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Swiss guidelines for the prehospital phase in suspected acute stroke

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Abstract

Acute stroke treatment has advanced substantially over the last years. Important milestones constitute intravenous thrombolysis, endovascular therapy (EVT), and treatment of stroke patients in dedicated units (stroke units). At present in Switzerland there are 13 certified stroke units and 10 certified EVT-capable stroke centers. Emerging challenges for the prehospital pathways are that (i) acute stroke treatment remains very time sensitive, (ii) the time window for acute stroke treatment has opened up to 24 h in selected cases, and (iii) EVT is only available in stroke centers. The goal of the current guideline is to standardize the prehospital phase of patients with acute stroke for them to receive the optimal treatment without unnecessary delays. Different prehospital models exist. For patients with large vessel occlusion (LVO), the Drip and Ship model is the most commonly used in Switzerland. This model is challenged by the Mothership model where stroke patients with suspected LVO are directly transferred to the stroke center. This latter model is only effective if there is an accurate triage by paramedics, hence the patient may benefit from the right treatment in the right place, without loss of time. Although the Cincinnati Prehospital Stroke Scale is a well-established scale to detect acute stroke in the prehospital setting, it neglects nonmotor symptoms like visual impairment or severe vertigo. Therefore we suggest

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"acute occurrence of a focal neurological deficit" as the trigger to enter the acute stroke pathway. For the triage whether a patient has a LVO (yes/no), there are a number of scores published. Accuracy of these scores is borderline. Nevertheless, applying the Rapid Arterial Occlusion Evaluation score or a comparable score to recognize patients with LVO may help to speed up and triage prehospital pathways. Ultimately, the decision of which model to use in which stroke network will depend on local (e.g. geographical) characteristics.

Keywords
Stroke, prehospital, guidelines, Swiss, large vessel occlusion

Introduction and methodology

Randomized controlled studies of the last two decades have proven the impressive benefit of acute stroke therapy. This is true for both treatment in a stroke unit[1] and for revascularization procedures such as intravenous thrombolysis (IVT) and endovascular therapy (EVT) of proximal vessel occlusion (large vessel occlusion (LVO)).[2–6]

Actually, 70–80% of patients with acute ischemic stroke do not have LVO and are ideal candidates for IVT in the setting of a stroke unit or center. In contrast, the remaining 20–30% of patients with LVO benefit from additional or isolated EVT in a stroke center setting. In the latter category, triage in a non-center hospital can delay the time to open the occluded vessel by up to 100 min.[7,8] Most of the time is lost in the first care hospital for diagnostics and possibly IVT before transfer to the stroke center. For patients without LVO, however, the longer transport to a distant stroke center instead of a nearby stroke unit could delay systemic thrombolysis. Accordingly, both under- and over-triage to a stroke center may be associated with worse outcome.

This knowledge indicates that the emergency medical service plays a crucial role in the appropriate triage of stroke patients. On the one hand, transfer of all stroke patients to a stroke center should be avoided. On the other hand, under-triage to a stroke center of patients with potential indication for EVT should be minimized.

An additional challenge in the prehospital phase is patients with unknown symptom onset, including strokes occurring during sleep ("wake-up stroke" and "siesta stroke"). With advanced imaging available in all stroke units and stroke centers, some of the patients can go on to benefit from IVT up to about 9 h after symptoms onset or last proof of good health (LPGH).[9,10] For EVT in the context of LVO, the time window may be extended to at least 24 h after symptoms onset/LPGH.[11,12]

The multidisciplinary working group for "Prehospital phase of stroke" of the Swiss Stroke Society prepared the present recommendations for the prehospital phase of stroke based on the current literature and Swiss conditions. The Swiss Society for Emergency and Rescue Medicine, the Swiss Neurological Society, the Swiss Association of Paramedics, and the Inter Association of Rescue Services coauthored and approved the recommendations. The overall aim is to organize clearly the prehospital phase for stroke in Switzerland so that (i) the vast majority ($\sim$90%) of patients with an acute stroke are treated at a stroke unit/stroke center and (ii) transport to a stroke unit or stroke center happens without unnecessary time delays.

144 emergency calls center: Does the patient have a possible acute stroke?

