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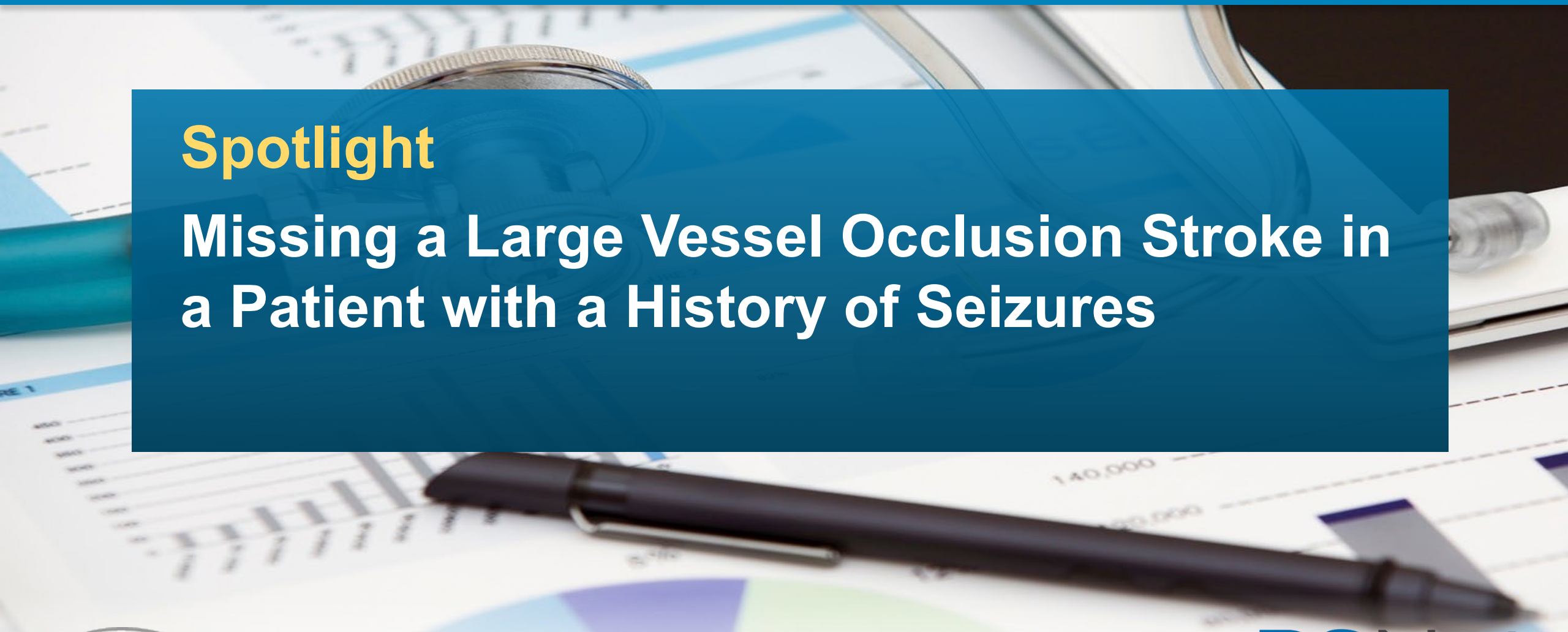

Spotlight

Missing a Large Vessel Occlusion Stroke in a Patient with a History of Seizures

AHRQ Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

PSNet
PATIENT SAFETY NETWORK

Source and Credits

- This presentation is based on the May 2022 AHRQ WebM&M Spotlight Case
  - See the full article at https://psnet.ahrq.gov/webmm
  - CME credit is available
- Commentary by: Kevin Keenan, MD and Daniel Nishijima, MD, MAS
- AHRQ WebM&M Editors in Chief: Patrick Romano, MD, MPH and Deb Bakerjian, PhD, APRN, RN
  - Spotlight Editors: Patrick Romano, MD, MPH and Amy Nichols, EdD, RN
  - Managing Editor: Meghan Weyrich, MPH

Objectives

At the conclusion of this educational activity, participants should be able to:

- Describe how health care providers should evaluate acute neurological deficits of less than 24 hours duration.
- Summarize the evidence base for the 24-hour time window for “stroke alerts” when patients present with acute neurological deficits.
- Explain why CT (computed tomography) angiography and perfusion imaging are now routine components of stroke alert assessment.
- Improve communication and teamwork among specialties involved in assessing and treating patients with acute neurological deficits.
- Describe the role of telestroke-guided care to reduce disparities and improve access to subspecialty services for patients in rural and underserved communities.

