Udar Mózgu
2007, tom 9, nr 2, 52–57

ISSN 1505–6740

Acute stroke monitoring. European standards

Monitorowanie chorych w ostrym okresie udaru mózgu. Zalecenia europejskie

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Abstract

Acute stroke is one of the leading causes of morbidity and mortality worldwide. At the same time stroke has increasingly been recognised as a medical emergency like myocardial infarction or severe trauma. Acute care of stroke patients in specialised stroke units has been proven to be effective in acute ischaemic stroke. Accordingly, several neurological societies have established guidelines for the management of acute stroke. A comprehensive set of recommendations, together with an overview of established and widely used therapeutic strategies, has been published by the European Stroke Initiative (EUSI). While revascularisation therapies such as IV and IA thrombolysis emerged as the only specific treatments in acute stroke to have been demonstrated as being effective in multicentre randomised controlled trials, the general supportive care and treatment of acute complications are of equal importance, even if these procedures have not been investigated in randomised controlled trials. The present article aims to review the state-of-the-art general supportive care which is usually provided on an acute care stroke unit.
Key words: acute stroke, monitoring

Streszczenie

Udar mózgu jest drugą lub trzecią pod względem częstości przyczyną zgonów na świecie oraz wiodącą przyczyną trwałego inwalidztwa, szczególnie w krajach wysokorozwiniętych.

We wstępie pracy, dotyczącym ogólnych aspektów rozpoznawania udaru, autor przedstawił aktualne wytyczne postępowania w udarze mózgu, przede wszystkim na podstawie standardów opracowanych przez *European Stroke Initiative* (EUSI), uzupełniając je o przegląd licznych doniesień z ostatnich lat.

Autor zaprezentował współczesny stan wiedzy na temat monitorowania stanu chorego w ostrym okresie udaru mózgu, z uwzględnieniem aspektów praktycznych, między innymi wpływu poszczególnych parametrów na rokowanie i śmiertelność oraz warunków funkcjonowania oddziału udarowego. Podstawowe zadania terapeutyczne w ostrej fazie udaru to: stabilizacja ogólnego stanu chorego; ukierunkowane leczenie, na które składają się ewentualna rewaskularyzacja i neuroprotekcja; profilaktyka i leczenie powikłań, takich jak: wtórne ukrwotocznienie udaru, obrzęk mózgu, napady padaczkowe, infekcje, odleżyny, zakrzepowe zapalenie żył głębokich powikłane zatorowością płucną; wczesna rehabilitacja. W dalszej części pracy omówiono techniki diagnostyczne przydatne w ostrej fazie udaru mózgu, a następnie szczegółowo przedstawiono zasady monitorowania podstawowych funkcji życiowych, objawów neurologicznych ze szczególnym uwzględnieniem stanu świadomości, układu oddechowego, równowagi wodno-elektrolitowej, ciśnienia śródczaszkowego, funkcji układu krążenia, ciśnienia tętniczego, metabolizmu glukozy oraz termoregulacji.
Słowa kluczowe: udar mózgu, monitorowanie

Introduction

From a worldwide perspective, acute stroke is one of the leading causes of morbidity and mortality. Particularly in industrialised countries stroke ranks as either the second or the third most common cause of death and as the leading cause of long-term disability. With respect to long-term disability, stroke also carries an enormous economic burden [1, 2].

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Praca wpłynęła do Redakcji: 9 listopada 2007 r.
Zaakceptowano do druku: 19 listopada 2007 r.

Acute care of stroke patients in specialised stroke units and has been proven effective in acute ischaemic stroke [3]. A recent meta-analysis revealed an 18% reduction in relative risk of mortality, the number needed to treat (NNT) being 33, and a 6% increase in independent survivors (NNT 16), when patients were treated in a stroke unit as compared to being admitted to a general medical ward [3]. Accordingly, several neurological societies have established guidelines for the management of acute stroke [4–6]. A comprehensive set of recommendations, together with an overview of established and widely used therapeutic strategies, has been published by the European Stroke Initiative (EUSI) [7]. These recommendations can also be assessed at the EUSI webpage at http://www.

eusi-stroke.com. While revascularisation therapies such as IV and IA thrombolysis emerged as the only specific treatments in acute stroke to have been demonstrated as being effective in multicentre randomised controlled trials [8–10], general supportive care and treatment of acute complications are of equal importance, even if these procedures have not been investigated in randomised controlled trials. The present article aims to review the state-of-the-art general supportive care which is usually provided on an acute care stroke unit.

