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REVIEW ARTICLE

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# The clinical relevance assessment of ROSIER scale in emergency care

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**ABSTRACT**

Stroke incidence and its consequences are nowadays a common cause of death, disability and financial burden for the health system. The scale of this phenomenon is estimated to increase in further years. To ensure the best patients care, therapy should be applied in a dedicated stroke unit as soon as possible. Nevertheless, even 2 out of 3 suspected patients visit the emergency department in the first place. The probable lack of knowledge and experience from the personnel indicates up to a 60% rate of misdiagnosis resulting in delays in treatment administration and consequently a reduction of chance for survival and full recovery. The Recognition of Stroke in the Emergency Room scale has been developed to improve the emergency physicians' assessment. It evaluates the initial event history and physical examination, which translates into a score from –2 to 5 with a > 0 cut-off point anticipating a high probability of stroke. Simple construction assures easy use and evaluation quality by all emergency staff members. The scale shows satisfactory accuracy, which establishes its superiority over the basic neurological examination, Face Arm Speech Time Test (FAST), and Cincinnati Prehospital Stroke Scale (CPSS) proven in several studies. On the contrary, the application is considerably reduced in cases of hemorrhage stroke, transient ischemic attack (TIA) and posterior circulation infarct in both adult and pediatric patients. Despite those limitations, the Recognition of Stroke in the Emergency Room Scale (ROSIER) scale constitutes a valuable instrument that can improve the insufficient stroke recognition rate and following patients' prognosis.

**Key words:** ROSIER scale, stroke, instrument characteristics, validation studies, emergency medicine

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## Introduction

Stroke is a medical condition with sudden and severe onset which occurrence has become a routine in an emergency department (ED). In the 21st century, the problem of stroke has grown to epidemic size as the second most frequent cause of death and disability-adjusted life years (DALYs) and an essential reason for the deteriorated quality of life (QoL) [1–3]. The estimations for coming years suggest a sustained augmentation of incidence and prevalence but a moderate decrease in death count and DALYs [4]. In the light of those factors, stroke prevention, detection, and treatment need to be improved. The recommendations provide for patient care in dedicated stroke units due to a significant decline in mortality and hospitalization length, together with the enhanced chance for a full recovery and functional independence [5, 6]. The result of applied therapy [thrombolysis/thrombectomy or intracerebral hemorrhage (ICH) secure strategies] is strongly dependent on the period between onset and treatment administration. Consequently, the delays in transfer to the stroke ward can markedly exacerbate the prognosis [7]. To avoid this situation, appropriate screening of potential stroke patients is indispensable. It is evaluated in the first place 29–65% of patients seek help in an ED, which determines its staff on the front-line of stroke assessment [8]. For this reason, stroke recognition scales such as Face Arm Speech Time Test (FAST), Balance Eyes Face Arm Speech Time Test (BE-FAST), Cincinnati Prehospital Stroke Scale (CPSS), Los Angeles Prehospital Stroke Scale (LAPSS), Medic Prehospital Assessment for Code Stroke (Med PACS), Ontario Prehospital Stroke Screening Tool (OPSS), Melbourne Ambulance Stroke Scale (MASS), PreHospital Ambulance Stroke Test (PreHAST) and Recognition

of Stroke in the Emergency Room Scale (ROSIER) have been developed. Relying on several history details and symptoms, they standardize stroke evaluation and ameliorate its accuracy (Tab. 1) [9–17]. This review aimed at a summary of previous ROSIER scale validation studies and compare it to other commonly used scales to conclude its utility as a dedicated tool in the emergency room - the first line of stroke identification.

## Stroke as medical problem

In the group of patients affected by stroke mortality rate ranges from 13% to 35% in the first month after the event and from 30% to 62% after the first year, though the values close to the upper threshold have been noticed especially in cases of ICH [18, 19]. Among stroke victims, 26% to even 50% suffer from a prolonged disability which represents 2–3% of all disabled adults [20, 21]. Physical and cognitive limitations can contribute to the QoL worsening, which manifests itself in productivity, social roles, personality, and family relationships of more than half of the patients [2]. According to stroke outcomes providing proper inpatient and outpatient care may require initial hospitalization and readmissions, primary care visits, drugs administration, rehabilitation, and house healthcare. All of the mentioned actions generate enormous costs assessed in recent studies for about 14 478 $–27 702 $ per patient per year in countries with high and upper-middle-income [22, 23]. Data from 2019 has shown that the global average stroke incidence was 150.8 per 100 000 people, similarly