When the emergency services first come into contact with the patient, the fundamental questions they need to resolve are, does the patient have a stroke at all and if yes, how acute is it. This should first be attempted by the 144 emergency calls center and then again by the paramedics on-site.

The 144 emergency call centers in all regions of Switzerland should have a standard checklist, which they can use to determine the level of emergency by checking a list of predefined stroke symptoms (or special signs). An example of such a checklist is shown in Table 1.

Triage 1 on-site: Does the patient have an acute stroke or not?

At first contact with the patient, the paramedics (on-site) should decide quickly if the patient has a stroke or not. At this stage triage with a high sensitivity is important and the Cincinnati Prehospital Stroke Scale (CPSS), for example, is well suited for this purpose. However, this scale only measures motor skills and speech.

We propose for triage 1 therefore, scoring the "acute occurrence of a focal neurological deficit." In addition to motor function and speech, we also include acute severe dizziness and acute visual impairment.

Table 1. Checklist for emergency call centers (144) to determine the operational level "with special signal."[a]

Symptom onset or Last Seen Well Time < = 24 h	Yes/no
At least one of the following acute neurological deficit(s)	
Paralysis of the face and/or arm and/or leg (usually unilateral)	Yes/no
Speech disorder	Yes/no
Visual impairment (loss of vision on one or both sides, double vision)	Yes/no
Acute severe dizziness with inability to walk	Yes/no

[a]In cases of complete recovery of symptoms and suspicion of a transient ischemic attack, the patient is immediately taken to the nearest stroke unit or stroke center. A special signal is not mandatory.

The emergency service staff should try to discover when the acute neurological deficit started. If the time of onset of symptoms is unclear, it should be taken as the time of last indication of a normal state of health ("Last Seen Well Time"). If the symptoms occurred in sleep, this is considered "acute."

Recommendations for triage 1

- A patient with an acute focal neurological deficit, that is, with symptom onset within the last 24 h or on waking, should be taken to a hospital with a stroke unit or stroke center as soon as possible (with special signal). These capable hospital facilities have neurovascular multimodal imaging (vessel/mismatch) and IVT offered 24 h/7 days.
- Nearby hospitals without these infrastructures should be bypassed unless cardiorespiratory instability prevents further travel.
- In cases of complete disappearance of all symptoms and clinical signs (transient ischemic attack) or in cases of a clear preexisting severe disability, transport to a stroke unit/stroke center can go ahead in the absence of a special signal.
- Difficult situations for triage decisions for the emergency service can be discussed with stroke specialists at the stroke center (SC)/stoke unit (SU).

Triage 2 on-site: Does the patient have a LVO?

In principle, the more severe the stroke, the more likely is an LVO. Since the paramedics usually treat a stroke patient without medical supervision on scene, a paramedic must be able to carry out triage 2 reliably and quickly. The prehospital LVO triage tool should have sufficient sensitivity/specificity to keep the number of false triages as low as possible. Several scores are under development to determine LVO yes/no as accurately as possible in the prehospital phase. The progress and performance of these scores are discussed in the Online Appendix 1. Although evidence is still lacking concerning triage benefit and the "best" triage score, this working group favors triage using the Rapid Arterial Occlusion Evaluation (RACE) score because of its good discriminatory power and its validation by paramedics already in the prehospital setting.[13–16] Other tests such as gaze-face-arm-speech-time (G-FAST) may also be used as they are faster and easier, but their discriminatory power seems less good (see Online Annex 1). Of note, it has been described that thrombectomy is also effective for LVO patients with low symptomatology (National Institutes of Health Stroke Scale (NIHSS) $\leq$ 5) (odds ratio [OR] for 90-day modified Ranking Scale [mRS] 0–2 for all patients: 2.35 versus for patients with low symptomatology: 4.37).[4,17]

If an LVO is likely based on the chosen score, there are different prehospital concepts which will briefly be discussed below.

Drip and Ship concept

A patient with a suspected stroke would be taken to the nearest stroke unit by ambulance if it were closer than the stroke center. If LVO is diagnosed in the unit by imaging (computed tomography [CT]/MRI), the patient is immediately transferred to the nearest stroke center (by ground or air) with ongoing systemic thrombolysis. The stroke center would be alerted, the images transmitted electronically, and the patient transferred directly on arrival to the angio-suite without repeating the diagnosis, provided there is no clinical worsening.