Although stroke has increasingly been recognised as a medical emergency like myocardial infarction or serious trauma, the majority of stroke patients still do not reach hospital soon enough to receive adequate therapy [11]. Several factors may contribute to the delay between the onset of symptoms and arrival at a hospital [12]. A lack of awareness by the victims or their relatives of the symptoms of stroke and resort to consultation with the primary care physician instead of immediately calling 112 to activate the emergency medical system (EMS) are obviously the most import issues which need to be addressed in public education campaigns to improve stroke management during the pre-hospital phase [13–15]. Furthermore, it has to be ensured that primary care physicians arrange priority transport and notify the receiving hospital for all patients with stroke symptoms or stroke warning signs or, if air transport is available, activate helicopter transportation promptly if there is a long distance to be travelled to the nearest in hospital providing organised acute stroke care [16–20].

Given the narrow therapeutic windows for revascularisation treatment of acute ischaemic stroke, timely evaluation and diagnosis are of the utmost importance [21]. Thus the in-hospital management of acute stroke patients should follow written guidelines and effective well co-ordinated pathways [22]. A multidisciplinary approach to patient management is usually guaranteed by specialised stroke units. In Europe different categories of stroke unit exist, including acute stroke units, rehabilitation stroke units and comprehensive stroke units, which provide both acute stroke management and stroke rehabilitation [23–27]. All categories of stroke unit are defined as hospital units with dedicated beds for stroke patients and a specialised team consisting of stroke physicians, trained nurses and rehabilitation staff, including physiotherapists, occupational therapists, speech therapists and social workers, who are all trained in stroke rehabilitation or familiar with the problems of stroke patients. Stroke units providing acute stroke care, such as those based on the German stroke unit model [24], also make immediate imaging (CT or MRI) and experience in revascularisation therapy a requirement and both are available on a 24-hours-per-day, 7-days-per-week basis, together with written guidelines and pathways for diagnostic procedures, acute treatment, monitoring to prevent complications and for secondary prevention, interventional neuroradiology, neurosurgery, cardiology and vascular surgery, an immediate start to mobilisation with prompt access to early rehabilitation, and continuing staff education [24].

Emergency treatment in the acute phase of stroke targets the following goals: 1) stabilisation of the general condition; 2) stroke-specific therapy, including recanalisation of an occluded vessel (IV or IA thrombolysis) and preventing activation of the mechanisms leading to neuronal death in the ischaemic brain; 3) prophylaxis and treatment of complications such as secondary haemorrhage, space-occupying oedema, seizures, aspiration, infections, decubital ulcers, deep venous thrombosis and subsequent pulmonary embolism; 4) early secondary prevention to avoid early stroke recurrence and 5) early rehabilitation [7].

The initial examination comprises observation of breathing, pulmonary function and any concomitant heart disease, measurement of blood pressure, heart rate and arterial oxygen saturation using infrared pulse oximetry, the drawing of blood samples for clinical chemistry, coagulation and haematology studies, targeted neurological examination, the careful taking of the medical history with the focus on risk factors for atherosclerosis, cardiac disease and contraindications for thrombolysis, and determination of body weight in case thrombolysis, for which the dosage is weight-dependent, is considered. The overall goal is not only to identify patients with possible stroke but also to exclude stroke 'mimics' (conditions with stroke-like symptoms), identify other conditions requiring immediate intervention and determine the potential aetiology of the stroke for early secondary prevention. In patients with suspected stroke cranial computer tomography (CT) is the most important diagnostic tool to distinguish between ischaemia and intracranial bleeding [28, 29]. MRI may replace CT if appropriate and includes susceptibility-weighted sequences to identify even small haemorrhages. Dynamic perfusion CT or diffusion and perfusion-weighted MRI may be helpful in assessing the risk/benefit ratio for reperfusion therapies by identifying regions of salvageable brain tissue. Furthermore, vascular imaging, such as CT-angiography, MR-angiography or ultrasonography, may provide additional information on the paten-

cy of the extracranial and intracranial arteries [30–33]. However, these imaging studies should not delay the onset of thrombolytic therapy [34, 35].

