

Chinese Stroke Association guidelines for clinical management of cerebrovascular disorders: executive summary and 2019 update on organizational stroke management

Min Lou ¹, Jing Ding,² Bo Hu ³, Yusheng Zhang,⁴ Hao Li ⁵, ZeFeng Tan,⁴ Yan Wan,³ An-Ding Xu ⁴, Chinese Stroke Association Stroke Council Guideline Writing Committee

To cite: Lou M, Ding J, Hu B, *et al.* Chinese Stroke Association guidelines for clinical management of cerebrovascular disorders: executive summary and 2019 update on organizational stroke management. *Stroke & Vascular Neurology* 2020;**5**: e000355. doi:10.1136/svn-2020-000355

Received 20 February 2020
Revised 26 April 2020
Accepted 3 May 2020
Published Online First
8 July 2020



© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Department of Neurology, The Second Affiliated Hospital of Zhejiang University, School of Medicine, Hangzhou, China

²Department of Neurology, Zhongshan Hospital Fudan University, Shanghai, China

³Department of Neurology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China

⁴Department of Neurology and Stroke Center, The First Affiliated Hospital, Jinan University, Guangzhou, China

⁵Beijing Tiantan Hospital, Capital Medical University, Beijing, China

Correspondence to

Dr An-Ding Xu; ttil@jnu.edu.cn

ABSTRACT

Aim Stroke is characterised by high morbidity, mortality and disability, which seriously affects the health and safety of the people. Stroke has become a serious public health problem in China. Organisational stroke management can significantly reduce the mortality and disability rates of patients with stroke. We provide this evidence-based guideline to present current and comprehensive recommendations for organisational stroke management.

Methods A formal literature search of MEDLINE (1 January 1997 through 30 September 2019) was performed. Data were synthesised with the use of evidence tables. Writing group members met by teleconference to discuss data-derived recommendations. The Chinese Stroke Association's Levels of Evidence grading algorithm was used to grade each recommendation.

Results Evidence-based guidelines are presented for the organisational management of patients presenting with stroke. The focus of the guideline was subdivided into prehospital first aid system of stroke, rapid diagnosis and treatment of emergency in stroke centre, organisational management of stroke unit and stroke clinic, construction of regional collaborative network among stroke centres and evaluation and continuous improvement of stroke medical quality.

Conclusions The guidelines offer an organisational stroke management model for patients with stroke which might help dramatically.

Stroke has become a serious global public health problem. To further reduce incidence rate, disability rate, mortality rate and recurrence rate of stroke and improve China's standardised prevention and treatment of cerebrovascular diseases, the Chinese Stroke Association organised a domestic expert to write the Chinese Stroke Association Guidelines for Clinical Management of Cerebrovascular Disorders. The guideline fully combines the research of Chinese scholars and the widely used clinical interventions in

China to elaborate the clinical comprehensive management of the diagnosis, treatment, prevention and rehabilitation of a series of stroke-related diseases, so as to help medical service providers make better clinical decisions, improve the quality of medical services and maximise the benefits of patients. Evidence-based medical evidence confirms that the organisational stroke management model can benefit all patients with stroke, and significantly improve the survival rate and independent living ability of patients with stroke.¹ Stroke organisational management covers prehospital first aid system of stroke, rapid diagnosis and treatment of emergency in stroke centre, organisational management of stroke unit and stroke clinic, construction of regional collaborative network among stroke centres at all levels and evaluation and continuous improvement of stroke medical quality related to the above-mentioned links. This chapter will elaborate on the above-mentioned content.

RECOMMENDED CLASSIFICATION AND EVIDENCE LEVEL OF THE GUIDELINE

This guideline adopts the recommended classification and evidence level specified in the *guidelines for the development of Stroke Society of China*. This recommended classification and evidence level are consistent with the system adopted in the latest American Heart Association and American Stroke Association (AHA/ASA) guidelines.

1. Recommended classification

- Class I: there is evidence to prove or unanimously agree that the operation or treatment given is effective.

- Class II: there are controversial evidences or opinions on the effectiveness of operation or treatment.
- IIa: some evidences or opinions support the validity.
- IIb: there is no good evidence for its effectiveness.
- Class III: operation and treatment are ineffective and harmful in some cases.

2. Level of evidence

- Level of evidence A: evidence comes from multiple randomised controlled trials (RCTs) or meta-analysis. References must be provided and quoted in the recommendations.
- Level of evidence B: evidence comes from a single RCT or non-randomised trial. References must be provided and quoted in the recommendations.
- Level of evidence C: evidence only comes from experts' opinions, case studies, etc.

CHAPTER 1: ORGANISATIONAL MANAGEMENT OF PREHOSPITAL EMERGENCY SYSTEM

'Time is brain'. The effect of stroke treatment is strongly time dependent. Prehospital emergency management is one of the key links in the life chain of stroke first aid, which plays a decisive role in the treatment and prognosis of patients with stroke. Intravenous thrombolytic therapy with recombinant tissue-type plasminogen activator (rt-PA) is one of the most effective treatments for acute ischaemic stroke (AIS). It is recommended by domestic and foreign guidelines,^{2,3} but restricted by strict time window (within 4.5 hours from onset).⁴ According to China National Stroke Registry, only 2514 (21.5%) of 11 675 patients with AIS arrived in the emergency room within 3 hours from onset, and only 284 (2.4%) received intravenous thrombolysis.⁵ In addition, the China Quality Evaluation of Stroke Care and Treatment (China QUEST) study showed that onset-to-door time of 6102 patients with stroke averaged 15 hours (ranging from 2.8 to 51.0 hours), of which 1546 cases (25.3%) and 2244 cases (36.8%) were within 3 hours and 6 hours, respectively, and exceeding 24 hours as high as 41.3%. In the end, only 1.9% of patients received intravenous thrombolysis.⁶ As showed, prehospital delays are common in patients with stroke in China, which is an important reason for the low thrombolytic therapy rate and poor clinical prognosis of patients with AIS. Highly efficient prehospital emergency management can make patients with stroke quickly and effectively identified and transferred as soon as possible to the hospital with stroke treatment capacity, which reduces prehospital delays and improves the thrombolytic treatment rate of patients with AIS, thereby significantly improving the prognosis of patients with stroke. This chapter made the recommendations of organisational management of prehospital first aid and public health education on prehospital stroke.