Advantages of this concept are:

- Short time to systemic thrombolysis (onset-to-needle) with possible revascularization by IVT alone.
- A higher thrombolysis rate.
- Triage LVO versus no LVO very good as based on imaging.

The disadvantages:

- The potential loss of time (onset-to-groin puncture) in patients with LVO due to the detour via a stroke unit and organization of further transport.

The following critical time variables should be met:

- The time from entry into the first stroke unit to further transport (door-in-to-door-out (DIDO) time) must be kept as short as possible (target: door-to-needle: 30 min, turnaround 20 min = DIDO target < 50 min; max 60 min).
- In addition, appropriate organization of the stroke center is necessary to keep the "door-to-groin-puncture time" as low as possible (target: 30 min; max. 60 min).[18]

Mothership concept

The core of this concept is that the emergency service drives (or flies) the patient directly to a stroke center if LVO is suspected, even if there is a stroke unit nearby. In the stroke center, the patient is usually thrombolysed after diagnosis and then transferred to the angio-suite for EVT.

Advantage of this concept:

- The likely time saving of onset-to-groin-puncture time compared to patients who are first screened and (if necessary) thrombolysed in a stroke unit.

The disadvantage:

- The possible time delay of systemic thrombolysis.

The data regarding the abovementioned concepts are still insufficient: Two nonrandomized prospective studies

Table 2. Advantages/disadvantages of different prehospital models.

	Advantages	Disadvantages
Drip and Ship	– Prompt IVT – Better patient selection – Higher thrombolysis rate – Prompt acute treatment of cerebral hemorrhages	– Delay to reperfusion in LVO
Mothership	– Earlier start with EVT – Shorter time to recanalization – Higher percentage of patients treated with EVT	– Delay or miss systemic thrombolysis – If the EVT is not successful, no, or delayed IVT
Drip and Drive	– Rapid start to EVT	– Need to keep personnel resource available on-site – Quality of treatment—aftercare – Neuroradiologist missing in the center
Mobile thrombolysis	– On-site diagnostics and therapy – Fastest onset-to-treatment time	– Given the density of SCs and SUs in Switzerland, it makes little sense

IVT: intravenous thrombolysis; EVT: endovascular therapy; SU: stroke unit, SC: stroke center.

showed worse functional outcome for Drip and Ship compared to the Mothership concept.[19,20] On the other hand, two retrospective studies did not find a difference in clinical outcome between the two prehospital concepts.[21,22] A randomized study comparing the Drip and Ship with the Mothership concept for suspected LVO strokes occurring remotely from and endovascular center showed similar 3 months functional outcomes in both arms.[23]

Drip and Drive concept

In this concept, a stroke patient living closer to a stroke unit than to a stroke center is examined in the former for LVO. If there is an indication for EVT, a neuroradiologist drives from a stroke center to the stroke unit to perform EVT there rather than transporting the patient.

Advantage of this concept:

– A small study measured average time intervals and saw that the time to recanalization was about 2 h shorter than the above Drip and Ship concept.[7]

Disadvantage:

– The data regarding this concept are not yet convincing and depend strongly on the local situation.
– The major problems of the Drip and Drive concept are the human resources certainly as well as the availability of trained personnel on-site.

At present, we consider this solution of little use in Switzerland. Nevertheless, this study does indicate that the Drip and Ship concept results in significant time loss.

Mobile thrombolysis on-site

Here, an ambulance incorporating acute imaging (CT) and IVT procedure drives to the patient with a suspected stroke.

Advantage:

This allows rapid IVT to be performed on-site if necessary, screening the patient for LVO and direct transport to a stroke center.[24]

Disadvantage:

This concept requires significant investments in money and human resources, and seems to be particularly useful for densely populated areas with about a million persons or more.

The authors agree that mobile thrombolysis is of unlikely benefit for Switzerland because of relatively small cities and the high density of stroke units and stroke centers and the geographical conditions.

Recommendations for triage 2: Does the patient have a LVO?