Monitoring of vital and neurological function

'General supportive care' or 'general stroke treatment' aims to stabilise a critically ill patient and to control those conditions which may adversely affect clinical outcome. Thus general supportive care constitutes the basis upon which specific therapeutic strategies may be applied [5, 7]. The monitoring of vital functions includes continuous monitoring of heart rate and oxygen saturation, while blood pressure may be monitored discontinuously using an automatic inflatable sphygmomanometer, although this should be done at least once per hour. On-line ECG monitoring is desirable in patients with a history of cardiac disease or arrhythmia and is specifically helpful in detecting intermittent atrial fibrillation. Moreover, ECG electrodes can be used for respiratory monitoring to identify abnormalities during sleep [36] or to diagnose a Cheynes-Stokes pattern, which occurs not infrequently in stroke patients [37]. Assessment of vigilance and neurological status should preferably be performed at least every 6 hours on validated standardised scales such as the NIH stroke scale [38].

Monitoring of pulmonary function and airway protection

The aim of monitoring respiratory function is to maintain sufficient tissue oxygenation and to prevent hypoxia, which could potentially worsen brain injury in the penumbra. Administration of > 2 l O_2/min is recommended if oxygen saturation (SaO_2) is below 95%. However, routine supplementation with oxygen in every patient is not supported by randomised clinical trials [39]. Patients with reduced vigilance or with bulbar or pseudobulbar paralysis have an increased risk for aspiration and airway obstruction because of reduced oropharyngeal mobility and loss of the protective reflexes. Mechanical airway protection should be considered in these patients [40].

Cardiac monitoring

Atrial fibrillation is the most frequent arrhythmia found in stroke patients. Furthermore, infarctions of the right hemisphere, specifically those involving the right insular cortex, are associated with an increased risk of cardiac complications, which can probably be explained by dysfunction of the autonomic nervous system [41, 42]. Cardiac monitoring is thus recommended for at least the first 24 hours in these patients.

Monitoring of blood pressure

Arterial blood pressure is frequently elevated in the acute phase of stroke. In many cases elevated blood pressure is a secondary response to stress, a full bladder, nausea, pain or a reaction to elevated intracranial pressure. Elevated blood pressure frequently declines spontaneously within a few hours of the patient being admitted to a quiet room, the bladder being emptied and pain relief achieved [43–45]. Lowering arterial blood pressure in the acute phase of stroke has been associated with a poor outcome for the first time in a randomised trial testing nimodipine against placebo [46–48]. Specifically, drops in either systolic or diastolic blood pressure within the first 24 hours were significantly related with early neurological deterioration, larger infarct volume and, consequently, with a poor outcome [49, 50]. Thus elevated blood pressure may be tolerated in the acute phase of ischaemic stroke without intervention, while hypotension or a drastic reduction in blood pressure should be avoided. However, physicians should be aware of acute cardiac conditions, such as cardiac failure, aortic dissection and acute coronary syndrome, which may require lowering of the blood pressure. According to the guidelines of the European Stroke Initiative (EUSI), routine blood pressure lowering is not recommended except for extremely elevated values ($>$ 220/120 mm Hg in ischaemic stroke or $>$ 180/105 mm Hg in intracerebral haemorrhage) [7]. However in patients receiving thrombolysis systolic blood pressure (SBP) $>$ 180 mm Hg should be avoided [7]. Although consensus exists about these threshold values, they are not based on data from randomised trials. Research activities aiming to clarify this issue are ongoing. If blood pressure lowering is necessary in the event of extremely elevated values, drugs, such as IV urapidil, which enable SBP levels to be titrated, should be preferred in order to avoid an abrupt drop in blood pressure. Although the point when antihypertensive medication should be restarted is uncertain, a target blood pressure of 180/100–105 mm Hg in patients with prior hypertension and 160–180/90–100 mm Hg in patients without prior hypertension should be achieved within the first days after stroke onset. Furthermore, physicians should avoid and treat hypotension by administering adequate amounts of fluid and, if required, volume expanders and catecholamines (0.1–2 mg/h epinephrine).