MISSING A LARGE VESSEL OCCLUSION STROKE IN A PATIENT WITH A HISTORY OF SEIZURES

This case highlights the importance of timely use of stroke alert protocols, challenges with CT angiography in early acute ischemic stroke, and the importance of communication and collaboration between ED and neurology teams.

Case Details (1)

- A 58-year-old man with a past medical history of seizures, meningioma, type 2 diabetes mellitus, and hypertension presented to the emergency department (ED) with acute onset of left gaze deviation, expressive aphasia, and right-sided hemiparesis
  - It had been 12 hours from the time he was last known to be at his neurological baseline.
- Initial laboratory tests, including kidney function, and a non-contrast cranial computed tomography (CT) scan, were unremarkable.

Case Details (2)

- The patient was evaluated by the general neurology team in the ED. They suspected an acute ischemic stroke and requested an evaluation by the stroke neurology team.
- A stroke alert was not activated upon ED arrival, nor at the first suspicion that a stroke had occurred.
- The stroke team promptly but remotely reviewed the electronic health records and CT images and concluded that the patient had suffered a focal seizure prior to arrival and had postictal deficits.
- The stroke team did not order emergent CT angiography and perfusion imaging, but recommended routine magnetic resonance imaging with angiography (MRI/MRA) for further evaluation.

Case Details (3)

- The MRI/MRA showed extensive cerebral infarction in the distribution of an occluded left middle cerebral artery (MCA).
- Continuous electroencephalogram monitoring did not reveal any seizure activity. Repeated physical examinations demonstrated persistence of the aphasia and hemiparesis.
- Due to the delayed diagnosis of left MCA stroke, it was too late to perform any neurovascular intervention.

MISSING A LARGE VESSEL OCCLUSION STROKE IN A PATIENT WITH A HISTORY OF SEIZURES

THE COMMENTARY

By Kevin Keenan, MD and Daniel Nishijima, MD, MAS

BACKGROUND

Background (1)

- Once considered experts in a field with very few interventions, neurologists now provide hyperacute treatment for neurological emergencies.
- The 1996 Food and Drug Administration approval of alteplase (a recombinant tissue plasminogen activator) for intravenous thrombolysis in acute ischemic stroke and, more recently, endovascular therapy for large vessel occlusion (LVO) strokes, has led to a paradigm shift towards time-dependent interventions.

Background (2)

- Currently, acute ischemic stroke patients can be treated as late as 24 hours after they were last known to be at their neurological baseline.
- This extended time window primarily applies to endovascular therapy for internal carotid and middle cerebral artery (MCA) strokes (i.e., LVOs), in which specialized catheters are deployed within the large arteries of the brain to remove cerebral clots in the hope of saving ischemic but not yet infarcted penumbral tissue.

EVALUATION OF ACUTE NEUROLOGICAL DEFICITS

Evaluation of Acute Neurological Deficits (1)

- Despite advances in technology, neurologists still use medical history and neurological examination to localize lesions and generate a differential diagnosis.
- In this case, the presence of aphasia, leftward gaze deviation, and right hemiparesis strongly suggested dysfunction of the left cerebral hemisphere. The patient's past medical history of seizures and his normal non-contrast cranial CT could be compatible with a postictal syndrome that followed left-hemispheric focal seizures.

Evaluation of Acute Neurological Deficits (2)

- However, premature closure on this diagnosis contributed to this missed opportunity to recognize that his symptoms were instead due to an LVO stroke.
- As a result, the patient was not evaluated for endovascular stroke treatment that might have saved ischemic, but not yet infarcted, brain tissue.

Evaluation of Acute Neurological Deficits (3)

- The evaluation of acute neurological deficits can be complicated, as many different conditions can present with symptoms similar to acute ischemic stroke.
- Emergency care providers should only make other diagnoses, such as postictal deficits or complex migraines, after acute ischemic stroke has been appropriately ruled out.
- The therapeutic time window for acute ischemic stroke is relatively narrow, and any delays in diagnosis and treatment lead to increased morbidity and mortality.