A precise statement on whether Drip and Ship or Mothership should be favored is not possible at present. Preliminary results of a large randomized study in Catalonia indicate that both models lead to similar clinical outcomes within a well-organized stroke care system.[23] Some studies have used models to calculate which concept should be favored over another and when.[18,25] The results depend highly on the distance between the event location, stroke unit, and stroke center but also on the capabilities of the particular stroke unit and stroke center. In principle, the current data allow us to make the following assertions (see Table 2):

– Patients should be transferred directly to the stroke center if the distance from the event to the stroke center is <20 min.
– If the distance to a stroke unit is shorter than to the stroke center, the Drip and Ship concept would make sense with a transport time of >20 min between the two institutions.

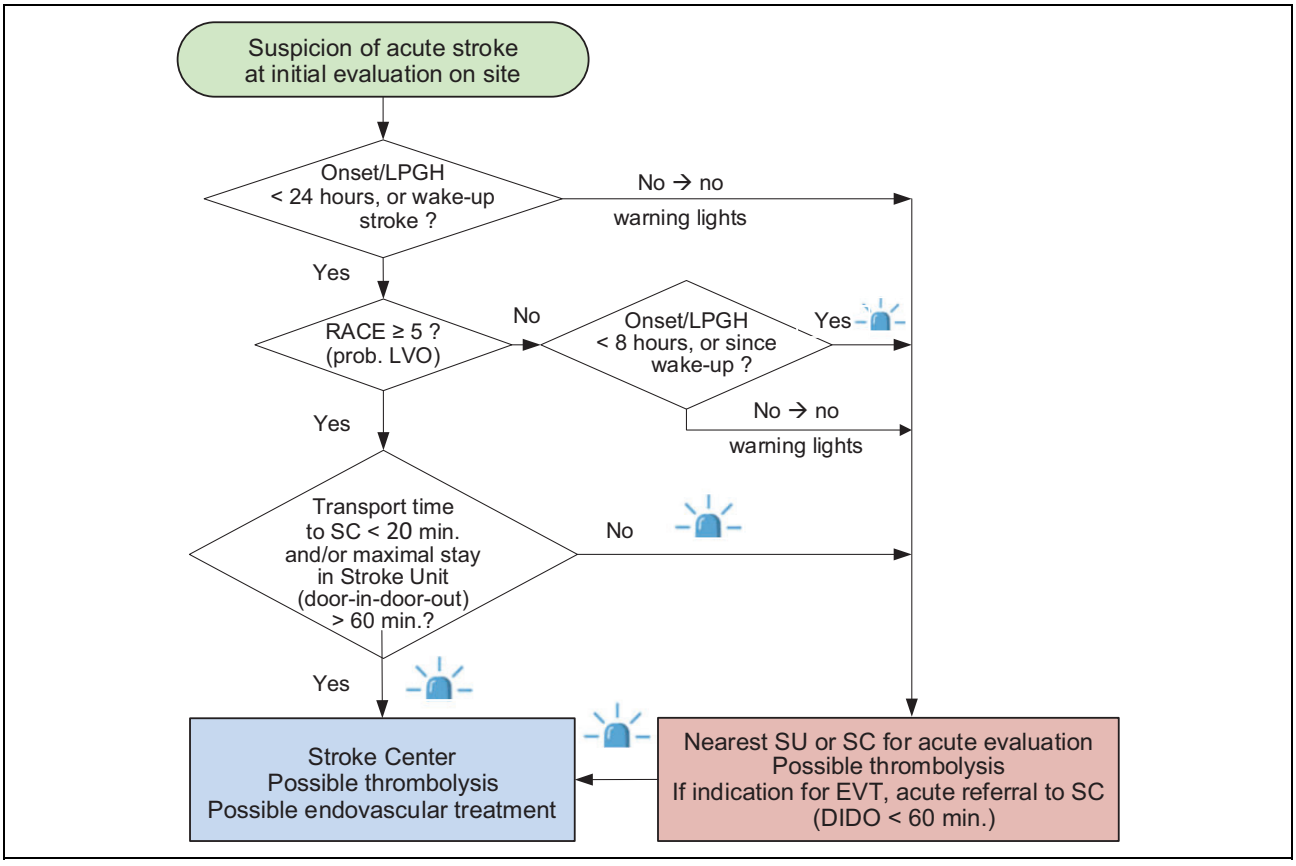

Figure 1. Prehospital patient flow in cases of suspected stroke at initial on-site evaluation, including triage for LVO. LPGH: last proof of good health; RACE: Rapid Arterial Occlusion Evaluation or comparable score; LVO: large vessel occlusion; SU: stroke unit; SC: stroke center; DIDO = door-in-to-door-out time.

