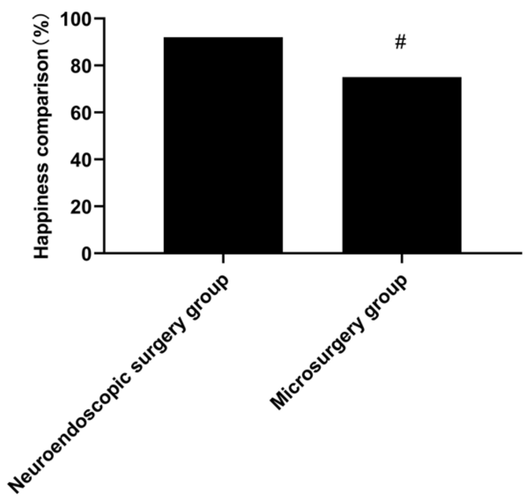

Figure 1. Comparison of the well-being of patients between the two groups. #, P<0.05.

There are many applications of neuroendoscopic surgery in clinical practices. The study by Powers et al. analyzed 58 ICH patients who had received neuroendoscopic surgery. It showed an average clearance rate of hematoma of 88.7%. This result indicated a better efficacy with neuroendoscopic surgery than with small bone window craniotomy. During the small bone window craniotomy, the light in the surgical field was insufficient due to a relatively small bone window. This resulted in a less clear surgical view and limited angle for observation [23]. In a retrospective study that included 48 patients who had undergone neuroendoscopic surgery, it was found that the average blood loss was 32 mL, which was close to 35.61 mL concluded in another similar study [23, 24]. The average blood pressure of the subjects in our study was higher than that in their study, which led to more blood loss during surgical clearance in our study. The average blood loss in patients who underwent small bone window craniotomy was 277 mL, which was conforming to our results [24].

Hematoma produced by hypertensive ICH injures the central nervous system. This causes abnormal regulations in immune and central nervous systems, leading to secondary immunodeficiency and reducing the body's immunity dramatically. Post-operative complications are likely to happen. The trauma brought by neuroendoscopic surgery is relatively small, which can largely reduce the damage to cranial nerves. The incidence of complications after neuroendoscopic hematoma evacuation was significantly lower than that after small bone window craniotomy [25].

In this study, the GCS scores were markedly higher in the neuroendoscopic hematoma evacuation group than that in the small bone window craniotomy, with less complications in patients in the neuroendoscopic hematoma evacuation group. This result indicated that neuroendoscopic hematoma evacuation is more effective for the treatment of hypertensive ICH, facilitating the recovery of patients after surgery. There are three major reasons. Neuroendoscopic hematoma evacuation causes less damage to brain tissues. Neuroendoscopic hematoma evacuation has clearer surgical views, which ensures more thorough removal of more hematoma and less incidence of complications. Neuroendoscopic hematoma evacuation has a broader and deeper surgical field, which is beneficial to directly remove the hematoma in the surgical field. With a smaller wound and clearer surgical view, normal brain tissues were less influenced by the surgery, shortening the operation time, and improving patients' prognosis significantly. Operations of neuroendoscopic hematoma evacuation were accurate enough to avoid damage to normal brain tissues, leading to less occurrence of post-operative complications [10].

Only a few samples were included in the study because of limited staff and limited funds. A larger sample size could be taken into consideration in the following studies.

In summary, neuroendoscopic hematoma evacuation has better efficacy in the treatment of hypertensive ICH as compared with small bone window craniotomy. It can improve the indications for patients and is safer than other traditional surgeries, which is worthy of being widely used in clinical settings.

Acknowledgements

This work was supported by the Science and Technology Department of Inner Mongolia Autonomous Region for the Application and Standardization of Neuroendoscopy for Intracerebral Hemorrhage in Inner Mongolia Autonomous Region (2021GG0114) and Science and Technology Department of Inner

Mongolia Autonomous Region for the Microsurgical Treatment for Hypertensive Brainstem Hemorrhage under the Guidance of Image Reconstruction Technology (2020GG0087).