**Table 1.** The comparison of stroke recognition scales construction

| | ROSIER | FAST | BE-FAST | CPSS | LAPSS | Med PACS | OPSS | MASS | PreHAST |
|---|---|---|---|---|---|---|---|---|---|
| **Assessed factors** | **Patients' history** | | | | | | | | |
| Age > 45 years | – | – | – | – | + | – | – | + | – |
| Onset symptoms time | – | – | – | – | < 24 h | < 24 h | < 2 h | – | – |
| Symptoms have not resolved when EMS arrived | – | – | – | – | – | – | + | – | – |
| Absent loss of consciousness at onset | + | – | – | – | – | – | – | – | – |
| Absent seizure at onset | + | – | – | – | + | + | + | + | – |
| At baseline patient is not wheelchair-bound or bedridden | – | – | – | – | + | – | – | + | – |
| Glasgow Coma Scale | – | – | – | – | – | – | > 10 | – | – |
| Patient is not terminally ill or in palliative care | – | – | – | – | – | – | + | – | – |
| CTAS level ≥ 2 and/or corrected airway/breathing/circulation | – | – | – | – | – | – | + | – | – |
| Glucose level | ≥ 63 mg/dL | – | – | – | 60–400 mg/dL | 60–400 mg/dL | > 72 mg/dL | 60–400 mg/dL | – |
| | **Physical examination** | | | | | | | | |
| Facial palsy | + | + | + | + | + | + | + | + | + |
| Arm weakness | + | + | + | + | + | + | + | + | + |
| Hand grip weakness | – | – | – | – | + | – | – | + | – |
| Leg weakness | + | – | + | – | – | + | + | – | + |
| Speech difficulty | + | + | + | + | – | + | + | + | + |
| Visual impairment | + | – | + | – | – | – | – | – | + |
| Gaze preference | – | – | – | – | – | + | – | – | + |
| Pain sensation | – | – | – | – | – | – | – | – | + |
| Commands execution | – | – | – | – | – | – | – | – | + |

BE-FAST — Balance Eyes Face Arm Speech Time Test; CTAS — Canadian Triage and Acuity Scale; CPSS — Cincinnati Prehospital Stroke Scale; EMS — Emergency Medical Service; FAST — Face Arm Speech Time Test; LAPSS — Los Angeles Prehospital Stroke Scale; MASS — Melbourne Ambulance Stroke Scale; Med PACS — Medic Prehospital Assessment for Code Stroke; OPSS — Ontario Prehospital Stroke Screening Tool; PreHAST — PreHospital Ambulance Stroke Test; ROSIER — Recognition of Stroke in the Emergency Room Scale

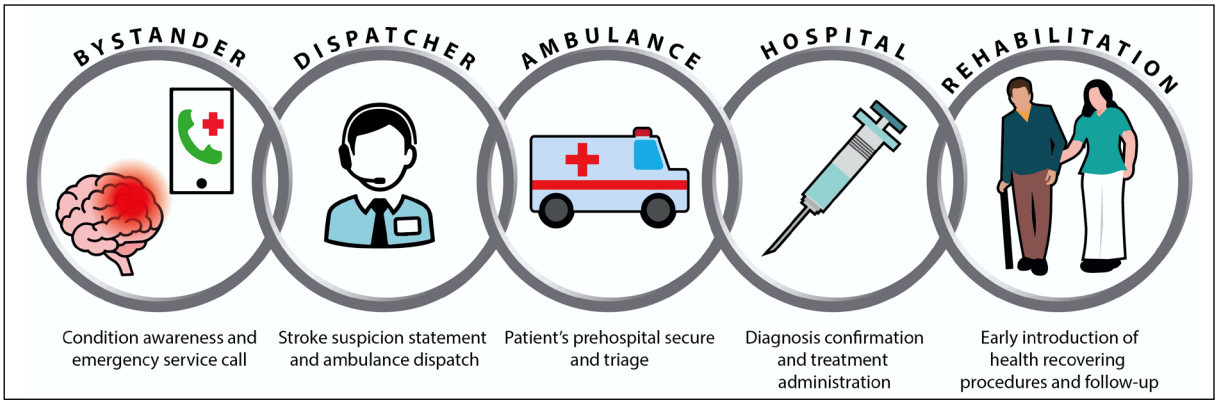


**Figure 1.** Chain of survival in stroke management based on Rudd et al. [26]

to findings from 2017. This is the effect of persistent increase in not only incidence but also prevalence, the death count, and DALYs over the last 30 years. It ought to be distinguished presented changes are accelerated by low and middle-income countries while we observe a downward trend in high-income countries [24, 25]. In order to promote knowledge and also to improve stroke care, a stroke chain of survival has been developed. The chain consists of five links. The whole concept is shown in Figure 1 [26]. Each of the key elements corresponds to the next level of care. In this chain, stroke recognition begins at the bystander stage. The role of the medical dispatcher and ambulance crew is then highlighted. However, emergency healthcare providers misdiagnose roughly 9% of people with suspected stroke, and even 60% if symptoms are transient [27, 28]. Therefore, professional medical staff should use appropriate scales to increase the accuracy of stroke detection. According to the chain principle, the strength of a chain is determined by the strength of the weakest link.