– Avoid driving away for more than 10 min from the stroke center toward a stroke unit, as this route would have to be taken again to the stroke center if needed (Figure 1).

With the Drip and Ship concept

– Critical time intervals should be measured and analyzed: DIDO time of the stroke unit: target <50 min; max. 60 min.
– The incoming emergency team should remain on-site until referral (or not) to an SC.
– Imaging should not be repeated at the SC, except in exceptional and justified cases.
– In the SC, the goal is to achieve a "door-to-groin-puncture time" of 30 min (max. 60 min).

Mothership concept

– Door-to-groin puncture of 60 min (max. 90 min) can be achieved.

In the event that there is no prehospital triage for LVO, the Drip and Ship concept critical time-criteria apply (Figure 2).

Prehospital concepts for specific time windows

If an acute neurological deficit occurs within 24 h, the patient must be triaged for transport to the stroke unit or stroke center. A fast and problem-oriented workup with targeted medication or interventional secondary prophylaxis in a stroke unit/stroke center reduces the probability of long-term disability even without acute revascularization treatment.[1]

Time window <8 h after symptom onset/LPGH or since waking up (wake-up stroke)

In this situation, the nearest thrombolysis-capable facility (stroke unit or stroke center) should be reached with special signal.

If the LVO score is positive (e.g. RACE $\geq$ 5), the above recommendations for triage 2 should be consulted for choosing a stroke unit or stroke center.

Time window 8–24 h after symptom onset/LPGH or since waking up (wake-up stroke)

If the LVO score is positive (e.g. RACE $\geq$ 5), patients in this time window should be taken to the nearest stroke

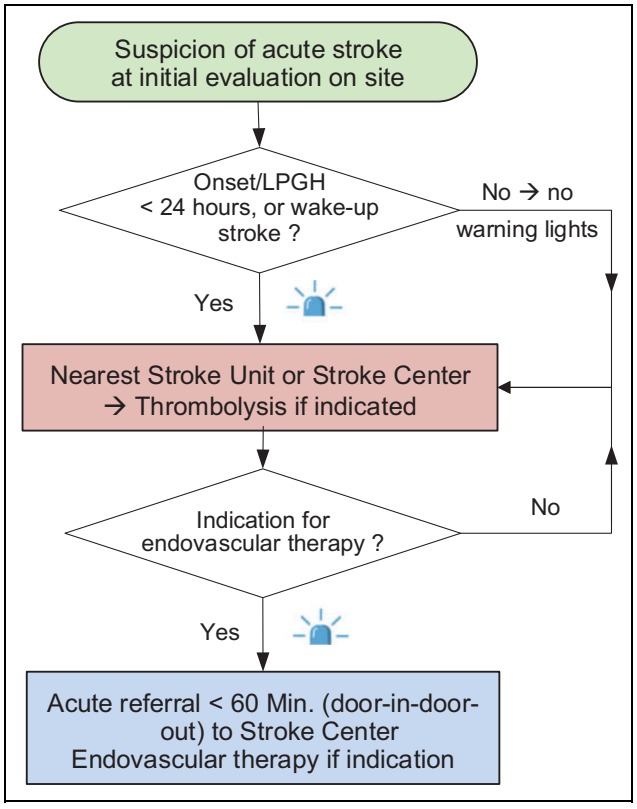

Figure 2. Prehospital patient flow in cases of suspected stroke at initial on-site evaluation, without triage for LVO. LVO: large vessel occlusion; LPGH: last proof of good health; SU: stroke unit; SC: stroke center.

center ("Mothership") with special signal. If the LVO score is low (e.g. RACE < 5), patients are transported without special signal to the nearest stroke unit or center for clarification and treatment.

If there is no triage for LVO, transfer should be performed with special signal to the nearest stroke unit/stroke center. The time indications for onwards transport to the SC apply as to the Drip and Ship concept.

Mode of transport and general measures in the prehospital phase

If a stroke is suspected from an acute neurological deficit, the general Swiss emergency number (144) should be called without delay.

