Section I

# Assessment of Stroke Patients

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## Emergency medical services (EMS): first line of defense against stroke

Noah Grose and Michel T. Torbey

### Introduction

The phrase 'time is brain' is the cornerstone for acute ischemic and hemorrhagic stroke management. Stroke management begins with the activation of the 9–1–1 system. Immediate triage and rapid dispatch of appropriate emergency medical services (EMS) is essential for improving long-term survival. Rapid on-scene assessment, emergent transportation, and immediate notification of the receiving facility by the EMS is essential and will ensure the best possible outcome for the acute stroke patient.

The benefits of EMS activation by patients with stroke symptoms appear to occur in both the pre-hospital and in-hospital settings. Patients who utilize EMS have faster time to initial medical attention, shorter time periods from symptom onset to hospital arrival, decreased time to initial physician examination, initial computed tomography (CT) imaging, and neurological evaluation. With each step in the chain of events contributing to an overall delay in treatment time, it is essential that the acute stroke patient be treated as an emergency.

On average, it takes pre-hospital EMS approximately 35 minutes to reach the emergency department (ED) with stroke patients. For each minute that a large-vessel ischemic stroke is untreated, the average patient loses 1.9 million neurons, meaning that an estimated 66 million neurons will be lost during the transport alone.

The concept of a "Chain of Recovery" was developed to improve the care of stroke patients by incorporating the pre-hospital and hospital management. The Chain of Recovery has five distinct components:

The Stroke Book, Second Edition, ed. Michel T. Torbey and Magdy H. Selim. Published by Cambridge University Press. 

1. Identification of stroke signs and symptoms by patients or bystanders.
2. Immediate EMS activation and appropriate 'dispatch life support' with pre-arrival instructions.
3. Rapid EMS response, assessment, evacuation, and appropriate EMS care.
4. Alerting of the receiving stroke center for resource preparation and mobilization.
5. Rapid definitive diagnosis and treatment by an experienced specialist at a stroke center.

With the first four components involving EMS and pre-hospital management of the stroke patient, the EMS system is essential to improving outcomes of the stroke patient.

## The golden hour

Originally developed in the setting of trauma treatment, the golden hour is a general concept in emergency medicine that is applied to conditions in which hyperacute therapy is more effective than later intervention, including trauma, myocardial ischemia, septic shock, cardiopulmonary resuscitation, and stroke. With the critical importance of rapid treatment, national recommendations for hospitals that accept acute stroke patients in the ED are to complete the clinical and imaging evaluation of the patients and initiate lytic therapy within 1 hour of patient arrival. The Joint Commission target for primary stroke centers is to achieve a door-to-needle (DTN) time of within 60 minutes in 80% or more of patients.

The introduction of thrombolytic therapy has revolutionized the management of acute ischemic stroke, now bringing a greater emphasis on efficient, structured care of this population. The benefit of intravenous thrombolytic therapy in acute ischemic stroke is largely time-dependent. The American Stroke Association's "Stroke Chain of Survival" (Table 1.1) is designed to improve response time and appropriateness of care in each of the seven areas and, in turn, could increase the number of patients receiving thrombolytic therapy with acute ischemic stroke.

At a minimum, the first four steps in the chain of survival involve the participation and cooperation of EMS providers.

**Table 1.1** Stroke chain of survival

| | |
|---|---|
| Detection | Recognition of stroke signs and symptoms |
| Dispatch | Call 9–1–1 and priority EMS dispatch |
| Delivery | Prompt transport and pre-hospital notification to hospital |
| Door | Immediate ED triage |
| Data | ED evaluation, prompt laboratory studies, and CT imaging |
| Decision | Diagnosis and decision about appropriate therapy |
| Drug | Administration of appropriate drugs or other interventions |

**Table 1.2** Key components of history

| |
|---|
| Onset of symptoms |
| Recent events |
| Stroke |
| Myocardial infarction |
| Trauma |
| Surgery |
| Bleeding |
| Comorbid disease |
| Hypertension |
| Diabetes mellitus |
| Use of medications |
| Anticoagulants |
| Insulin |
| Antihypertensives |

## EMS pre-hospital assessment

The EMS assessment begins with the initial 9–1–1 call. The dispatch must be able to identify signs and symptoms of stroke to ensure immediate triage and dispatch of appropriate EMS providers when an acute stroke patient is suspected.

