- The leading cause of serious long-term disability in the US with 800,000 people per year suffering a stroke (1:440 people in the US or 23 per 10,000 population). The mortality is 140,000 per year, or 17.5% of those having strokes, leaving a potentially 82.5% with some disability from stroke. Over half of stroke survivors over age 65 have mobility limitations. 1/3 of patients hospitalized for stroke are less than 65. There are 4 million people living in the US with impairments from strokes. -23% of strokes are in people with previous strokes - 87% of strokes are ischemic, 13% are hemorrhagic. - 93% of patients recognize unilateral numbness is a sign of stroke but only 38% are aware of all major symptoms and knew to call 9-1-1. - HTN, hyperlipidemia, smoking, obesity, and DM are the leading causes of stroke. Over 1/3 of the US population have at least one of these. - The highest rates of strokes are in the southeast US, particularly AR, MO, MS, AL, GA, SC, NC, TN, KY, WV, and TX. Florida has lower stroke rates than these other states.

STROKE PATHOPHYSIOLOGY
87% of strokes are ischemic, 13% are hemorrhagic. Of ischemic strokes there are two types: thrombotic and embolic. Thrombotic strokes are due to clots that form inside one of the arteries supplying blood to the brain- associated with atherosclerosis and dyslipidemia. Large vessel thrombosis is the most common type of thrombotic stroke caused by long term atherosclerosis plus rapid clot formation. Hyperlipidemia is a common risk factor. Small vessel disease may produce lacunar infarction, and is associated with hypertension. Embolic stroke is due to embolus traveling to the brain from elsewhere in the body. 15% are caused by atrial fibrillation. Hypertension is the leading cause of stroke.

STROKE CT EVALUATION (image below)
Non-contrast CT- not very sensitive for ischemic stroke, cannot determine infarction vs ischemic tissue.
The non-contrast CT is used as a rapid initial evaluation of stroke but one cannot see the extent of the stroke nor the vascular distribution.
Red circled area shows MCA disruption with a thrombus.

CTP (CT Perfusion)
This is the best technique for determining salvagable brain tissue from large vessel occlusion in ischemic stroke. The technique involves injection of iodinated contrast into the cerebral circulation then performing serial spiral CT scans to track the iodinated contrast as it moves through the brain. Cerebral blood flow, cerebral blood volume, time to peak (TTP) and mean transit time are measured. Using this data differentially can then determine the area of infarction (decreased TTP, severely decreased CBV and CBF and MTT) and ischemia (the penumbra area) where collateral flow is supplying the brain tissue. In a penumbra area, the TTP is decreased but the CBV is almost normal and the CBF is only slightly decreased, making this tissue viable if rapid de-clotting of the large occluded artery is possible.
Fig. 3. CTP imaging study showing a right-sided middle cerebral artery (MCA) stroke without any salvageable penumbra. Of the six-image panel, the upper right image represents time to peak (TTP), which indicates a delay in blood flow to the region of the brain seen as bright red on the color map. The upper middle component of the six-image panel represents cerebral blood volume (CBV). Notice the dark blue within that image, which highlights significant core infarct and large volume loss. Regions of irreversibly infarcted tissue show matched areas of decreased CBF and TTP. No stroke intervention was offered for this patient.
Fig. 4. **CTP** imaging study showing an **acute stroke** of the right MCA territory with salvageable **penumbra**. The upper right panel indicates increased TTP (red area on **perfusion** map), whereas the upper middle panel indicates no significant CBV loss as seen by the minimal blue coloring in the right MCA territory. This patient underwent **thrombectomy** on the basis of **CTP** imaging findings and **National Institutes of Health Stroke Scale** score.
STROKE SCALES
NIHSS (National Institutes of Health Stroke Scale)- complex stroke scale usually used in hospitals but rarely outside of hospitals- certification is available for training on how to use this complex scale that has a maximum value of 42 evaluating 11 different elements and assigns different scores to pre-existing conditions. A NIHSS value of 6 has a false negative rate of 3% and a false positive rate of 73% (3). A score of 6 or greater is used by many Comprehensive Stroke Centers to trigger a "stroke alert" that involves IR and anesthesia for possible emergency mechanical thrombectomy. Patients with a NIHSS score of 0-3 are highly likely to have good clinical outcomes. MDCalc is an online calculator of the NIHSS score [http://www.mdcalc.com/nih-stroke-scale-scores-nihss](http://www.mdcalc.com/nih-stroke-scale-scores-nihss)


Emergency Triage Scales
Rapid Arterial Occlusion Evaluation Scale [RACE]- has the best accuracy of 78% (3). This scale assesses facial palsy, arm motor impairment, leg motor impairment, head and gaze deviation, and hemiparesis left vs right. Scores for each section range from 0 to 2, and a score of 5 or more is an indication for transport to a Comprehensive Stroke Center. Scores of 4 or under suggest a stroke should be considered so transfer to an Primary Stroke Center (lower level) should be considered.

Field Assessment Stroke Triage for Emergency Destination [FAST-ED] (4) is a scale that evaluates six different elements and are graded 0-1 for one element (facial palsy) and 0-2 for the remainder of the elements (arm weakness, speech changes, eye deviation, denial/neglect). This is the scale used by Sunstar Paramedics in Pinellas County. A score of 4 will trigger sending the patient to a Comprehensive Stroke Center.