If the estimated time by ground transport from the patient's location to the target hospital is more than 45–60 min, air transport may be faster. The choice of the most appropriate means of transport is the responsibility of the 144 emergency control center and depends on the weather conditions, traffic density, landing possibilities, and availability of transport.

If the patient goes by air (helicopter), the patient should be taken directly to the nearest stroke center, regardless of the severity of the symptoms (RACE score). A stopover in a stroke unit can lead to long delays for LVO, which is counterproductive to the time gained by flying directly to a stroke center.

Table 3. Recommended information to forward as "Stroke Code Call" by the rescue service (with or without suspected LVO).

Information	Comment
Name, first name, sex, and date of birth	
Preexisting severe disability	Yes/no (Walker? Dementia? Need of assistance?)
Symptom onset	<24 h?
- Known	Date and time
- Unknown/wake up	Last proof of good health
RACE score	Score
Anticoagulation	Phenprocoumon, apixaban, rivaroxaban, edoxaban, and dabigatran
Platelet inhibitors	Aspirin, clopidogrel, ticagrelor, and prasugrel
Contraindication for MRI[a]	Claustrophobia, pacemaker, and metal
Next of kin contact	Name and phone number
Estimated time of arrival	Time and mode of transportation

LVO: large vessel occlusion; RACE: Rapid Arterial Occlusion Evaluation.
[a]For target hospitals using MRI for acute imaging.

To improve information flow, the rescue service/air rescue should provide practical preliminary information to the facility, where the patient is being transferred (stroke unit and stroke center) in the form of a "stroke code call."

This should accelerate onset-to-treatment time, internal "door-to-needle time," "door-to-groin-puncture time," and result in a higher thrombolysis rate (Table 3).

The following measures should be taken by the paramedics/air rescue team in cases of suspected stroke on-site in the shortest possible time, especially if symptom onset is less than 24 h:

- Secure the respiratory tract and circulation.
- Do not give antithrombotics.
- Blood pressure reduction only if systolic pressure over 220 mmHg or organ manifestations according to internal algorithms.
- Advance information to stroke unit/stroke center (Stroke Code Call).
- Travel with special signal for ground transport.

Stroke care in geographically remote regions

Small remote hospitals with specific expertise in acute stroke care

On the one hand, the basic requirement is to move patients as quickly as possible to the nearest capable hospital for

Table 4. Criteria for specific expertise in stroke care in geographically remote hospitals.[26]

Criterion	Quality indicator
Presence of stroke expertise	Within 30 min (physically or virtually via telemedicine)
Protocols for acute stroke care	Regularly reevaluated
Emergency room	Standard operating procedures for stroke
Lab/ECG	24/7 and available within 45 min
Brain-CT (including CT-A, CT-P (or MRI))	Available 24/7
Stroke unit	Not required
Systemic thrombolyses	Within 60 min (door-to-needle) possible
Transfer to stroke unit/ stroke center	According to Drip and Ship criteria
Systematic documentation quality indicators	Number of stroke patients, number of systemic thrombolyses (door-to-needle times), and transfers to SC/SUs

ECG: electrocardiogram; SU: stroke unit, SC: stroke center.

acute stroke treatment (i.e. a stroke unit and stroke center). On the other hand, small hospitals in remote regions cannot reach the minimum mandatory number of cases for certification as a stroke unit (minimum of 200 stroke patients and 20 systemic thrombolyses per year). Due to the large distance of remote hospitals from nearest stroke unit/stroke centers (>60 min) and ensuing time delay to specific start of therapy, there is a need for small hospitals to be able to at least start acute stroke treatment including systemic thrombolysis. In principle, acute processes, medical stroke expertise, and infrastructure (CT and laboratory) should be available in these hospitals as in certified stroke units, so they can perform systemic thrombolysis and triage (LVO yes/no).

Virtual stroke expertise (telemedicine) is well suited for these hospitals, as a neurological presence on-site (24/7) cannot usually be guaranteed for hospitals of this size (Table 4).