RECOMMENDATIONS

Organisational management of prehospital emergency system

Rapid identification of stroke before hospital

- Emergency personnel use standardised tools such as stroke 120, Cincinnati Prehospital Stroke Scale, Los Angeles Prehospital Stroke Scale or face arm speech test (FAST) scale to screen patients with stroke before hospital, so that patients with stroke can be quickly identified. (Class I, level of evidence B)
- Emergency personnel used Rapid Arterial Occlusion Evaluation, Los Angeles Motor Scale, Field Assessment Stroke Triage for Emergency Destination (FAST-ED) or Prehospital Acute Stroke Severity Scale to screen patients with stroke for large vessel occlusion before hospital. (Class II, level of evidence B)

Dispatch of emergency medical service personnel and onsite diagnosis and treatment

- Emergency medical service (EMS) dispatchers should use prehospital identification and screening tools to quickly identify suspected patients with stroke, and priority should be given to ambulances and EMS personnel. (Class I, level of evidence B)
- EMS personnel should make brief assessment and necessary emergency treatment as soon as possible for suspected patients with stroke, including determining the onset time, dealing with respiratory and circulatory problems, conducting ECG examination and vital signs monitoring, establishing intravenous channels and avoiding delays in transportation due to prehospital intervention. (Class I, level of evidence B)

Rapid transportation to hospitals with stroke treatment capacity

- In order to achieve the purpose of rapid and efficient transportation, EMS personnel should formulate a reasonable transportation plan based on the patient's condition and the ability of referral hospital to treat stroke, while following the principle of proximity. (Class I, level of evidence A)
- For suspected patients with AIS who may need intravenous thrombolysis within the onset time window, EMS personnel should transfer them to the nearest qualified primary stroke centres (PSC)/comprehensive stroke centres (CSC) in the shortest time. (Class I, level of evidence A)
- Patients suspected of large vessel occlusion (LVO)-induced AIS may need emergency thrombolysis and/or endovascular therapy within the time window (up to 24 hours of onset) and should be transported to CSC in time for endovascular therapy. (Class I, level of evidence A)
- Hub, drip-and-ship and trip-and-treat mode have their own advantages and disadvantages. When EMS personnel choose the transport mode for suspected LVO-induced patients with AIS, they should make a reasonable transport plan based on the patient's condition, onset time, local PSC/CSC distribution,

traffic condition, transport distance and patient's willingness. (Class I, level of evidence B)

Prehospital notice

- Prehospital emergency personnel should notify the receiving hospital of brief conditions of the suspected patients with stroke before they arrive, so that the receiving hospital can start the green channel of stroke ahead of time. Prehospital emergency personnel and medical staff in receiving hospitals should make the handover right. (Class I, level of evidence B)

Public health education on prehospital stroke

- Strengthen public health education on prehospital stroke, focus on identifying early symptoms of stroke, understanding the urgency of stroke treatment and calling 120 emergency phone in time. (Class I, level of evidence B)

CHAPTER 2: ORGANISATIONAL MANAGEMENT OF STROKE CENTRE

How to provide the best diagnosis and treatment services for patients with stroke, especially in rural and township areas, is still a serious challenge. High-quality planning and evaluation of patients with stroke is an essential part of acute stroke treatment, which can improve the quality of medical services and clinical outcomes. Professional treatment with evidence-based medical evidence is one of the most effective ways to reduce the mortality and disability rate after stroke. Therefore, it is necessary to build a reasonable stroke diagnosis and treatment system in qualified stroke centres according to clinical guidelines, to provide the best medical services, and actively explore the construction pattern of stroke centres that can adapt to various hospital scales.

RECOMMENDATIONS

Organisational management of stroke emergency

Main contents of stroke emergency management

Rapid collection of clinical data

- Emergency teams should rapidly identify patients with AIS and initiate thrombolytic procedures whenever possible for thrombolysis or endovascular therapy. (Class I, level of evidence A)
- Emergency teams need to start the stroke diagnosis and treatment procedures for patients who have been notified in advance; emergency nurses should notify emergency doctors to receive and start the diagnosis and treatment procedures for patients who have arrived at the hospital after triage. (Class I, level of evidence B)
- After initiating the thrombolytic or intravascular treatment process, emergency nurses need to quickly send the patient's laboratory samples, including blood routine, blood biochemistry and coagulation spectrum, which should not exceed 30min after the

patient arrives at the emergency. (Class I, level of evidence B)

- Comprehensively assess patients with cerebral haemorrhage as soon as possible, including medical history, general examinations, neurological examinations and laboratory examinations. Conditions permitting, necessary examinations should be carried out to identify the cause. (Class I, level of evidence C)
- Patients with sudden severe headache and positive meningeal irritation signs should be highly suspicious of subarachnoid haemorrhage (SAH) diagnosis. (Class I, level of evidence B)
- The aetiology and risk factors of cerebral venous sinus thrombosis (CVST) are complex and varied. It is suggested to actively find out possible causes of blood hypercoagulability and blood stasis. (Class I, level of evidence C)

