

# Therapeutic and treatment procedures in the acute phase of stroke

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Review article

## Abstract

**Introduction:** The high mortality rate, as well as the percentage of disability resulting from stroke, constitute a significant social and socioeconomic problem. Many countries are introducing prevention programs to minimize the primary and secondary risk factors that trigger stroke. Currently, efforts are being made to raise awareness of the urgent implementation of specialist and effective treatment, and the extremely significant role of physiotherapy introduced immediately at the early stages of stroke is underlined.

**The objective of work:** To present the activities and procedures for a patient with a stroke. Discussion of the principles and goals of early post-stroke rehabilitation, including physiotherapeutic activities undertaken in the case of life-threatening and highly impeding the therapeutic process of stroke complications. The aim of the authors was also to present the current leading methods and concepts of rehabilitation used in early stroke therapy and to review modern methods used in secondary post-stroke rehabilitation.

**Materials and methods:** The article is a narrative review of topics related to therapeutic and management in the acute phase of stroke. The study includes the analysis of literature from the period 2009 to 2021. The database contained books, magazines, and articles. Browsers were used: Google Scholar and PubMed.

## Keywords

- stroke
- acute stroke
- rehabilitation

## Contribution

- A – the preparation of the research project
- B – the assembly of data for the research undertaken
- C – the conducting of statistical analysis
- D – interpretation of results
- E – manuscript preparation
- F – literature review
- G – revising the manuscript

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## Article info

### Article history

- Received: 2021-11-24
- Accepted: 2022-04-27
- Published: 2022-04-28

### Publisher

University of Applied Sciences in Tarnow  
ul. Mickiewicza 8, 33-100 Tarnow, Poland

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### Conflict of interest

None declared.

### Financing

This research did not received any grants  
from public, commercial or non-profit  
organizations.

## Introduction

Stroke is a serious disease – following heart disease, it is the second most common cause of death (according to data from the World Health Organization for 2019).<sup>1</sup> In 2013, stroke was the cause of almost 12% of all deaths worldwide, while in 2017, this rate increased to 13% (American Heart Association).<sup>2</sup> In the analysis conducted by Bejot et al.,<sup>3</sup> it was shown that more than 1 million Europeans suffer a stroke per year. Globally, this number is around 17 million people, of which 25% is a repeat incident.<sup>4</sup> The most common cause of ischemic stroke is lack of perfusion in the brain tissue due to narrowing or blockage of the arteries that supply blood to the brain. Ischemic strokes can be divided into thrombotic and embolic. In Western countries, they account for a much greater percentage of cases – 85–90%, with a 10–15% incidence of haemorrhagic stroke.<sup>4</sup> Adult survivors of stroke are likely to develop severe and/or chronic disability. Even every second patient (25–50%) experiences reduced mobility, they are often dependent and require assistance in performing everyday activities.<sup>5</sup> As a result of the common phenomenon of population aging, civilisation stressors related to the number of strokes in young and middle-aged people (currently around 31% of stroke incidents in people below the age of 65), an upward trend in stroke incidents should be expected in the future.<sup>6,7</sup>

Therefore, stroke is a global and significant social and socio-economic problem (high cost of acute stroke treatment and long-term expenditure).<sup>4</sup> It is also a major challenge in the future prevention (minimisation of pro-stroke risk factors), treatment and physiotherapy of people affected by this disease.

## Stroke – strategies for action and treatment

The redefinition of stroke introduced in 2013 by the AHA/ASA (American Heart Association / American Stroke Association) describes it as a sudden, permanent focal injury to the brain, spinal cord or retina due to vascular causes, in which clinical symptoms are visible for a min. of 24 h (except for earlier death), there is evidence of acute ischaemia in neuroimaging or there is a regression of clinical symptoms after reperfusion treatment (then, the 24 h limit is not necessary).<sup>7</sup> Transient ischemic attack (TIA) is diagnosed when clinical symptoms associated with focal brain dysfunction and/or monocular symptoms last less than 24 hours. TIA currently uses CNS neuroimaging (MRI) to exclude

or confirm the presence of ischemic foci. Due to the fact that MRI may not initially detect up to 20–30% of ischemic strokes, the term “acute cerebrovascular syndrome” is also acceptable, taking into account both the early symptoms of TIA and ultimately, the experienced stroke.<sup>4,7</sup>