Evaluation of Acute Neurological Deficits (4)

- The Neurocritical Care Society offers Emergency Neurological Life Support (ENLS) training for those interested in improving their approach to the differential diagnosis and initial management of acute neurological deficits.
  - ENLS training addresses what emergency care providers should do in the first hour to best help patients and to appropriately hand them off to specialty care providers.
  - The instructional program is focused on recognizing symptoms and signs and learning diagnostic and therapeutic protocols, checklists, decision points, and suggested approaches to handoff communication

STROKE ALERTS

Stroke Alerts (1)

- Stroke alerts comprise a mechanism to expedite the work-up and treatment of patients with new – within 24 hours – neurological deficits.
- This time window is based on two key studies published in 2018.
  - The ***DAWN trial*** used clinical-core mismatch (a combination of age-adjusted National Institutes of Health Stroke Scale [NIHSS] score and age-adjusted core infarct size on CT perfusion imaging or MRI) to select patients with large anterior circulation vessel occlusion for mechanical thrombectomy between 6 and 24 hours from last known normal. This trial demonstrated an overall benefit in functional outcome at 90 days, with 49% of treatment group versus 13% of control group patients having no or slight disability, with a modified Rankin score (mRS) of 0–2 (adjusted difference, 33%; 95% confidence interval [CI], 21–44%).
  - The ***DEFUSE 3 trial*** used perfusion imaging to select patients with sufficient ischemic tissue that was not yet infarcted (penumbra), relative to tissue that was already infarcted (core), for mechanical thrombectomy of anterior circulation occlusions at 6 to 16 hours from last known normal. This trial also showed a benefit in functional outcome at 90 days, with 45% of treatment group versus 17% of control group patients having an mRS score 0–2 (RR, 2.67; 95% CI, 1.60–4.48).

Stroke Alerts (2)

- Stroke alerts typically involve notification of an on-call neurologist, a radiologist, and nursing and pharmacy team members who acutely evaluate the patient.
- Stroke alerts emphasize ruling out intracerebral hemorrhage with a non-contrast cranial CT, administering intravenous thrombolysis for suspected acute ischemic stroke, and identifying patients with possible LVO strokes who require further evaluation using CT angiography (to identify the occluded vessels) and perfusion imaging (to determine penumbra size and identify otherwise missed occlusions).
  - It is important to remember that non-contrast cranial CT can look completely normal early in the course of acute ischemic stroke. The presence of hypodensities can alert clinicians to the presence of ischemic stroke, *but their absence does not exclude a diagnosis of acute ischemic stroke*.

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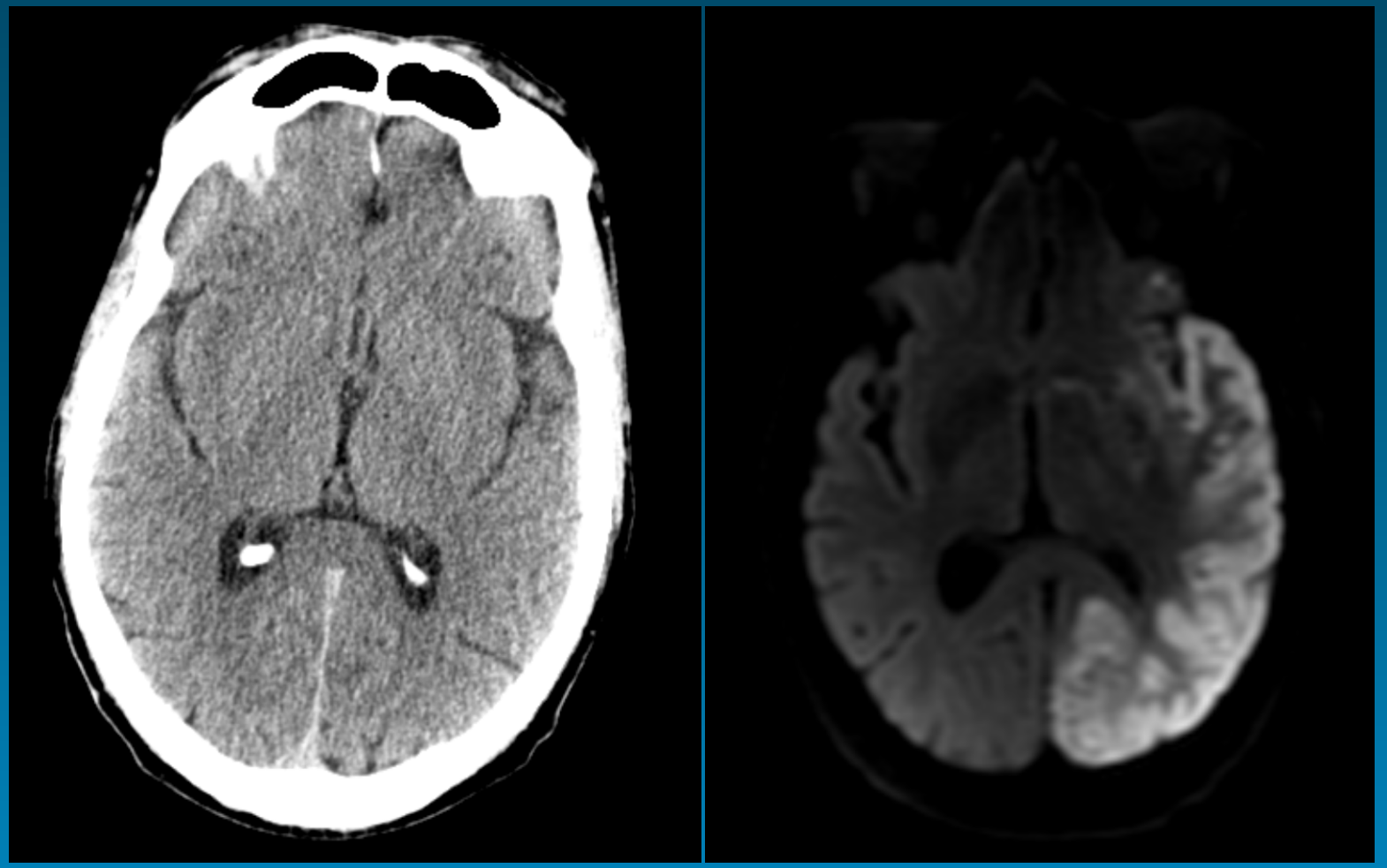
Stroke Alerts (4)