Preliminary assessment and classification of stroke symptoms

- Emergency physician/thrombolytic team should inquire the patient's medical history, verify the onset time, conduct physical examination and score the patient's symptoms according to National Institutes of Health Stroke Scale (NIHSS). It is recommended that these steps be taken on the way to the imaging department. (Class I, level of evidence B)
- Suspected patients with stroke should be diagnosed by CT or MRI as soon as possible. Patients with AIS should be treated as early as possible in stroke unit. (Class I, level of evidence A)
- Sudden severe headache and positive meningeal irritation signs are highly suggestive of SAH, and patients should be triaged as soon as possible to neurosurgery. (Class I, level of evidence A)
- The possibility of CVST should be considered in clinic for unexplained headache, optic papilla oedema and increased intracranial pressure. (Class II, level of evidence)
- Once a patient is diagnosed with intracerebral haemorrhage (ICH), he or she should be immediately triaged to the stroke unit or the neurological intensive care unit. (Class II, level of evidence B)

Rapid image scanning

- In order to perform thrombolysis or endovascular therapy, cranial CT/MRI scan should be started within 25min of the patient's arrival, and the post-processing and interpretation of the image scan should be completed within 45min of the patient's arrival. (Class II, level of evidence B)
- It should be avoided to select imaging examinations which are prone to delay the process of stroke diagnosis and treatment. According to the existing evidence, CT-based imaging is the main choice. Patients should first receive non-contrast CT to exclude bleeding, and/or choose CT angiography (CTA) to assess whether blood vessels are occluded, or CT perfusion (CTP) to assess the cerebral core

infarction area and ischaemic penumbra area. It should be noted that for CTA and CTP examinations, operators and analysts need to be adequately trained and experienced. (Class I, level of evidence A)

- Conventional sequential MRI examination will prolong the door-to-needle time (DNT) of stroke diagnosis and treatment process, and it is not recommended for the time being. Considering posterior circulation ischaemic stroke, we may select MRI examination. (Class IIb, level of evidence B)
- CT or MRI should be performed as soon as possible for suspected patients with stroke. (Class I, level of evidence A)
- CT examination should be the first choice for suspected patients with SAH, and digital subtraction angiography (DSA) examination should be performed early for patients with SAH to determine whether there are aneurysms or not. (Class I, level of evidence B)
- CT/CT venography and MR/MR venography can be the first choice for patients with suspected CVST. (Class II, level of evidence C)
- CVST can be further diagnosed by DSA. (Class II, level of evidence C)

Management of emergency multidisciplinary team

Establishment of emergency multidisciplinary team

- Stroke centres should be provided with medical services by neurologists to improve the clinical outcomes of patients with stroke. Medical staff should receive continuing education. (Class I, level of evidence B)
- The establishment of acute stroke team should be established in stroke centre to shorten treatment time and improve clinical outcomes. (Class I, level of evidence A)
- Interdisciplinary teamwork is needed. Teams should meet frequently to analyse the steps of hospital process, nursing quality and patient outcomes, and to put forward suggestions for improvement and implementation. (Class IIa, level of evidence B)
- It is recommended that the whole stroke team be activated by a dedicated telephone. Emergency nurses call emergency specialists to open the green channel immediately after pre-examination, emergency specialists call thrombolytic team to start the thrombolytic process, and then the whole thrombolytic team (including imaging department, thrombolytic nurse group, etc) is called by the members of the thrombolytic team to participate in the treatment of patients. (Class IIa, level of evidence B)
- The thrombectomy team should adopt a parallel mode, which includes: (1) patients arriving at the emergency room; (2) emergency team/thrombolytic team conducting clinical evaluation and informing the thrombectomy team in advance; (3) emergency team/thrombolytic team conducting image evaluation for patients, making thrombectomy decisions,

initiating thrombectomy team and anaesthesia team; (4) emergency team/thrombolytic team delivering patients to catheter room, and at the same time, the thrombectomy group and anaesthesia group were prepared before operation; (5) puncture. (Class IIa, level of evidence B)

- The management of other types of patients with stroke (cerebral haemorrhage, SAH, CVST) should be carried out by a team of neurologists, neurosurgeons, neurointerventional departments and anaesthesiologists. (Class IIa, level of evidence B)

Improvement of teamwork procedures

- To improve the team cooperation process, we can accurately measure and track patients' time from arriving emergency to thrombolysis, from arriving emergency to puncture, from puncture to recanalisation and record the treatment rate and relevant information of patients meeting thrombolysis and/or thrombolysis indications, so as to enable the team to identify the parts needing improvement to take appropriate improvement measures. (Class IIa, level of evidence B)
- The training, simulation training and the latest procedure chart release to the new team members are helpful to maintain and improve the normal team cooperation. (Class IIa, level of evidence A)

Continuous quality improvement of emergency green channel

- Apply Toyota Production System (TPS) to improve the quality of green channel, set up TPS improvement team, and analyse the delays in the current intravenous thrombolysis process. According to its importance and difficulty, list the problems that can be improved quickly and in a short time, and formulate specific solutions accordingly. (Class IIa, level of evidence B)
- Apply PDCA (Plan, Do, Check, Action) cycle method to continuously improve the quality of green channel through four steps of cycle: Plan (making process time-consuming plan and problem); Do (implementing improvement plan); Check (checking and evaluating legacy problems) and Action (continuing implementation and execution). (Class IIa, level of evidence B)
- Apply 6-SIGMA management method to improve the quality of green channel, implementing 'Define (setting process improvement objectives); Measure (decomposing process to measure the time needed in current process); Analysis (using various statistical strategies to analyse the reasons for failure to achieve standards); Improve (problem-based adjustment to improve process); Control (continuously monitoring process, ensuring continuous improvement of green channel quality)'. Five-step cycle. (Class IIa, level of evidence B)
- Apply quality control circle, establish quality control circle within stroke team, promote circle cooperation

and discussion within circle and solve the quality problem of green channel. (Class IIa, level of evidence B)