Stroke is an emergency, life-threatening condition that requires an immediate response in the form of the patient’s rapid transport to a centre where s/he can be treated. The time between the detection of a stroke event and the beginning of treatment is extremely valuable and affects the patient’s later prognosis, thus, it should not exceed 60 minutes from the onset of symptoms (the so-called “golden hour of stroke”). The term “time lost is brain lost” is also common. Every quarter of an hour of reperfusion treatment started as soon as possible means a lower risk of death (5%) and a greater chance of independent activity (4%).<sup>7</sup> The need for urgent stroke treatment is made socially aware through informational posters and brochures to disseminate knowledge about the need to immediately start the so-called rescue chain. An example is the FAST test and its Polish counterpart, the UDAR test.<sup>4,8</sup>

Treatment of patient after a stroke incident is provided by stroke units or sub-units. A qualified, interdisciplinary stroke team is responsible for this and consists of: specialist doctors (in the field of neurology and internal diseases), a neurological therapist, a psychologist (neuropsychologist), a team of physiotherapists and a nursing team.<sup>7</sup> In patients eligible for reperfusion therapy, the most common treatments are intravenous thrombolysis (in stroke units) or mechanical thrombectomy (at comprehensive stroke centres – OKLUM). Currently, procedures are being implemented to improve formal co-operation between the basic stroke units / sub-units and OKLUM. The purpose of this is to promptly undertake mechanical thrombectomy in a patient with such indications.<sup>7</sup> Thrombolytic therapy is based on the use of a recombinant synthetic tissue plasminogen activator (rtPA, alteplase, better known as Actylise). In simple terms, it leads to the activation of the plasmin enzyme in the body, which enables the breakdown of fibrin – and as an outcome, a revascularisation effect is achieved. Another method of treatment is mechanical thrombectomy, i.e. endovascular restoration (removal of the blockage from the cerebral artery). This procedure is recommended for patients with obstruction of large cerebral vessels, i.e. when the clot is 8-mm in length or longer.<sup>4</sup> The effectiveness of both methods has been confirmed in research, however, these treatments are not available to all patients. Restrictions apply to the time after the onset of the first stroke symptoms. The window of opportunity for

thrombolysis is up to 4.5 hours following the stroke onset, and for thrombectomy – this totals approx. 7 hours. There are also other relative and absolute contraindications (e.g. prior application of anticoagulants).<sup>4</sup> In this case, basic antithrombotic prophylaxis and treatment with low molecular weight and unfractionated heparin are initiated. However, caution should be exercised and full heparinisation should be avoided due to the risk of bleeding-related complications.<sup>4,7</sup>

During the initial, acute phase of hospitalisation at the stroke unit, the patient is constantly monitored for basic vital functions. The dynamics of symptoms is observed (especially in patients undergoing thrombolytic therapy), and neurological assessment is performed using standardised neurological scales, e.g. the National Institute of Health Stroke Scale (NIHSS) or the Glasgow Coma Scale (GCS). A swallowing screening test is performed to rule out/confirm dysphagia.<sup>7</sup> The functional level (fitness) of the patient is also determined in relation to the condition from before the disease (and additionally, on the day of discharge from the ward). For example, the modified Rankin Scale (mRS) is used. Other frequently used functional scales include: the Barthel Index (scale), the Katz Scale, ADL (Activities of Daily Living), Functional Independence Measure (FIM) and its modified version – the Repty Functional Index.<sup>9</sup> The process of diagnosing the etiology of stroke includes, first of all, neuroimaging examination at admission (computed tomography, magnetic resonance imaging), possible control neuroimaging examination (performed in patients after thrombolysis or with significant deterioration of neurological condition), and a number of other diagnostic tests (e.g. laboratory blood tests, ultrasound examinations of the carotid, vertebral and cerebral arteries, 24-h monitoring of the heart and/or arterial pressure using the Holter method, transesophageal echocardiography, cerebrovascular angiography).<sup>7</sup> ESD (Early Supported Discharge) is a community-support early discharge programme. Discharge takes place a few to several days earlier than in standard treatment, and the patient is covered by multi-specialist rehabilitation care at home (its scope depends on the possibilities and resources of a given country). This programme applies to selected patients – with Barthel index values ranging between 10–19/20 points, the level of cognitive functions cannot be below 23/30 for the Short Mental State Examination Scale (MMSE). ESD has been shown to have concrete economic benefits and to also reduce the risk of death or severe disability.<sup>10,11</sup>