## Structure and score interpretation

ROSIER scale consists of 7 items which involve stroke event history (loss of consciousness, seizure) and clinical symptoms (facial palsy, arm weakness, leg weakness, speech difficulty, visual impairment). History factors are scored: –1 (present) or 0 (absent), whereas clinical signs are scored: +1 (present) or 0 (absent). As a consequence, the total score ranges from –2 to 5 (Fig. 2). The cut-off point has been determined as value > 0, which denotes stroke diagnosis with 92% sensitivity and 86% specificity in the instrument development phase. It is significant to measure a glucose blood level to exclude hypoglycemia as the cause of the patient's condition. The glucose concentration < 3.5 mmol/L (63 mg/dL) should firstly be normalized with the following score reassessment. This simple design facilitates scale introduction, which may be performed during a 15-minute seminary. Further training enables medical personnel to carry out a patient's evaluation with ease in about 5–10 minutes and save crucial time [15].

## Accuracy and functionality

The invention of scale has focused on obtaining a tool that will contain high sensitivity, good specificity, and usability in emergency department conditions [15]. Therefore it has had to eclipse physicians experience deficiency via accuracy improvement. The development research results are consistent with its objectives however, follow-up works suggest a discrepancy in accuracy markers (Tab. 2.) [15, 29–34]. In the view of other stroke recognition scales establishment, data from comparative studies is especially valuable in the validation process. Unfortunately, the number of researches that raises this issue is restricted. Moreover, the existing ones refer mainly to FAST and to a lesser extent CPSS, LAPSS, MASS, and MedPACS. In comparison with LAPSS, MASS, and MedPACS, ROSIER demonstrates higher sensitivity. Compared to commonly used scales — FAST and CPSS, ROSIER exhibits a better accuracy regarding adult and pediatric patients. In contrast, the reports about specificity value, the most crucial parameter, are inconclusive [30, 34–38].

On admission to ED, a medical staff, which in the first place has contact with a patient, is usually a nurse or paramedic. To shorten stroke recognition time, it has been assessed whether trained nurses are capable of performing an exact ROSIER evaluation. Compared to doctors carrying out a standard neurological examination, nurses' accuracy was greater. There have been no statistical differences in sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) between both groups using ROSIER [29, 39].

| **Assessment** | | **Symptom onset** | |
|---|---|---|---|
| Date: | | Date: | |
| Time: | | Time: | |
| **Glasgow Coma Scale** | | **Blood pressure** | ____/____ |
| Eye opening response | __/4 | **Blood glucose*** | ____ mmol/L |
| Verbal response | __/5 | | |
| Motor response | __/6 | | |

| **Patients' history** | **Present** | **Absent** |
|---|---|---|
| Loss of consciousness or syncope | -1 | 0 |
| Seizure | -1 | 0 |

| **Clinical examination** | **Present** | **Absent** |
|---|---|---|
| Facial palsy | +1 | 0 |
| Arm weakness | +1 | 0 |
| Leg weakness | +1 | 0 |
| Speech difficulty | +1 | 0 |
| Visual impairment | +1 | 0 |

**Total score[#]:** _____

**Provisional diagnosis:** Stroke

Other: _____

*If glucose level is < 3.5 mmol/L (63 mg/dL) repeat the assessment after normalization

[#]Total score is ≤ 0 indicates low possibility of stroke however it cannot be excluded

**Figure 2.** ROSIER assessment proforma based on Nor et al. [15]

**Table 2.** The comparison of sensitivity, specificity, PPV, and NPV between original and further validation studies

| Parameter | Original study | Validation studies |
|---|---|---|
| Sensitivity | 92% | 50–98% |
| Specificity | 86% | 18–96% |
| PPV | 88% | 44–97% |
| NPV | 91% | 34–91% |

NPV — negative predictive value; PPV — positive predictive value

**Table 3.** The frequency of most common among all stroke mimics

| Stroke mimic | Incidence |
|---|---|
| Seizure | 1.3–12.9% |
| Headache disorders | 4.8–9.5% |
| Circulatory diseases (including syncope) | 1.3–11% |
| Vertigo | 4.0–7.9% |
| Infections | 1.9–4.0% |

The occurrence of stroke in pediatric patients is uncommon but constitutes one of 10 the most frequent causes of death in this group [40]. The clinical manifestation of stroke in children is similar to adults, nevertheless, there is no recommended tool that would improve diagnosis making. On examination, ROSIER has shown superior sensitivity to FAST and CPSS, although each scale has reported declined accuracy than among adults [32, 41].