Organisational management of stroke unit

Concept and importance of stroke unit

- ▶ Stroke units should be established as far as possible in hospitals for patients with stroke, and all patients with AIS should be treated as early as possible in stroke units. (Class I, level of evidence A)
- ▶ Emergency centres can choose to set up acute stroke units. Large general hospitals or rehabilitation centres should choose to set up comprehensive stroke units. Grass-roots hospitals and small/medium-sized rehabilitation centres should choose to set up rehabilitative stroke units. (Class I, level of evidence B)
- ▶ It is recommended that standardised stroke units be used to improve the treatment of patients. (Class I, Level of Evidence B)
- ▶ Recommend the application of comprehensive professional stroke treatment (stroke unit) combined with rehabilitation. (Class I, level of evidence A)

Construction contents of stroke unit

Establishment of stroke unit

- ▶ The medical team of the stroke unit should include doctors, rehabilitation therapists, nurses, language trainers, psychotherapists and intensive care physicians, etc. All personnel should be organically integrated to ensure the smooth operation of the stroke unit. (Class I, level of evidence B)
- ▶ Intensive speech function training is recommended for patients with speech disorders in stroke units. (Class I, level of evidence A)
- ▶ The formulation of clinical operating procedures and standards should be based on the specific conditions of the unit and follow the guidelines. (Class I, level of evidence C)
- ▶ The medical activities of stroke unit should follow the standard working schedule and have a fixed working mode. (Class I, level of evidence C)

Working mode of stroke unit

- ▶ Stroke unit can work in a variety of ways, such as stroke group meeting, multiprofessional group ward rounds, health education and building a reasonable ward structure, in order to improve the effect of medical care in an all-round way. (Class I, level of evidence C)
- ▶ A stroke unit suitable for the hospital should be established according to the situation of the hospital. (Class I, level of evidence C)

Mobile stroke unit

- ▶ Mobile stroke unit (MSU) can shorten the time from onset to treatment and improve the prognosis of patients with stroke. It may be reasonable for conditional medical institutions to have MSU. (Class IIa, level of evidence B)

Organisational management of stroke unit

- ▶ Stroke unit should be operated in a multidisciplinary cooperative way, which combines medical treatment, nursing and rehabilitation to improve the therapeutic effect. (Class I, level of evidence C)
- ▶ Personnel in the stroke unit need professional training. (Class I, level of evidence B)

Organisational management of stroke clinic

Management of stroke clinic

Composition of multidisciplinary team in stroke clinic

- ▶ It is recommended that a multidisciplinary collaborative team consisting of doctors, nurses, rehabilitation therapists and stroke liaison workers participate in the management of patients with poststroke. (Class IIa, level of evidence A)

Management scope of stroke outpatient team

- ▶ It is effective to establish a special stroke clinic to guide and manage the use of secondary prevention drugs for patients with poststroke. (Class I, level of evidence A)
- ▶ It is recommended that clinicians pay more attention to patients' compliance with secondary preventive drugs for stroke, and popularise the causes, side effects and precautions of secondary preventive drugs for stroke to patients. (Class I, level of evidence A)
- ▶ Secondary preventive interventions, including medication education, initiated in the hospital and extended to patients after discharge, are effective. (Class I, level of evidence A)
- ▶ It is reasonable to identify poststroke depression and poststroke cognitive impairment in stroke clinics. (Class IIa, level of evidence B)
- ▶ Framingham stroke risk assessment model can be used to assess stroke risk of hypertension patients in outpatient clinics. Intensive interventions for high-risk and middle-risk patients, including file-building and written management education, guidance for patients to manage blood pressure and other risk factors, and follow-up feedback, are likely to be recommended. (Class IIa, level of evidence B)
- ▶ In the outpatient clinic, it is reasonable to use multiple scales of Atrial Fibrillation Investigators, CHADS₂ (congestive heart failure, hypertension, age ≥ 75 years, diabetes, previous stroke or transient ischaemic attack), National Institute for Health and Clinical Excellence, ACC/AHA/ESC 2006 and American College of Chest Physicians to assess the risk of stroke in patients with atrial fibrillation taking warfarin. (Class IIa, level of evidence B)
- ▶ Nurse-centred outpatient service, setting up personal files for screened high-risk groups, regular telephone follow-up, regular appointments and regular stroke education for patients and their families may be considered. (Class IIb, level of evidence C)
- ▶ For patients with limb dysfunction after stroke, it is reasonable to carry out rehabilitation training in

stroke clinic and guide rehabilitation training at home after discharge. (Class IIa, level of evidence B)

- It is reasonable to use poststroke checklist to assess the cognitive, emotional and life abilities of patients with poststroke. (Class IIa, level of evidence B)

Health education for patients with stroke

- It is recommended that education for patients with stroke be strengthened. Stroke education should include risk factors, identification of stroke symptoms, initiation of emergency medical services, follow-up of physicians and guidance of drug use at discharge. (Class I, level of evidence B)
- It may be reasonable to provide personalised return visit education for patients with stroke after discharge. (Class IIb, level of evidence C)
- It may be reasonable to issue a stroke knowledge brochure at the average reading level for patients with stroke. (Class IIb, level of evidence C)
- It is reasonable to organise a multidisciplinary collaborative team consisting of doctors, nurses, physiotherapists, rehabilitation therapists and community health workers to conduct multidisciplinary integrated support education. (Class IIa, level of evidence B)