After starting acute care in such a hospital, the patient should then be transferred to a stroke unit or stroke center to benefit from specialized treatment (number needed to treat [NNT] of stroke unit 6–8 regarding outcome in independence) in these more capable facilities.[1]

Conclusions

Due to the increasing diversification of treatment methods for stroke patients, the organization of the prehospital phase needs to be adapted accordingly. These guidelines describe a prehospital organization that creates efficacious access for all stroke patients to specialized systems (stroke unit/ stroke center) allowing for appropriate and rapid treatment. The working group does not provide a conclusive recommendation on the use of the RACE score (LVO yes/no): Ultimately, the decision of which model to use will depend on local (e.g. geographical) characteristics. However, it is important that the critical time intervals of the chosen model are taken into account, measured, and evaluated.

Authors' note

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Supplemental material

Supplemental material for this article is available online.

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Annex 1
Scores distinguishing LVO vs no LVO

National Institutes of Health Stroke Scale (NIHSS):

This widely used scale assesses the severity of a stroke. An NIHSS threshold of > 10 points gives a sensitivity and specificity of 73% and 74% respectively. A lower threshold of > 6 points gives a sensitivity of 87% and specificity of 52%.

Advantages: Long-established test to define the severity of a stroke and predict LVO.

Disadvantages: The test is not validated for pre-hospital use, or for emergency services. On-site use by emergency services does not seem practical in terms of time and staff training.

Rapid Arterial oCclusion Evaluation (RACE) Score

This scale was first derived retrospectively from the NIHSS items taking the highest predictive value with respect to LVO. In a second step, the scale was validated by the paramedics in a prospective study in a pre-hospital setting and achieved an AUC of 0.82. A RACE score > 5 has a sensitivity of 0.85 and a specificity of 0.68, a positive predictive value of 0.42 and a negative predictive value of 0.94 for detecting large vessel occlusion (13). (Tables 2 and 3).

Advantages: Validated in the pre-hospital setting by the emergency services. Brings good selectivity.

Disadvantages: Proximal vascular occlusion was partially confirmed or searched for using transcranial duplex sonography. Motor symptoms have more weight than, for example, gaze deviation, which is a disadvantage for predicting LVO.

The Field Assessment Stroke Triage for Emergency Destination (FAST-ED) Score

The score was tested in a prospective study recruiting 734 patients in 2 university hospitals. In a score comparison with the FAST-ED score, NIHSS, RACE Score and CPSS (see below), the FAST-ED score was as good as the more complex NIHSS regarding differentiation of the presence of an ACI-M1-M2 closure. (At a cut off of >3 it reaches a sensitivity of 71%, specificity of 78%; PPV: 0.62, NPV: 0.84 (27).

Advantages: Good selection of the relevant items from the NIHSS, giving an equally good selectivity with significantly less effort. An app is also available.

Disadvantages: No validation in the pre-hospital setting.

Cincinnati Pre-hospital Stroke Severity Scale (CPSSS)

The scale is easy to perform and therefore amenable to the rescue service on site. The CPSS includes conjugate gaze turn, speech disorder, and arm weakness (22).

Advantages: Easy and quick to carry out. Feasible for the rescue service

Disadvantages: The high sensitivity of over 80% is at the expense of the specificity, which is only 40%.

Gaze-Face-Arm-Speech-Time (G-FAST)

This test consists of the well-known and almost universally applied Face-Arm-Speech-Time Test, in addition to the forced gaze deviation sign, best associated with a proximal vessel occlusion. In a retrospective evaluation of LVOs in the SITS register, a G-FAST of >3 showed a sensitivity of 88.7% for predicting LVO but a low specificity of 31% (PPV 31, NPV 91.8) (28).

Advantages: Since the rescue service uses the FAST Score extensively, supplementing the FAST with gaze deviation would be very rapid and easy.

Disadvantages: G-FAST is not validated in pre-hospital settings. A cut-off of 3 points has a good sensitivity but the specificity is low and does not correspond to the recommended "upper triage limit" of max. 30% (29).