The description and results of reviewed ROSIER validation works are summarized in Supplementary Table 1.

## Limitations and disadvantages

The aforementioned difficulties in recognizing among emergency department personnel besides the lack of specialized knowledge, arise from a diversity of conditions that can imitate stroke. The most common stroke mimics are seizure, headache disorders (e.g. migraine), circulatory diseases (including syncope), vertigo, and infections (Tab. 3.). It is estimated that mimics may be responsible for more than 50% of stroke suspected admissions [36, 42, 43]. In comparison to stroke, the majority of its mimics are not the reason for direct threat to patients' life. Thus, a more relevant issue in diagnosing is stroke exclusion rather than confirmation. Regarding recognition instruments, it translates into focusing especially on their specificity, not sensitivity. The findings of ROSIER examining works are congruent in the matter of good sensitivity however, quality of scale specificity remains controversial [44].

The main division of stroke types distinguishes arterial ischemic stroke (AIS), hemorrhage stroke (HS), and transient ischemic attack (TIA). Although AIS is undoubtedly the most frequent one, the rest several percent of HS and TIA are significant, due to respectively high mortality and identification problems. The relatively large rate of TIA among false negatives in all TIA cases and the above twofold decrease in HS recognition sensitivity when compared to AIS suggest a restricted use of ROSIER in their assessment [32, 38]. Based on Oxford Community Stroke Project Categories, AIS can be additionally divided into four subtypes: total anterior circulation infarcts (TACI), partial anterior circulation infarcts (PACI), lacunar infarcts (LACI), and posterior circulation infarcts (POCI). Among them, POCI is characterized by the highest incidence of misdiagnosis. Their occurrence accounts for 4% to almost 18% of stroke cases however, even up to 50% of POCI may be undetected [29, 30, 39]. Presumably, it arises from POCI distinctive manifestations such as visual impairment, vertigo, ataxia, nystagmus, headache, nausea, and vomiting of which only the first one is included in ROSIER examination. The described trends in HS and POCI are observed in both adult and pediatric patients [15, 41].

The general symptomatology of stroke is similar regardless of age. On the other hand, it is worth mentioning seizure that predominantly imitates stroke in adults can accompany childhood stroke in 29% [41, 45]. The seizure presentation in ROSIER (scored as –1) constitutes a negative predictive factor for stroke. For this reason, there is a considerably raised probability of recognition failure in the children group.

## Prehospital care

Current data do not clearly indicate which scale should be used in pre-hospital care [46]. The problem of the high rate of missed diagnoses made by paramedics in pre-hospital care is, in our opinion, very complex. Patients with fresh consciousness or balance disorders may constitute the biggest diagnostic problem. From the perspective of pre-hospital care, it seems to be safer for the patient to be treated as a potential stroke victim until it is ruled out in hospital settings. Unfortunately, we could not find any paper describing this problem in the Polish health care system.

It is also noticeable that there is a large divergence in the assessed parameters cited in the study results. In our opinion, it may be related to the fact that studies were performed in various centers. The training of physicians and paramedics differs considerably between countries. However, stroke is undoubtedly a problem that should be managed by every physician and paramedic around the world.

Koivulahti [47] found that agreement between the paramedics' preliminary diagnosis *vs.* hospital diagnosis was 70%. Misdiagnosed patients mostly suffered from mental diseases, intoxication, cerebral strokes, infections, complex migraine, Bell's palsy, hypertensive emergency, syncope [48, 49]. Brunton [49] confirmed these reasons and pointed out, that also patient presenting agitation, previous post-stroke weakness, or dementia are challenging for paramedics.

The results of their research are a very valuable source of knowledge. It helps to identify groups of patients with problems that are a particularly cause for potential error. It is therefore a useful consideration in both pre-graduate and post-graduate education.

## Conclusions

ROSIER scale provides valuable support for stroke evaluation in the prehospital and in-hospital environment. The simplicity of learning and use improves the

assessment and consequently allows to avoid delays in treatment administration. The high sensitivity has been confirmed when performed by ED physicians, nurses, and paramedics, which enables its extensive application. In our opinion, ROSIER implementation in clinical practice at this stage of knowledge will raise the efficiency of stroke patients' care. Nevertheless, further evidence is still necessary to establish the advantages and specify the constraints.

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