Stroke volunteer work

- It may be reasonable for volunteers to educate patients with stroke in community. (Class IIb, level of evidence B)
- Peer support for patients with stroke during hospitalisation and after discharge may be reasonable. (Class IIb, level of evidence C)

CHAPTER 3: REGIONAL COOPERATIVE NETWORK CONSTRUCTION OF STROKE CENTRE

The purpose of establishing stroke centre is to improve stroke medical staff and facilities, so as to adapt them to the methods of stroke treatment and improve the level of stroke diagnosis and treatment.⁷ The US health facility accreditation programme classifies stroke centres into three levels: CSC, PSC and stroke ready hospital. As early as 2000, BAC published a proposal to develop PSC, so as to improve the level of stroke diagnosis and treatment in the USA and improve stroke outcomes.⁸ Based on a large number of literature searches and the consultation of alliance members, the proposal requires PSC to have stroke team, stroke centre, fixed operating procedures, integrated emergency system, 24 hours CT examination and image interpretation, rapid laboratory examination and strong administrative support. Studies have shown that PSC using procedural procedures significantly improves the outcome of patients with stroke, compared with hospitals that do not use procedural procedures or have no stroke centres.⁸ In 2005, BAC launched a second proposal to define the standard of main medical types of CSC.⁹ Through evidence-based medicine, BAC has identified the following key steps: medical staff equipped with neurosurgery and neurovascular expertise; advanced

nervous system imaging capabilities, such as cerebral angiography; surgery and intravascular operation technology, including aneurysm clipping, carotid endarterectomy, intra-arterial treatment and other infrastructure, such as neurointensive care unit. These measures may improve the prognosis of patients with complex cerebrovascular disease.

Based on the basis of evidence-based medicine and the current situation of domestic medical environment, the expert committee of stroke field of the Center for Medical Quality Control of Neurological Medicine of the National Health and Family Planning Commission has initially formed a guideline for the construction of stroke centres in China in 2015 to standardise the access standards of stroke medical institutions,¹⁰ improve the quality of medical services and rationally distribute medical resources, which provided the basis for the allocation of medical resources and quality supervision of health administrative departments and reasonable and optimised treatment for patients with stroke, and improved the overall construction of stroke medical service system in China.

Pattern of development and construction for stroke centre

- We should actively promote the establishment of stroke centres at all levels, and all types of acute patients with stroke should enter the stroke centres for diagnosis and treatment. (Class I, level of evidence A)
- For large-scale ischaemic or haemorrhagic stroke, stroke with unknown aetiology, stroke requiring special examination and treatment, stroke that PSC cannot complete and stroke requiring multidisciplinary treatment, direct entry or transfer to CSC is recommended for treatment. (Class I, level of evidence A)
- Third-party stroke centre certification is strongly recommended. (Class I, level of evidence B)

Construction of regional emergency network for stroke

- Stroke centres with different treatment capabilities should establish a regional emergency network system with clear responsibilities, resource sharing and win-win cooperation. (Class II, level of evidence B)
- It is suggested that stroke education programme be implemented for EMS personnel. (Class I, level of evidence B)
- It is suggested that EMS personnel use the stroke assessment system to initiate the preliminary treatment of stroke on the spot and notify the receiving hospital of the suspected patients with stroke before arriving, so that the hospital can mobilise the corresponding resources before the arrival of the patients. (Class I, level of evidence B)
- The stroke emergency map should be jointly carried out with the 120 emergency centres, regional comprehensive stroke centres and other qualified medical institutions (stroke prevention and control centre,

etc) organised by the city health department. (Class IIa, level of evidence A)

- ▶ It is suggested that the regional comprehensive stroke centres establish special programme to train all participating institutions on how to use the stroke emergency map. The training should include relevant administrative staff and relevant staff of all institutions that carry out the stroke treatment process. (Class IIa, level of evidence B)
- ▶ To improve public stroke education, using 'stroke 1-2-0', FAST scale and other rapid stroke recognition tools can facilitate public recognition of acute stroke and therefore, early treatment. (Class IIa, level of evidence A)
- ▶ It may be reasonable to conduct periodic assessment of the performance of the participants of stroke map hospital. (Class IIb, level of evidence B)
- ▶ A network of regional stroke centres, including primary medical institutions, should be established to provide primary emergency treatment (including intravenous alteplase thrombolysis), endovascular treatment and comprehensive perioperative management and rapid transfer of patients to comprehensive stroke centres when needed. (Class I, level of evidence A)
- ▶ Patients suspected of stroke should be quickly transported to the nearest medical institution capable of rt-PA thrombolysis. When the medical institutions cannot deal with patients with stroke with complex and critical conditions, it is suggested to adopt network consultation and referral to shorten the treatment time of AIS. (Class I, level of evidence B)

Telemedicine of stroke

Importance of telemedicine

- ▶ Smart phones, tablets and other communication tools can assist neurologists to assess the severity of prehospital stroke and make reasonable clinical decisions for patients with stroke. (Class I, level of evidence A)
- ▶ Telestroke can shorten the time of intravenous thrombolysis and improve the thrombolytic rate in patients with AIS. (Class I, level of evidence A)
- ▶ Rt-PA intravenous thrombolysis may be as safe and effective as in-hospital thrombolysis in patients with AIS guided by telestroke. (Class IIb, level of evidence B)
- ▶ Telestroke can provide guidance and support for rehabilitation treatment and secondary prevention of patients with stroke. (Class IIb, level of evidence C)
- ▶ Telestroke can optimise the allocation of health resources and reduce medical costs. (Class IIb, level of evidence C)
- ▶ Under the guidance of the government and the overall planning of the national/provincial stroke quality control centre, it may be reasonable to construct a regional stroke telemedicine network. (Class IIa, level of evidence B)