Disclosure of conflict of interest

None.

Address correspondence to: Qiang Yun, Department of Neurosurgery, Inner Mongolia People's Hospital, No. 20 Zhaowuda Road, Saihan District, Hohhot 010017, Inner Mongolia Autonomous Region, China. Tel: +86-0471-6620302; E-mail: qiangyun1148@163.com

References

[1] Zhao J, Mao Q, Qian Z, Zhu J, Qu Z and Wang C. Effect of mild hypothermia on expression of inflammatory factors in surrounding tissue after minimally invasive hematoma evacuation in the treatment of hypertensive intracerebral hemorrhage. Exp Ther Med 2018; 15: 4906-4910.

[2] Maruya J, Tamura S, Hasegawa R, Saito A, Nishimaki K and Fujii Y. Endoscopic hematoma evacuation following emergent burr hole surgery for acute subdural hematoma in critical conditions: technical note. Interdiscip Neurosurg: Adv Tech Case Manage 2018; 12: 48-51.

[3] Du B, Shan AJ, Zhang YJ, Wang J, Peng KW, Zhong XL and Peng YP. The intra-neuroendoscopic technique: a new method for rapid removal of acute severe intraventricular hematoma. Neural Regen Res 2018; 13: 999-1006.

[4] Teasdale GM, Pettigrew LE, Wilson JT, Murray G and Jennett B. Analyzing outcome of treatment of severe head injury: a review and update on advancing the use of the glasgow outcome scale. J Neurotrauma 1998; 15: 587-597.

[5] Li L, Li Z, Li Y, Su R, Wang B, Gao L, Yang Y, Xu F, Zhang X, Tian Q, Zhang X, Guo Q, Chang T, Luo T and Qu Y. Surgical evacuation of spontaneous cerebellar hemorrhage: comparison of safety and efficacy of suboccipital craniotomy, stereotactic aspiration, and thrombolysis and endoscopic surgery. World Neurosurg 2018; 117: 90-98.

[6] Curtis K, Fry M, Shaban RZ and Considine J. Translating research findings to clinical nursing practice. J Clin Nurs 2017; 26: 862-872.

[7] Li W, Gao J, Wei S and Wang D. Application values of clinical nursing pathway in patients with acute cerebral hemorrhage. Exp Ther Med 2016; 11: 490-494.

[8] Hickman JL. Outcomes management for stroke patients using thrombolytics. Crit Care Nurs Clin North Am 1998; 10: 101-115.

[9] Broderick JP. Practical considerations in the early treatment of ischemic stroke. Am Fam Physician 1998; 57: 73-80.

[10] Hickmann CE, Castanares-Zapatero D, Bialais E, Dugernier J, Tordeur A, Colmant L, Wittebole X, Tirone G, Roeseler J and Laterre PF. Teamwork enables high level of early mobilization in critically ill patients. Ann Intensive Care 2016; 6: 80.

[11] Liu K, Ogura T, Takahashi K, Nakamura M, Ohtake H, Fujiduka K, Abe E, Oosaki H, Miyazaki D, Suzuki H, Nishikimi M, Lefor AK and Mato T. The safety of a novel early mobilization protocol conducted by ICU physicians: a prospective observational study. J Intensive Care 2018; 6: 10.

[12] Sibilla A, Nydahl P, Greco N, Mungo G, Ott N, Unger I, Rezek S, Gemperle S, Needham DM and Kudchadkar SR. Mobilization of mechanically ventilated patients in Switzerland. J Intensive Care Med 2020; 35: 55-62.

[13] Johnson AM, Henning AN, Morris PE, Tezanos AGV and Dupont-Versteegden EE. Timing and amount of physical therapy treatment are associated with length of stay in the cardiothoracic ICU. Sci Rep 2017; 7: 17591.