## Regulations and objectives of rehabilitation for acute stroke patients

The early stage of stroke (acute period) is the time between the onset of symptoms and the end of day 7 of disease. Then comes the late phase of the disease.<sup>7</sup> According to the Helsingborg Declaration, early rehabilitation should apply to all stroke patients “without prior selection” and the patient should be treated as if s/he were to fully regain lost movement and functional abilities.<sup>12</sup> It is recommended so-called patient mobilisation (early rehabilitation) be implemented as soon as possible. The term “mobilisation” refers to physical activity performed by the patient or staff regardless of body position.<sup>7</sup>

The objectives and goals of the initial patient rehabilitation therapy will depend on the patient's baseline clinical status and identified needs. Due to the difficulties in distinguishing treatment for the acute phase of stroke and rehabilitation, a staged rehabilitation model is proposed in some European countries:

- stage A – acute treatment period, urgent treatment of the acute phase in a stroke unit, transfer to the intensive care unit (ICU) if necessary, intensive medical supervision and nursing care;
- stage B – early neurological rehabilitation (individual rehabilitation) – a patient with deep awareness disorders, intensive diagnostics and medical therapy, nursing care (increased supervision);
- stage C – comprehensive individual rehabilitation – a patient co-operating during therapy, but requiring care (partial medical supervision and nursing activities);
- stage D – complex therapy – after completing early mobilisation, the patient is independent at the bedside, may require slight nursing assistance;
- stage E – continuation of rehabilitation (e.g. at the rehabilitation ward, professional reintegration);
- stage F – includes long-term care, activities supporting and maintaining the patient's condition (medical control at the clinic, outpatient or at home rehabilitation).<sup>4</sup>

Currently, the optimal time to begin the rehabilitation of patients after stroke has not been established. Early rehabilitation, in practice, may mean starting the patient's mobilisation even within 24 hours of stroke onset. The necessary and obligatory condition for this is to stabilise the patient's general state. At present, it

is advisable that stable patients, at the initial stage of ischemic and haemorrhagic stroke, not avoid exercising in high positions (sitting or even standing), as there is no evidence confirming potentially detrimental effects of these activities.<sup>7,10</sup> In the case of secondary ischemic stroke, cerebral oedema, haemorrhagic stroke with vascular oedema, which are characterised by increased intracranial pressure, it is recommended to position the trunk at a 30-degree angle (as this allows for the reduction of intracranial pressure). With high intracranial pressure values and with the danger of intussusception, the patient should be positioned flat on the bed. Particular care must be taken in the case of patients with severe stroke and comorbidities – activities related to the implementation of mobilisation are then considered on an individual basis. In general, it can be assumed that early mobilisation and activation of a stroke patient in bed, in the absence of contraindications, is recommended to be introduced within 24 hours, while standing exercises – assuming elevated positions in bed, can be implemented starting the second or third day.<sup>4</sup>

The success of comprehensive rehabilitation will be the minimisation of disability and the achievement of the highest quality of life for patients, including those who have survived the acute condition. Work with a patient is to be focused on damage (structural defects), with attention paid to the patient's functional activity. Close co-operation between the therapist, patient and family (caregiver) should be based on positive communication, commitment and jointly setting treatment goals and priorities. This will be of great help in achieving optimal patient self-care and independence. Checking the effects of therapy should include the measurement of structural damage and activity levels according to the international ICF (International Classification of Functioning, Disability and Health – ICF – introduced as a guideline by WHO in 2001).<sup>13</sup> Patient independence is the first priority.<sup>14,15</sup> Movement strategies (implemented or recovered) should be as safe as possible and the best in terms of cost-effectiveness regarding the activities undertaken by the patient. It should also be noted that the quality of the patient's life will always be more important than the quality of his/her movement.<sup>14</sup> When the damage is irreversible, a different motor strategy must be used as an adaptation (compensation) of a given motor activity in order to maintain the greatest functional potential. Maintaining function can be considered a success even if full recovery is not achieved. If there is no long-term progressive improvement at a given stage of rehabilitation, the patient's fitness level should be maintained as high as possible. The goals of neurological (including stroke)

physiotherapy can be more colloquially defined using the acronym RAMP: Restore, Adopt, Maintain, Prevent [Pol. PZUZ: Przywrócić, Zaadoptować, Utrzymać, Zapobiegać].<sup>13</sup>