- Preliminary neurological assessment via phone interview
- Key questions
  - acute unilateral weakness
  - acute confusion
  - acute change in speech pattern or quality of speech
  - onset of symptoms.

Stroke should be given a priority dispatch similar to that for acute myocardial infarction or trauma. Dispatches for suspected stroke patients should be initiated rapidly and expedited because of the time restraints on approved treatment options.

When the EMS arrive on the scene, the EMS providers should obtain a focused history (Table 1.2) and patient assessment (including ABCs, glucose evaluation, and blood pressure), provide necessary stabilization and treatment, and transport immediately to the closest appropriate stroke center.

## Pre-hospital stroke assessment instruments

To optimize stroke identification in the field, pre-hospital professionals should be competent in the uses of pre-hospital stroke screening instruments that have been prospectively evaluated for sensitivity and specificity. The sensitivity of paramedic identification of stroke patients unaided by a formal screening algorithm has varied between 61% and 72%. However, the use of a pre-hospital stroke

**Table 1.3** Los Angeles pre-hospital stroke scale (LAPSS)

| Screening criteria |
|---|
| 1. Age > 45 |
| 2. History of seizures absent |
| 3. Symptom duration < 24 hours |
| 4. At baseline, patient is not wheelchair-bound or bedridden |
| 5. Blood sugar between 60 and 400 mg/dL |
| 6. Obvious asymmetry (right versus left) |
| 7. Facial smile/grimace |
| 9. Grip |
| 10. Arm strength |

If 1–5 are "yes" with asymmetry on exam then LAPSS criteria are met.

assessment instrument has been shown to increase paramedic sensitivity to stroke identification in the field markedly.

### The Los Angeles pre-hospital stroke screen (LAPSS)

The LAPSS (Table 1.3) is composed of four key history items, blood sugar measurement, and three areas of motor assessment, and was developed in the 1990s. The four key history items are aimed at ruling out potential stroke mimics and consist of:

- Age > 45
- Absent history of seizure
- Duration of symptoms < 24 hours
- Determines that at baseline the individual was not wheelchair-bound or bedridden.

Blood glucose is obtained and a reading of 60–400 mg/dL eliminates hypoglycemia as a differential diagnosis. On physical exam, LAPSS evaluates for the presence and symmetry of:

- Facial droop
- Grip strength
- Arm drift.

LAPSS demonstrated a sensitivity of 91% and a specificity of 97% for the identification of acute stroke patients. The test can be performed in less than 3 minutes.

### The Cincinnati pre-hospital stroke scale (CPSS)

The CPSS (Table 1.4) is a three-item scale based on the National Institutes of Health stroke scale (NIHSS). There are three components in the NIHSS:

- Facial palsy
- Arm weakness
- Dysarthria.

**Table 1.4** Cincinnati pre-hospital stroke scale (CPSS)

| |
|---|
| **Facial droop:** Have patient smile, show teeth |
| ***Normal:*** Both sides of face move equally |
| ***Abnormal:*** One side of face does not move or does not move as well as the other |
| **Arm drift:** Arms held out straight in front of body with eyes closed for 10 seconds |
| ***Normal:*** Both arms held equally |
| ***Abnormal:*** One arm unable to maintain position or drifts |
| **Speech:** Have patient repeat a phrase |
| ***Normal:*** Patient uses correct words, no slurring |
| ***Abnormal:*** Slurred words, inappropriate words, or unable to speak |

**Table 1.5** Face arm speech test (FAST)

| | | | |
|---|---|---|---|
| **Speech impairment** | Yes | No | Uncertain |
| **Facial palsy** | Yes | No | Uncertain |
| | **Left** | **Right** | |
| **Arm weakness** | Yes | No | Uncertain |
| **Affected side** | Right | Left | |

CPSS identified 100% of stroke patients. The scale rates the specific activity as normal versus abnormal and can be performed in less than 2 minutes. The test has a sensitivity of >95% when performed by EMS. CPSS identifies anterior circulation stroke more accurately than posterior circulation stroke.