Cincinnati Prehospital Stroke Severity Scale [CPSSS] (5). This 4 point scale assigns 2 points to conjugate gaze deviation, one point for incorrectly answering age or current month, and one point for inability to hold arm (either right, left, or both) up for 10 seconds before the arms fall to the bed. A score of 2 or more is 89% sensitivity and 73% specificity for detecting severe stroke and 75% sensitivity and 85% specificity for detecting moderate stroke.

3-item stroke scale [3I-SS]. (6) This graded scale has scores ranging from 0 to 2 on each element: Disturbance of consciousness, gaze and head deviation, and hemiparesis. The total score ranges from 0-6. With a score of 5 or 6 there is a 100% probability of vessel occlusion (MRA). A score of 0 has a 5% chance of occlusion, score of 1 18% chance of occlusion, score of 2 33% chance of occlusion, score of 4=60% chance of occlusion.

Prehospital Acute Stroke Severity Scale [PASS] (7) is a three point scale that assigns 0-1 points for each of the elements level of consciousness (month/age recognition), gaze palsy/deviation, and arm weakness. A score of 2 or more correlates to NIHSS of 17 while a PASS of less than 2 correlates with NIHSS of 6 or less. The accuracy in detecting large vessel occlusion is 76% and the sensitivity is 66% and specificity of 83% for PASS score of 2 or 3.
POST STROKE EVALUATION SCALES

Modified Rankin Scale (mRS) is one of the most widely used stroke outcome scales and ranges from 0-6 in score with 6 being dead. A score of 0 is no symptoms, 1=no disability despite symptoms, 2=slight disability and unable to carry out all previous activities but able to look after own affairs without assistance; 3=moderate disability requiring some help but can walk without assistance; 4=moderately severe disability, unable to walk or attend to bodily needs without assistance; 5= severe disability, bedridden, incontinent, and requiring constant nursing care and attention.

There are over 20 other scales used in stroke rehabilitation for specific elements post-stroke, but these are not commonly used outside of Rehabilitation Centers or in Rehab Assessment.

STROKE TREATMENT

Alteplase (tPa)

tPA (tissue plasminogen activator) is the only FDA approved drug treatment for acute ischemic stroke.

Outcome if treated within 3 hours of onset - good outcome in 33% vs 23% for controls (OR 1.75)
Outcome if treated 3-4.5 hours 35% vs. 30% for control (OR 1.26) Exclusions: older than 80, NIHSS score > 25
Outcome >4.5 hours - should not receive tPA due to risk > benefits and no difference in outcome to controls. Mechanical thrombectomy is indicated up to 24 hours. Beyond 24 hours - no tpa or thrombectomy is indicated.

MECHANICAL THROMBECTOMY (Interventional Radiology, Stroke Alert)

Thrombectomy is employed by passing a basket into the vessel with the clot, and retrieving the clot under continuous suction using a device similar to that seen below:
ANESTHESIA TYPE AND MECHANICAL THROMBECTOMY (IR)
An observational study (10) to answer the question of the best anesthetic for stroke thrombectomy was published in 2019 and found the mean time from room to reperfusion time was twice as high in the general vs. MAC group. Long-term outcomes (Rankin score) were better in the MAC vs the GA group. Another study published in 2015 (11) found in this randomized study that local anesthesia was safer than general with improved outcome, lower mortality, and fared better than routine general anesthesia for mechanical thrombectomy in stroke patients.
A third recent study (12) compared conscious sedation with local anesthesia for endovascular treatment of stroke patients and found long term outcomes were worse in patients that had conscious sedation and mortality was higher in conscious sedation patients.
A fourth randomized controlled study published in 2019 (13) found conscious sedation patients had significantly better outcomes (functional independence at 3 months was 23% for GA, 53% for conscious sedation, and 17% for medical management)
A fifth observational study (14) found using ketamine/propofol for sedation vs GA, that there was a shorter door to recanalization time, mean duration of mechanical thrombectomy and other measures for sedation compared to General anesthesia. There were no differences in 3 month Rankin scale outcomes.
A sixth non-randomized study (15) using GA vs Conscious sedation found no difference in Rankin score, mortality, successful revascularization, or recanalization time metrics but there was a longer angiosuite arrival time to groin puncture time.
A meta-analysis (16) was performed incorporating twenty-three studies including 6703 patients. "We found that patients in the GA group have lower odds of favorable functional outcome (mRS scores ≤2) compared with the CS group (odds ratio [OR] = 0.62, 95% confidence interval [CI]: 0.49-0.77), and higher risk of mortality (OR = 1.68, 95% CI: 1.49-1.90), pneumonia (OR = 1.78, 95% CI: 1.40-2.26), symptomatic intracranial hemorrhage (OR = 1.64, 95% CI: 1.13-2.37)" A RCT subanalysis found no significant difference.

BLOOD PRESSURE MAINTENANCE AND OUTCOME AFTER MECHANICAL THROMBECTOMY
A series of patients receiving general anesthesia were found to have improved ischemic lesion volumes, lower hemorrhage rates, and improved Rankin scale disability outcomes when blood pressure was maintained at 20% above the initial blood pressure values prior to induction of general anesthesia.

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