The Rapid Arterial Occlusion Evaluation Scale (RACE) (13)

Item	RACE Score	NIHSS equivalent
Facial palsy		
absent	0	0
mild	1	1
moderate to severe	2	2-3
Arm motor function		
normal to mild	0	0-1
moderate	1	2
severe	2	3-4
Leg motor function		
normal to mild	0	0-1
moderate	1	2
severe	2	3-4
Head and gaze deviation		
absent	0	0
present	1	1-2
Aphasia (if right hemiparesis)		
normal (performs both tasks correctly)	0	0

mild (performs one task correctly)	1	1
severe (performs neither tasks)	2	2
Agnosia (if left hemiparesis)		
normal (no asomatognosia nor anosognosia)	0	0
moderate (asomatognosia or anosognosia)	1	1
severe (both of them)	2	2
total	0-9	

NIHSS, National Institutes of Health Stroke Scale; RACE, Rapid Arterial oCclusion Evaluation.
Aphasia: ask the patient 1) to close his eyes, 2) to make a fist
Agnosia: 1) Show the paralyzed arm to the patient and ask, "Whose arm is it?" 2) Ask patient if he can lift both arms to clap. Evaluate if he can recognize the functional deficit

RACE Score Performance (13)

RACE Score	Sensitivity	Specificity	PPV	NPV	Accuracy
≥1	1	0.13	0.24	1	0.31
≥2	0.97	0.27	0.27	0.97	0.42
≥3	0.93	0.40	0.30	0.96	0.51
≥4	0.89	0.55	0.35	0.95	0.62
≥5	0.85	0.68	0.42	0.94	0.72
≥6	0.72	0.77	0.46	0.91	0.76
≥7	0.53	0.89	0.56	0.87	0.81
≥8	0.32	0.95	0.65	0.84	0.82
9	0.07	0.99	0.56	0.79	0.79

PPV: positive predictive value, NPV: negative predictive value

Retrospective analysis of existing scores differentiating LVO vs no LVO

Score	Accuracy	sens/spec	Paramedics	Validated for LVO	Validated in pre-hospital-setting

NIHSS ≥ 12	69.9	72.1 / 69.9	-	+	-
G-FAST ≥ 3	50.8	88.7 / 39.1	-	-	-
FAST=3	53.1	84/43.5	+	-	-
RACE ≥5	68.9	71.2/68.2	+	+	+
C-STAT	68.4	72/65			

Retrospective analysis from the SITS Registry (30)

Annex 2:

Affiliations of authors, and possible previous conflicts of interest regarding IVT and EVT

Name	Institution	Possible conflicts of interest concerning IVT and EVT
Georg Kägi	Department of Neurology, Cantonal Hospital, St.Gallen	Bayer, Medtronic: Fees for lectures and advisory boards
David Schurter	Protection & Rescue Zurich, Ambulance	none
Julien Niederhäuser	Stroke Unit, GHOL, Nyon	none
Gian Marco De Marchis	Department of Neurology and Stroke Centre, University Hospital Basel	none
Stefan Engelter	Department of Neurology and Stroke Centre, University Hospital Basel; Neurorehabilitation FELIX PLATTER, University Basel	Boehringer-Ingelheim, Medtronic: Fees for lectures and advisory boards
Patrick Arni	Protection and Rescue Bern, Medical Police	none
Olivier Nyenhuis	Inter Association for Rescue Services, Bern	none
Christophe Bonvin	Division of Neurology and Stroke Unit, Hôpital du Valais, Sion	none
Andreas Luft	Department of Neurology, University Hospital Zurich and cereneo, Vitznau	none
Susanne Renaud	Division of Neurology, Neuchâtel Hospital Network	none
Krassen Nedeltchev	Department of Neurology, Cantonal Hospital Aarau	Boehringer-Ingelheim, Medtronic: Fees for lectures and advisory boards
Emmanuel Carrera	Department of Neurology, University Hospitals of Geneva	none
Carlo Cereda	Department of Neurology, Neurocentro della Svizzera Italiana, Lugano Civic Hospital	No conflicts of interest
Urs Fischer	Department of Neurology, Inselspital Bern and University of Bern	Medtronic, Stryker, CSL Behring, Böhringer Ingelheim for study projects. Consultants for Medtronic and Stryker. Fees for lectures go

		to the employer and are used for research and education.
Marcel Arnold	Department of Neurology, Inselspital Bern and University of Bern	Boehringer-Ingelheim, Covidien, Medtronic: Fees for lectures and advisory boards.
Patrik Michel	Department of Neurology, Centre Hospitalier Universitaire Vaudois, Lausanne	Boehringer-Ingelheim, Medtronic, PROMISE steering committee (Penumbra). Fees for lectures go to the employer and are used for research and education.

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