## Complications related to acute stroke

Complications related to the acute phase of stroke significantly affect the overall treatment and rehabilitation process. If not diagnosed or left untreated, they can be life-threatening.<sup>7</sup> The risk of many of them increases proportionally along with the poor clinical condition of the patient. The age of the patient (the older the patient, the more likely they are to occur) and the coexistence of other diseases (e.g. heart failure, hypertension, diabetes) also have a great influence.<sup>16</sup>

Complications life-threatening to patients may result from the consequences of an adverse condition determined by stroke. These include: deep vein thrombophlebitis, pulmonary embolism, bronchial (aspiration) pneumonia, malnutrition, dehydration, urinary tract infections, pressure ulcers and other inflammatory conditions (e.g. sepsis).<sup>7,17</sup> The complications directly related to stroke include: haemorrhage of the brain (10–15% of patients), circulatory aberrations (e.g. arrhythmias, fluctuations in blood pressure), post-stroke epilepsy and central post-stroke pain.<sup>16</sup> Unfavourable symptoms of damage to the cerebral hemispheres, which may significantly limit early therapy, include disorders of higher mental functions, depression and decreased muscle tone (paresis).<sup>12</sup>

Immobilisation related to paresis or unconsciousness of the patient may be the cause of deep vein thrombosis (11% of patients) and pulmonary embolism (1% of patients), which often leads to death at the early stage of this disease (5–10% of patients).<sup>7</sup> It is essential to prevent these complications by mobilising the patient as soon as possible. Hospital beds with hydraulic or electric adjustment, with the possibility of positioning patients in high positions (so-called passive upright position in bed), are helpful in this. In the case of patients with amputations or bilateral paresis, it is recommended to verticalise tables.<sup>18</sup> By using pillows, rollers and pads, it is possible to properly arrange the trunk and limbs (especially those affected by paresis) in drainage positions. Additionally, the patient is turned onto the healthy and “ill” sides, as well as the back. It is recommended that, as in the case of pressure ulcer prophylaxis, the time between changes in the patient's position should not exceed 2 hours.<sup>7</sup>

These tasks are performed jointly by physiotherapeutic and nursing teams in an interdisciplinary model.<sup>12,19</sup> Vascular exercises performed by physiotherapists are introduced (passive, active-passive, active limb exercises), and adherence to the principle of prohibiting injections into the limbs affected by paresis.<sup>12</sup> Anti-coagulation stockings have not been indicated as effective in preventing deep vein thrombosis or pulmonary embolisms in post-stroke patients, and may increase the risk of skin damage.<sup>7,10</sup>

Bronchopneumonia (in 22% of patients) is often associated with undiagnosed dysphagia, which occurs in more than half of patients at the early stage of stroke. Attempts at improper oral feeding and hydration of a patient with symptoms of dysphagia cause dangerous aspiration of fluids and food to the bronchial tree.<sup>12</sup> It is estimated that acute stroke patients with neurogenic dysphagia are at a 3-fold greater risk of developing pneumonia than patients without dysphagia. In addition, dysphagia can contribute to malnutrition and dehydration.<sup>20</sup> To avoid the risk of aspiration, early diagnosis of speech and swallowing disorders (including gag screening and gag reflex tests) should be implemented and the patient's diet adjusted (oral, intravenous, via a gastric tube, percutaneous gastrostomy). Mucus secretions also need to be removed from the respiratory tract as often as possible.<sup>12</sup> Treatment of dysphagia is based on methods allowing to improve the movements of the lips, tongue, larynx, vocal folds and temporomandibular joints. This is required to rebuild motor control of swallowing.<sup>20</sup> Prevention of pulmonary complications also includes: breathing exercises (performed several times a day), lung drainage positions, mechanical tapping of the trunk, and repositioning in severely ill patients. Standard aids, such as a bottle of water and a straw, a swab, a sheet of paper, and inexpensive, disposable breathing apparatus, will be useful for patients who can exercise their active respiration.<sup>12</sup>