Operation and management of telemedicine

- ▶ Comprehensive stroke centres should actively promote telemedicine, strengthen the integration of medical resources and form a stroke medical network covering the surrounding primary stroke centres or primary hospitals. (Class IIb, level of evidence B)

CHAPTER 4: EVALUATION AND CONTINUOUS IMPROVEMENT OF MEDICAL QUALITY OF STROKE

Medical quality is the work quality of medical preventive institutions and the standard to measure the level of medical staff. It covers the content of medical quality, and emphasises patient satisfaction, medical work efficiency, medical technology and economic effect (input-output relationship), continuity and systematic effect of medical treatment. Therefore, medical quality is a comprehensive reflection of medical technology, management methods and economic benefits.

Improvement of medical service quality in patients with stroke

- ▶ Establish a stroke registration system for quality improvement, monitor medical quality and provide reliable data for quality improvement. Ideal stroke registration should have appropriate management structure and supervision methods to ensure the normal operation of the registration work. At the same time, the follow-up system should be improved to verify whether the quality improvement is related to the prognosis of patients. In order to ensure the authenticity and standardisation of data, the Quality Improvement Commissioner should check and upload data regularly. (Class I, level of evidence B)
- ▶ Establishment of clinical pathway for stroke and written standardised operating procedures with continuous quality improvement. Organise multidisciplinary collaborative team to discuss continuous quality improvement. Analyse the current situation, find out the problems, put forward the possible solutions, put them into practice and test the feasibility of the scheme. Based on this, the standard operation process is updated to ensure its effectiveness and operability. (Class I, level of evidence B)
- ▶ Establish standardised assessment and measurement criteria for stroke medical services, namely key performance indicators. Supervisory departments should strengthen link quality control, implement the existing evidence-based medicine guidelines to the greatest extent possible and supervise whether the centres implement the standard operating procedures. Setting up standard quality management standards, eliminating regional differences in medical quality and realising standardisation of medical services. (Class IIa, level of evidence B)

Quality indicators of medical services in primary stroke centres

Mandatory quality indicators of PSC stroke diagnosis and treatment

To be strengthened and regularly controlled.

Quality indicators of medical services during acute hospitalisation

- ▶ The proportion of NIHSS score for neurological impairment: NIHSS is the most commonly used scale in the world for neurological impairment score of patients with stroke.
- ▶ The proportion of cranial CT examination within 25min and clinical laboratory diagnostic information within 45min of emergency treatment reflects the level of organisational medical care for stroke in hospitals.
- ▶ Intravenous rt-PA thrombolysis: (i) proportion of intravenous rt-PA thrombolysis within 4.5 hours of onset; (ii) proportion of patients treated with intravenous thrombolysis <60 min from emergency visit to intravenous thrombolysis (DNT); (iii) number and types of haemorrhage transformation and the proportion of intracranial haemorrhage with clinical symptoms within 36 hours.
- ▶ The proportion of patients with AIS receiving antiplatelet drugs within 48 hours of admission.
- ▶ The proportion of patients who could not walk within 48 hours of admission who took preventive measures against deep venous thrombosis.
- ▶ The proportion of swallowing function evaluation measures taken within 48 hours of admission.
- ▶ The proportion of patients receiving vascular assessment within 1 week of admission.
- ▶ The proportion of rehabilitation evaluation and implementation for patients with stroke.
- ▶ The proportion of patients with stroke transported to CSC.

Indicators of medical services at discharge

- ▶ The proportion of non-cardiogenic patients with ischaemic stroke treated with antiplatelet drugs.
- ▶ The proportion of patients with atrial fibrillation receiving anticoagulation therapy.
- ▶ The proportion of patients with low-density lipoprotein cholesterol >2.6 mmol/L receiving statins.
- ▶ The proportion of hypertension patients treated with antihypertensive therapy.
- ▶ The proportion of patients with diabetes mellitus treated with antidiabetic medication.
- ▶ The proportions of previous or current smokers receiving smoking cessation education.
- ▶ Average hospitalisation days and mortality.
- ▶ Average hospitalisation expenses and average hospitalisation drug expenses.
- ▶ Health education on risk factors and control of cerebrovascular disease, symptoms of stroke attack, medication compliance, rehabilitation treatment, etc.

Additional quality indicators for PSC stroke diagnosis and treatment

At least three of them should be met:

- ▶ The proportion of patients with atherosclerotic ischaemic stroke treated with statin during hospitalisation.
- ▶ The proportion of hypertensive patients treated with antihypertensive therapy during hospitalisation.
- ▶ The proportion of patients with stroke whose hospitalisation days are <14 days.
- ▶ It is suggested that patients should be followed up in stroke prevention clinic 3 months and 6 months after discharge to evaluate the efficacy of stroke unit and ensure that patients receive standard secondary prevention.
- ▶ Courses on stroke warning and prehospital training for hospital staff are designed to identify stroke symptoms quickly and to be admitted to stroke centres immediately.

Quality indicators of medical services in comprehensive stroke centres

Mandatory quality indicators of CSC stroke diagnosis and treatment

Establishment of clinical pathway management

- ▶ Central venous thrombolysis intervention plan compiled according to current clinical guidelines.
- ▶ Establishment of emergency-related clinical standard process.
- ▶ Standard clinical pathway and start-up process of intravascular therapy based on current guidelines.
- ▶ Standard process of preoperative and postoperative management of multidisciplinary endovascular treatment of stroke.
- ▶ Standard process of preoperative and postoperative management of multidisciplinary surgical intervention of stroke.
- ▶ Standard procedure of dealing with two or more patients with complex cerebrovascular diseases at the same time.