## The Newcastle face arm speech test (FAST)

The FAST (Table 1.5) was developed in the United Kingdom in 1998 and contains three key elements (facial weakness, arm weakness, and speech disturbances) from the CPSS, but avoids the need to repeat a sentence as a measure of speech and instead uses assessment of language ability by EMS during normal conversation with the patient. FAST was designed for assessment of a seated subject and hence does not assess leg weakness. Inter-relater reliability between EMS and stroke physician was the best for assessment of arm weakness (95%).

### Speech

Assess quality of speech for difficulty articulating (slurring of words) or expressing oneself (word-finding difficulties, object identification).

### Facial movements

Observe for symmetry of movement (ask patient to smile) and document side of asymmetry.

**Table 1.6** Melbourne ambulance stroke screen (MASS)

| |
|---|
| **History items** |
| 1. Age >45 years |
| 2. No history of seizure or epilepsy |
| 3. At baseline patient is not wheelchair-bound or bedridden |
| 4. Blood glucose level is between 2.8 and 22.1 mmol/L |
| **Motor items** |
| 5. Unilateral facial droop |
| 6. Unilateral hand grip weakness |
| 7. Unilateral arm drift |
| 8. Abnormal speech |

History items 1–4 must all be "yes" in the presence of at least one motor item for MASS criteria to be met and stroke diagnosis given.

### Arm movements

Observe for symmetry of movement – ask patient to simultaneously raise arms 90° while sitting/supine; monitor for 5 seconds. Document the side of drift/weakness.

## Melbourne ambulance stroke screen (MASS)

Similar to the LAPSS, this stroke assessment tool was studied by EMS personnel. They received stroke education and instruction in the use of the MASS (Table 1.6) to assist in stroke diagnosis, demonstrating a sensitivity of 94%. In this study there was an increase in pre-notification of impending arrival to the ED, and a decreased triage and door-to-CT scan time.

## Miami emergency neurological deficit (MEND)

This exam is being instructed in the Advanced Stroke Life Support (ASLS) course (Table 1.7).

**Table 1.7** MEND exam

| | | | |
|---|---|---|---|
| **Mental status** | Level of consciousness | | |
| | Speech (you can't teach an old dog new tricks) | | |
| | Questions (age, month) | | |
| | Commands (close, open eyes) | | |
| | | **Right** | **Left** |
| **Cranial nerves** | Facial droop (smile, show teeth) | | |
| | Visual fields (four quadrants) | | |
| | Horizontal gaze (side to side) | | |
| **Limbs** | Motor drift – arm (close eyes, hold arms out) | | |
| | Motor drift – legs (open eyes, lift each leg) | | |
| | Sensory – arm/leg (close eyes, touch or pinch) | | |

**Table 1.8**

| | CENTRAL OHIO TRAUMA SYSTEM Regional EMS/Hospital STROKE ALERT TOOL | |
|---|---|---|
| EMS Agency Name: | | |
| Patient Name: | | |
| Date/Time last without symptoms: | | |
| Patient taking Coumadin (warfarin) | Yes | No |
| Witness Name: | | |
| Witness Phone No.: | | |
| Fingerstick blood glucose done: | Yes | No |
| **STROKE SIGNS & SYMPTOMS** | | |
| • Decreased level of consciousness | Yes | No |
| • Speech slurred, inappropriate or mute | Yes | No |
| • Unilateral facial droop | Yes | No |
| • Unilateral arm drift/paralysis | Yes | No |
| **STROKE ALERT CRITERIA**: | | |
| • Presence of any stroke symptoms above | Yes | No |
| • Time of symptom onset < 3 hours | Yes | No |
| • No known head trauma with onset | Yes | No |
| • Fingerstick blood glucose >50 | Yes | No |

The Pre-hospital Report to the Emergency Department should include STROKE SIGNS AND SYMPTOMS and STROKE ALERT CRITERIA details as documented in this tool. If "YES" to all Stroke Alert Criteria, **call in a "STROKE ALERT"** and emergently transport patient to closest stroke-capable hospital per local protocol. Pediatric patients (<18 years of age) in Central Ohio should be transported without delay to Nationwide Children's Hospital per local protocol.
*This tool is adapted from the Cincinnati & Los Angeles Stroke Scales. See* www.goodhealthcolumbus.org/cots/index.html *for the latest version of this tool.* **Approved by the COTS Board on 12/2/08**.