Urinary incontinence is the most common (40–60%) urological complication occurring during the early phase of stroke and is associated with the need to catheterise the patient. This can lead to infections of the urinary tract that are harmful to health, which significantly worsen the patient's condition (fever, generalised inflammation) and may widen the ischemic focus. Treatment of urological complications is based on pharmacotherapy, as well as improving the function of the lower urinary tract (prolonging the intervals between micturitions, complete emptying of the bladder or reduction of incontinence) and the prevention of other serious diseases of the urinary tract (e.g. nephrolithiasis, hydronephrosis, renal failure, sepsis).<sup>21</sup> Upright positioning, combined with loading the lower

limb affected by paresis, strengthens the trunk and pelvic muscles, which enables the return of sphincter functions and shortens the time of using a catheter. Catheter clamping, active and conscious exercises of the pelvic floor and abdominal prelum muscles, as well as electrostimulation, are also used.<sup>22</sup> In the research by Song et al., a significant, positive effect was shown of electroacupuncture (EA) on the improvement of bladder function and the regression of urinary incontinence.<sup>23</sup> All patients with acute stroke should have the frequency and volume of urination monitored, as well as retention of urine after micturition, and retention in the case of anuria. Catheterisation should only be applied in necessary situations (the duration of catheterisation should be minimised).<sup>10</sup>

In order to prevent pressure ulcers, it is recommended to minimise friction and pressure, provide anti-bed-sore mattresses (not too soft due to impaired perception in stroke patients), appropriate pads and diapers, as well as changing positions (turning the patient - at least every 2 hours during the day and every 4 hours at night).<sup>15</sup> The condition of the skin and the risk of pressure ulcer development should be systematically assessed (e.g. using the Braden scale).<sup>7</sup> Increased risk of pressure ulcers predominantly occurs in obese patients with uncontrolled diabetes and/or dysuria.<sup>12</sup>

Prevention and treatment of acute stroke also includes pharmacotherapy of analgesia in the case of central-neuropathic pain analgesia and nociceptive pain (e.g. iatrogenic subluxation in the shoulder joint quite often, other musculo-articular pain related to paresis and/or immobilisation of the patient).<sup>23</sup> Painful musculoskeletal complications usually result from improper care, incorrect patient positioning, or poorly conducted kinesiotherapy.<sup>12</sup>

Falls among patients at stroke units (14–25%) may result in fractures and head injuries. Preventive measures are related to the use of balance exercises, strengthening the muscle strength of the lower limbs, limiting drugs that depress the CNS, creating safe environmental conditions limiting the risk of falls.<sup>7</sup>

Disturbances of higher functions associated with damage to the cerebral hemispheres, such as unilateral (hemi) neglect syndrome, with the associated hyperactivity disorder or repulsion syndrome, hypoaesthesia, hemianopia, as well as aphasia and other cognitive disorders, can be a serious issue in implementing the patient rehabilitation programme and be a great challenge for physiotherapeutic teams, neurologopedists and neuropsychologists.<sup>18,24</sup>

Post-stroke depression during the acute and sub-acute periods of stroke affects 30–40% of patients. This percentage increases to 50% during the course of the

disease.<sup>7</sup> In research on the subject, a decrease has been confirmed in BDNF (Brain-Derived Neurotrophic Factor) levels with a simultaneous increase in the severity of depression. This reduces the chances of obtaining better brain plasticity, and thus, reduces the patient's chances of functional improvement.<sup>25</sup> Depression also doubles the risk of experiencing another stroke.<sup>16</sup> Antidepressants are indicated for all patients diagnosed with post-stroke depression.<sup>25</sup>