Quality indicators of medical services for patients with acute ischaemic stroke receiving endovascular therapy

- ▶ The average time from admission to multimode CT or multimode MRI (only one of them) in patients within 6 hours after onset of stroke.
- ▶ The proportion of patients with AIS treated with endovascular therapy.
- ▶ Average time from admission to intravascular therapy (door-to-groin) in patients with ischaemic stroke.
- ▶ The proportion of intracranial haemorrhage with clinical symptoms within 36 hours after treatment in patients undergoing endovascular therapy.

Quality indicators of medical services for diagnosis and treatment of intracranial and extracranial vessels

- ▶ The proportion of stroke or death after diagnostic cerebral angiography.

- ▶ The proportion of stroke or death within 30 days after carotid artery dissection or stenting.
- ▶ The proportion of stroke or death within 30 days after intracranial angioplasty and/or stenting for atherosclerosis.

Quality indicators of medical services for SAH and ICH

- ▶ The proportion of patients with SAH and ICH who had written records of the initial severity assessment.
- ▶ The proportion of aneurysm clipping and interventional treatment in the past year.
- ▶ The average time from admission to clipping or interventional treatment of ruptured aneurysms for patients with SAH with ruptured aneurysms within 48 hours from onset.
- ▶ The proportion of patients with SAH confirmed ruptured aneurysm treated with nimodipine within 24 hours of diagnosis and continued to discharge or 21 days after bleeding.
- ▶ Mortality rate of patients with ICH undergoing haematoma clearance.

Quality indicators of medical services for neurosurgery

- ▶ Mortality rate of patients with massive cerebral infarction undergoing decompressive craniectomy.
- ▶ The proportion of patients with ischaemic or haemorrhagic stroke undergoing ventricular drainage.
- ▶ The proportion of patients with ischaemic or haemorrhagic stroke who underwent ventricular drainage and complicated with ventriculitis.

Quality indicators of medical services for warfarin-related intracranial haemorrhage

- ▶ The average time from admission to the reversal measures of international normalised ratio in patients with warfarin-related intracranial haemorrhage.

Additional quality indicators for CSC stroke diagnosis and treatment

At least three of them should be met:

- ▶ Frequency of non-invasive vasospasm monitoring in patients with aneurysmal SAH during 3–14 days.
- ▶ The proportion of complications in patients undergoing aneurysm clipping or embolisation.
- ▶ The proportion of patients with stroke with arteriovenous malformations treated surgically or with intravascular therapy within 30 days.
- ▶ The average interval from telephone notification to CSC arrival in patients with ischaemic stroke or haemorrhagic stroke or transient ischaemic attack (TIA) who has written records of referrals from another hospital to CSC.
- ▶ The proportion of patients with ischaemic stroke, SAH, intracranial haemorrhage, TIA, intracranial and extracranial vascular stenosis enrolled in clinical trials.

Construction of information platform for stroke medical quality monitoring and continuous quality improvement

- ▶ Establish an information platform for medical quality monitoring and continuous quality improvement, strengthen the management of medical quality control, promote feedback of medical service safety and provide decision-making basis for the improvement of medical service quality in medical institutions at all levels. (Class I, level of evidence B)

Collaborators Chinese Stroke Association Stroke Council Guideline Writing Committee. *Chairmen:* Yongjun Wang, yongjunwang@ncrcnd.org.cn, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Jizong Zhao, zhaojz205@163.com / zhaojz@public.bta.net.cn, Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Beijing, China. *Vice-Chairmen:* Qiang Dong, dong_qiang@fudan.edu.cn, Department of Neurology, Huashan Hospital, Fudan University, Shanghai, China; Anding Xu, tilil@jnu.edu.cn, Department of Neurology and Stroke Center, the First Affiliated Hospital, Jinan University, Guangzhou, China. *Members of Academic Committee:* Kangning Chen, ckn_640827@126.com, Department of Neurology, The Southwest Hospital, the First Affiliated Hospital of Third Military Medical University, Chongqing, China; Junbo Ge, ge.junbo@zs-hospital.sh.cn, Shanghai Institute of Cardiovascular Diseases, Department of Cardiology, Zhongshan Hospital, Fudan University, Shanghai, China; Li Guo, guoli6@163.com, Department of Neurology, The Second Hospital of Hebei Medical University, Shijiazhuang, China; Li He, heli2003new@126.com, Department of Neurology, West China Hospital, Sichuan University, Chengdu, China; Bo Hu, hubo@hust.edu.cn, Department of Neurology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology (HUST), Wuhan, China; Yong Huo, huoyong@263.net.cn, Department of Cardiology, Peking University First Hospital, Beijing, China; Linong Ji, jiln@bjmu.edu.cn, Department of Endocrinology and Metabolism, Peking University People's Hospital, Medicine at Peking University, Beijing, China; Xunming Ji, robertjxm@hotmail.com / jixunming@vip.163.com, Department of Neurosurgery, Xuanwu Hospital, Capital University of Medicine, Beijing, China; Tielin Li, tielin2013@126.com / tielin.li@tom.com, Zhujiang Hospital of Southern Medical University, Guangzhou, China; Liping Liu, lipingsister@gmail.com, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Benyan Luo, luobenyan@zju.edu.cn, Department of Neurology, 1st Affiliated Hospital of Zhejiang University, Hangzhou, China; Zhongrong Miao, zhongrongm@163.com, Department of Interventional Neuroradiology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Xiaoyuan Niu, niuxiaoyuan1958@163.com, Department of Neurology, First Hospital of Shanxi Medical University, Taiyuan, China; Bin Peng, pengbin3@hotmail.com; Department of Neurology, Peking Union Medical College Hospital, Peking Union Medical College and Chinese Academy of Medical Sciences, Beijing, China; Dingfeng Su, dfsu@smmu.edu.cn, Department of Pharmacology, the Second Military Medical University (SMMU), Shanghai, China; Beisha Tang, bstang7398@163.com, Department of Neurology, Xiangya Hospital, Central South University, Changsha, China; Chen Wang, wangchen-tr2002@163.com, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Ning Wang, nwang900@yahoo.com, Department of Neurology and Institute of Neurology, First Affiliated Hospital of Fujian Medical University, Fuzhou, China; Shuo Wang, captain9858@vip.sina.com, Department of Neurosurgery, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Wei Wang, wwang@vip.126.com / wwang@tjh.tjmu.edu.cn, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China; Xin Wang, wang.xin@zs-hospital.sh.cn, Department of Neurology, Zhongshan Hospital, Fudan University, Shanghai, China; Yilong Wang, yilong528@aliyun.com, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Shizheng Wu, wushizheng2005@hotmail.com, Qinghai Province People's Hospital, Xining, China; Peng Xie, xiepeng@cqmu.edu.cn, Chongqing Medical University (CQMU), Chongqing, China; Yuming Xu, 13903711125@126.com / xym13903711125@126.com, Department of Neurology, the First Affiliated Hospital of Zhengzhou University, Zhengzhou, China; Yun Xu, xuyun20042001@aliyun.com, Department of Neurology, Drum Tower Hospital, Medical School of Nanjing University, Nanjing, China; Yi Yang, doctoryangyi@163.com / doctor_yangyi@hotmail.com, Department of Neurology, the First Hospital of Jilin University, Changchun, China; Jinsheng Zeng, zengjs@pub.guangzhou.gd.cn, Department of Neurology and Stroke Center, the First Affiliated Hospital of Sun Yat-Sen University, Guangdong, China; Chaodong Zhang, scdzhang@163.com, The First affiliated Hospital of China Medical University, Shenyang, China; Tong Zhang, zt61611@sohu.com, Capital Medical University School of Rehabilitation Medicine, China