## Central Ohio trauma system (COTS)

### Regional EMS/hospital stroke alert tool

A regional example of a pre-hospital stroke tool is utilized by the COTS (Table 1.8). This scale prompts the EMS personnel to obtain a focused history, blood glucose, anticoagulants and last known well, and the tPA eligibility criteria. The assessment is adapted from the Cincinnati and Los Angeles stroke scales.

## EMS pre-hospital management of the acute stroke patient

After initial stabilization, it is recommended that the patient transport commence as soon as possible, with cardiac monitoring and intravenous access established during transport (Table 1.9). If needed, isotonic crystalloids (0.9% normal saline)

**Table 1.9** Guidelines for EMS management of patients with suspected stroke

| Recommended | Not recommended |
|---|---|
| Manage ABCs | Dextrose-containing fluids if non-hypoglycemic patients |
| Cardiac monitoring | Hypotension/excessive blood pressure reduction |
| Intravenous access | Excessive intravenous fluids |
| Oxygen (as required $O_2$ saturation <92%) | |
| Assess for hypoglycemia | |
| Remain NPO | |
| Alert receiving ED | |
| Rapid transport to closest appropriate facility capable of treating acute stroke | |

are recommended for resuscitation; avoid the use of dextrose-containing fluids unless hypoglycemia is present or strongly suspected because of the increasing evidence that hyperglycemia may be associated with worsened neurological outcome.

Although it is important to monitor the stroke patient's blood pressure, there are no current recommendations for pre-hospital management of hypertension in patients with suspected stroke. Although persistently elevated blood pressure will exclude patients from receiving intravenous tPA, this intervention is best accomplished after hospital arrival.

### EMS communication with receiving emergency departments

The delivery and pre-hospital notification of the inbound stroke patient can provide significant time for hospital personnel to mobilize and prepare necessary resources for the patient's arrival. Advanced notification of patient arrival by EMS has demonstrated a decreased time in neurological assessment, more rapid initial brain imaging, and was associated with a modest increase in the use of thrombolytic medication.

### Determining the stroke patient's destination

Policies for pre-hospital triage of the stroke patient should address time variables, distance variables, and available stroke care capabilities in the region. Determining a hospital's capabilities in providing emergent stroke care has several factors. Some of these factors include:

- The presence of trained physicians with expertise in the diagnosis and management of stroke
- 24-hour advanced CT and MRI brain imaging and interpretation
- The availability of knowledgeable personnel to carry out approved stroke therapies, including IV tPA

– The presence of an institutional plan to handle, or at least provide, initial evaluation of primary hemorrhages and hemorrhagic transformation or cerebral infarcts.

Research has demonstrated that there are improved outcomes in patients who receive in-hospital care at facilities specializing in stroke care. In addition, transporting patients to a center with immediate access to stroke expertise has been shown to increase tPA use. These findings suggest that the preferential routing of acute stroke patients to a primary stroke center (PSC) has increased the proportion of patients cared for at stroke-capable centers and also increased the proportion of patients treated with thrombolytic therapy to >10%, thus improving patient outcomes.

In an attempt to improve the organization and delivery of care to stroke patients, the Brain Attach Coalition published two sets of recommendations.

### Primary stroke center (PSC)

A PSC has the personnel, programs, expertise, and infrastructure to care for many patients with uncomplicated stroke. It can use many acute therapies (i.e. intravenous tPA) and admits these patients to designated stroke units.

### Comprehensive stroke center (CSC)

A CSC is designed to care for patients with complicated types of strokes, patients with intracerebral hemorrhage or subarachnoid hemorrhage, and those requiring specific interventions (i.e. surgery or endovascular procedures) or an intensive care unit type of setting. Such centers have acted as a regional resource for stroke care with good results and will be pivotal for further advancements in acute stroke care, stroke prevention, and rehabilitation.

## Summary

Acute stroke management requires a multidisciplinary team approach to management. This begins in the pre-hospital setting and extends through stroke rehabilitation. EMS provides the first line care of this population and can dramatically decrease the patient's time to treatment, thus improving outcomes in their communities.

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