## Selected therapeutic methods based on brain plasticity

Currently, the views from the 1950s indicating that brain damage is permanently irreversible are being denied.<sup>26</sup> Studies and experiments on animals and humans have confirmed that motor improvement after stroke causes the restoration and reorganisation of functions in the area of the motor cortex.<sup>27,28,29</sup> The biological capacity of microstructures to repair themselves is also called the (neuro) compensatory plasticity of the brain. Due to this, it is possible to create new functional areas that can partially or completely replace the functions of damaged areas.<sup>15,27</sup>

The main and most popular methods based on brain plasticity used in early post-stroke therapy include the NDT-Bobath neurodevelopmental concept and the PNF method of proprioceptive neuromuscular facilitation.<sup>30</sup> In research, the effectiveness of their use has been confirmed.<sup>31</sup> The Bobath concept alludes to sensory stimulation, experience and learning that constantly modify the nervous system and are naturally present throughout a person's life. Facilitation techniques are used to obtain physiological movements and inhibition techniques to eliminate pathological movements.<sup>15,31</sup> The PNF method is based on complex, diagonal movement patterns of the entire body (patterns of the limbs, scapula, pelvis, head, trunk). Great emphasis is placed on proprioceptive-exteroceptive (tactile) and visual-auditory stimulation.<sup>14,31</sup> Both methods rely on the accurate diagnosis of a patient's movement disorders in terms of structure, function and activity. They allow to introduce painless therapy based on movements that are close to those natural and include everyday activities. They are aimed at achieving a specific goal, strengthening and consolidating the positive functional effects of therapy. Both the NDT Bobath and PNF methods offer work with the patient at all levels of dysfunction and are widely available (they do not have great equipment requirements (patient's hospital bed, ladders, cots, etc.)).<sup>14,15</sup>

Therapy with the use of the PUM armchair (Positioning Unweight Movement) is also worth mentioning. It allows to make a slight movement in safe conditions of appropriate positioning (dynamic stabilisation), while relieving the load. Additionally, maintaining balance in various planes engages the deep muscles of the trunk, stimulating deep feeling. It has been shown in research that modelled posture and variable movement carried out using the PUM chair improve activity of the deep muscles, allowing to assume correct posture and activity patterns.<sup>30</sup>

In the case of co-operating patients, at the early stages of stroke, mirror therapy may also be applied. This is based on activation of so-called mirror neurons. It consists in placing a mirror between the arms or legs of a patient so that the image of a healthy, moving limb reflected in the mirror gives the patient the illusion of normal movement regarding the limb affected by paresis. Due to this, the areas of the brain responsible for sensations and movement planning are stimulated. Research results emphasize its effectiveness in improving motor functions (especially in the upper limbs).<sup>32,33</sup>

In clinical trials, the effectiveness has also been confirmed of other methods based on brain plasticity. They are introduced mainly in post-hospital rehabilitation and they complement the leading therapies: NDT Bobath and PNF.<sup>31</sup> One of them is Constraint-Induced Movement Therapy (CIMT), the assumption of which is intensive use of the upper limb affected by paresis, while immobilising the healthy limb with a splint (thermosetting scale).<sup>34</sup> The methods that stimulate the brain include non-invasive: transcranial DC and transcranial magnetic, as well as invasive epidural cortical stimulation types.<sup>35</sup> Training with the use of virtual reality based on observation, feedback and repetitive activities, by generating "artificial" sensory information, may improve physical fitness in the real world.<sup>31</sup> Functional electrostimulation (FES), mainly used to stimulate the peroneal nerve by arousing (with the aid of an orthosis) functionally useful foot movements, may improve gait pattern.<sup>26</sup> Post-stroke rehabilitation is heading towards robotics – stationary lokomats, overground walking systems (Rewalk, EKSO) and active exoskeletons are being increasingly used.<sup>26</sup>

## Conclusions

In order to reduce the degree of disability and mortality rate following stroke, it is necessary to urgently implement intensive and effective treatment of patients at the initial stage of the disease. The rapid initiation of early rehabilitation in stroke patients has significant

benefits with regard to improved structure and function. It is indicated that the therapy implemented at the initial stage of the disease is more effective. The longer the time after a stroke, the greater the decrease in therapy effectiveness.<sup>30,36,37</sup> Early stroke complications significantly affect the overall treatment-therapeutic process. There is an on-going, intense search for new, effective methods that, by influencing the plasticity of the brain, would support rehabilitation following stroke.

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