Rehabilitation Research Center, Beijing, China; Zhuo Zhang, zzhao005@gmail.com, Beijing Anzhen Hospital, Capital Medical University, Beijing, China; Gang Zhao, zhaogang@fmmu.edu.cn, Department of Neurology, Xijing Hospital, The 4th Military Medical University, Xi'an, China; Xingquan Zhao, zxq@vip.163.com, Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China.

Contributors A-DX and ML designed the protocol and framework and also participated in revision. YZ drafted the section of Organizational Management of Pre-hospital Emergency System. ML drafted the sections of Organizational Management of Stroke Center and the sections of Evaluation and Continuous Improvement of Medical Quality of Stroke. BH and YW drafted the sections of Construction Contents of Stroke Unit. JD drafted the sections of Organizational Management of Stroke Clinic. YZ drafted the section of Regional Cooperative Network Construction of Stroke Center. HL and ZT reviewed all the studies' design and interpretation, and confirmed the level of evidence and classification.

Funding This research received specific funding from Chinese Stroke Association Guidelines Writing Committee.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Min Lou <http://orcid.org/0000-0002-6627-064X>

Bo Hu <http://orcid.org/0000-0003-1462-8854>

Hao Li <http://orcid.org/0000-0002-8591-4105>

An-Ding Xu <http://orcid.org/0000-0003-3154-0985>

REFERENCES

- 1 Collaboration. SUT. organised inpatient (stroke unit) care for stroke. *Cochrane Database Syst Rev* 2013;9:CD000197.
- 2 Powers WJ, Rabinstein AA, Ackerson T, *et al.* 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:e46–110.
- 3 Chinese Society of Neurology, Chinese Stroke Society. Chinese guidelines for diagnosis and treatment of acute ischemic stroke 2018. *Chin J Neurol* 2018;51:666–82.
- 4 Emberson J, Lees KR, Lyden P, *et al.* Effect of treatment delay, age, and stroke severity on the effects of intravenous thrombolysis with alteplase for acute ischaemic stroke: a meta-analysis of individual patient data from randomised trials. *Lancet* 2014;384:1929–35.
- 5 Wang W, Zhu M, Wang Y, *et al.* Outline of China cardiovascular disease report 2012. *Chinese Circulation Journal* 2013;28:408–12.
- 6 Jin H, Zhu S, Wei JW, *et al.* Factors associated with prehospital delays in the presentation of acute stroke in urban China. *Stroke* 2012;43:362–70.
- 7 León-Jiménez C, Ruiz-Sandoval JL, Chiquete E, *et al.* Hospital arrival time and functional outcome after acute ischaemic stroke: results from the premier study. *Neurologia* 2014;29:200–9.
- 8 LaBresh KA, Paul Coverdell National Acute Stroke Registry. Quality of acute stroke care improvement framework for the Paul Coverdell National acute stroke Registry: facilitating policy and system change at the hospital level. *Am J Prev Med* 2006;31:S246–50.
- 9 Adams HP, del Zoppo G, Alberts MJ, *et al.* Guidelines for the early management of adults with ischemic stroke: a guideline from the American heart Association/American stroke association stroke Council, clinical cardiology Council, cardiovascular radiology and intervention Council, and the atherosclerotic peripheral vascular disease and quality of care outcomes in research interdisciplinary working groups: the American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists. *Circulation* 2007;115:e478–534.
- 10 Lou M, Wang Y, Li Z, *et al.* Guidelines for the establishment of Chinese stroke center. *Chinese Journal of Stroke* 2015;10:499–507.