[14] Duncan PW, Bushnell CD, Rosamond WD, Jones Berkeley SB, Gesell SB, D'Agostino RB Jr, Ambrosius WT, Barton-Percival B, Bettger JP, Coleman SW, Cummings DM, Freburger JK, Halladay J, Johnson AM, Kucharska-Newton AM, Lundy-Lamm G, Lutz BJ, Mettam LH, Pastva AM, Sissine ME and Vetter B. The comprehensive post-acute stroke services (COMPASS) study: design and methods for a cluster-randomized pragmatic trial. BMC Neurol 2017; 17: 133.

[15] Lo SH, Chang AM and Chau JP. Study protocol: a randomised controlled trial of a nurse-Led community-based self-management programme for improving recovery among community-residing stroke survivors. BMC Health Serv Res 2016; 16: 387.

[16] Towfighi A, Cheng EM, Ayala-Rivera M, McCreath H, Sanossian N, Dutta T, Mehta B, Bryg R, Rao N, Song S, Razmara A, Ramirez M, Sivers-Teixeira T, Tran J, Mojarro-Huang E, Montoya A, Corrales M, Martinez B, Willis P, Macias M, Ibrahim N, Wu S, Wacksman J, Haber H, Richards A, Barry F, Hill V, Mittman B, Cunningham W, Liu H, Ganz DA, Factor D and Vickrey BG. Randomized controlled trial of a coordinated care intervention to improve risk factor control after stroke or transient ischemic attack in the safety net: secondary stroke prevention by uniting community and chronic care model teams early to end disparities (SUCCEED). BMC Neurol 2017; 17: 24.

[17] Nielsen MM, Lambertsen KL, Clausen BH, Meyer M, Bhandari DR, Larsen ST, Poulsen SS,

Spengler B, Janfelt C and Hansen HS. Mass spectrometry imaging of biomarker lipids for phagocytosis and signalling during focal cerebral ischaemia. Sci Rep 2016; 6: 39571.
[18] Wang Y, Yang F, Shi H, Yang C and Hu H. What type of transitional care effectively reduced mortality and improved adl of stroke patients? A meta-analysis. Int J Environ Res Public Health 2017; 14: e11-e12.
[19] Nickels MR, Aitken LM, Walsham J, Barnett AG and McPhail SM. Critical care cycling study (CYCLIST) trial protocol: a randomised controlled trial of usual care plus additional in-bed cycling sessions versus usual care in the critically ill. BMJ Open 2017; 7: 017393.
[20] Guerry MJ, Vanhille P, Ronco P and Debiec H. Serum anti-PLA2R antibodies may be present before clinical manifestations of membranous nephropathy. Kidney Int 2016; 89: 1399.
[21] Qin HZ, Zhang MC, Le WB, Ren Q, Chen DC, Zeng CH, Liu L, Zuo K, Xu F and Liu ZH. Combined assessment of phospholipase A2 receptor autoantibodies and glomerular deposits in membranous nephropathy. J Am Soc Nephrol 2016; 27: 3195-3203.
[22] Cai Q, Zhang H, Zhao D, Yang Z, Hu K, Wang L, Zhang W, Chen Z and Chen Q. Analysis of three surgical treatments for spontaneous supratentorial intracerebral hemorrhage. Medicine (Baltimore) 2017; 96: 8435.
[23] Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV and Tirschwell DL. 2018 guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018; 49: 46-110.
[24] Rojanasarot S. The impact of early involvement in a postdischarge support program for ostomy surgery patients on preventable healthcare utilization. J Wound Ostomy Continence Nurs 2018; 45: 43-49.
[25] Chang EL, Wefel JS, Hess KR, Allen PK, Lang FF, Kornguth DG, Arbuckle RB, Swint JM, Shiu AS, Maor MH and Meyers CA. Neurocognition in patients with brain metastases treated with radiosurgery or radiosurgery plus whole-brain irradiation: a randomised controlled trial. Lancet Oncol 2009; 10: 1037-1044.