Monitoring glucose metabolism

A pooled analysis of 26 studies on the relationship between hyperglycaemia and stroke outcome revealed that in stroke patients with no history of diabetes even moderately elevated glucose levels were associated with a poor outcome and a three-fold increase in the risk of 30-day in-hospital mortality in comparison with lower glucose levels [51]. Accumulation of lactate and intracellular acidosis due to anaerobic glycolysis, lipid peroxidation and free radical formation are possible mechanisms that may promote neurotoxic effects in the ischaemic penumbra region [52–54]. Furthermore, hyperglycaemia may alter the blood–brain barrier, facilitating the development of brain oedema [55]. In about one third of patients with acute stroke, hyperglycaemia is seen on hospital admission [56], but this may not only reflect a history of diabetes mellitus. It is supposed that in non-diabetic patients in particular hyperglycaemia is secondary to the stress caused by the cerebrovascular event [51]. This hypothesis is further supported by the observation that hyperglycaemia is associated with more severe strokes [57], leading to a greater release of stress hormones such as cortisol or norepinephrine [51]. On the other hand, several clinical studies have reported that persistently elevated glucose levels independently predict expansion of the infarct volume, neurological worsening and a poor clinical outcome [51, 53, 58]. Although studies investigating the effect of intervention on clinical outcome are lacking, there is reasonable evidence that should prompt physicians to monitor and control persistent hyperglycaemia in the acute phase of stroke. The recommendations of the EUSI are that relating hyperglycaemia to insulin should be considered when blood glucose exceeds 10 mmol/l [7]. Moreover, since hypoglycaemia could mimic stroke symptoms, it is reasonable to correct hypoglycaemia by IV infusion of 10–20% glucose immediately [7].

Monitoring of body temperature

A significant, albeit mild, association between increased body temperature in the acute phase of stroke and poor outcome has been reported in a recent meta-analysis of six studies [59]. Furthermore, the Copenhagen Stroke Study revealed a 3.4-fold increase in the risk of one-year mortality in stroke patients with hyperthermia compared with normothermic patients [60]. Hypothermia may increase the release of potentially cytotoxic neurotransmitters such as GABA and glycine, and the production of free radicals in the ischaemic penumbra [61, 62]. Obviously, the timing of the onset of hyperthermia may play an important role. In a study by Castillo et al. [63] only hyperthermia occurring within the first 24 hours of stroke was an independent risk factor for poor outcome, while fever that appeared later than 24 hours after the onset of symptoms was not related to brain damage. Although no beneficial effect of antipyretic treatment on either febrile or afebrile acute stroke patients has yet been established, it seems reasonable to lower an acutely elevated body temperature [64–66]. EUSI recommends treating fever and its cause when the temperature reaches 37.5 °C [7]. However, no evidence exists that patients will benefit from prophylactic antibiotic treatment. In contrast, data from the ESPIAS trial suggest that prophylactic administration of IV levofloxacin could be potentially harmful [67].

Monitoring fluid and electrolyte status

A balanced fluid and electrolyte status is of great importance. It is necessary to avoid hypovolaemia and hypervolaemia, plasma volume contraction and raised haematocrit.

Monitoring intracranial pressure (ICP)

Routine invasive measurement of ICP is fortunately not necessary in the majority of patients. However, in large middle cerebral artery infarctions and in cerebellar infarctions, brain oedema may occur within the first 24 to 48 hours. Elevated ICP is therefore one of the leading causes of clinical deterioration [68]. Impairment of consciousness should prompt physicians to order additional CT scans to investigate for space-occupying brain oedema. The basic management of elevated ICP includes head elevation of up to 30°, pain relief and sedation, normothermia and osmotic agents. Further escalation includes ventilatory support and short-acting barbiturates, which may reduce ICP significantly, although their effect is only short lasting. To assess effective ICP reduction where there is barbiturate treatment invasive ICP monitoring and EEG monitoring is recommended to demonstrate the burst-suppression pattern. However, in young patients with complete middle cerebral artery infarction, standard treatment is frequently not effective in preventing transtentorial herniation and the mortality rate thus rises to 80%. In these cases decompressive surgery performed within the first two days of stroke onset and before signs of herniation are present has been demonstrated in

three randomised clinical trials as being the only effective treatment option. A pooled analysis of the DECIMAL, DESTINY and HAMLET trials revealed an absolute risk reduction of 51% for survival with a modified Rankin Score (mRS) ≤ 4, resulting in an NNT of two [68]. Mild hypothermia is still regarded as experimental. Because of severe complications during re-warming, the first results from clinical trials have been discouraging [69, 70].

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