Left - A normal non-contrast head CT during acute ischemic stroke does not rule out an acute ischemic stroke.

Right - MRI of the same patient demonstrates a left temporal and occipital acute ischemic stroke.

ROUTINE USE OF CT ANGIOGRAPHY AND PERFUSION IMAGING

Routine Use of CT Angiography and Perfusion Imaging (1)

- The routine use of CT angiography and perfusion imaging as part of an initial stroke alert assessment is supported by consensus recommendations published in 2021 that resulted from a meeting of stroke thought leaders.
- This recommendation represents a change from the 2019 American Heart Association/American Stroke Association (AHA/ASA) guidelines, which recommended such imaging only for certain patients, especially those being considered for mechanical thrombectomy 6 to 24 hours after symptom onset.

Routine Use of CT Angiography and Perfusion Imaging (2)

- Routinely including non-contrast cranial CT, CT angiography, and CT perfusion in a single stroke alert imaging protocol has important advantages.
  - Most salient to the patient discussed in this case, CT angiography and CT perfusion can help clinicians who did not initially suspect LVO stroke to make the diagnosis earlier.
  - This advantage also applies to strokes from medium or distal vessel occlusions, which may present with atypical stroke symptoms and therefore not be recognized as eligible for thrombolysis.

Routine Use of CT Angiography and Perfusion Imaging (3)

- Reliance on the NIHSS as a trigger to obtain CT angiography and CT perfusion imaging is not recommended due to its poor sensitivity and specificity for treatment-eligible LVO stroke.
- However, there remains room for judgment, and either CT angiography or perfusion imaging can be canceled if a thoughtful clinical assessment determines the likelihood of stroke or stroke intervention is particularly low.

Routine Use of CT Angiography and Perfusion Imaging (4)

- Historically, there has been hesitance to routinely perform CT angiography during stroke alerts due to concerns about causing contrast-related acute kidney injury.
- Some stroke alert imaging protocols require obtaining the results of serum creatinine testing prior to performing CT angiography.
- However, given that LVO strokes are associated with significant morbidity and mortality and that contrast-induced nephropathy is rare and reversible, these protocols are flawed.

Routine Use of CT Angiography and Perfusion Imaging (5)

- According to 2019 AHA/ASA guidelines, it is reasonable to proceed with stroke imaging by CT angiography without waiting for serum creatinine results when there is suspicion of an LVO, no known history of kidney disease, and the patient would otherwise qualify for endovascular treatment.
- As suggested by Brinjiki and colleagues, physicians should focus on saving “neurons over nephrons” when an LVO stroke is suspected.
- There are also concerns that performing CT angiography and perfusion imaging during the initial stroke alert may delay intravenous thrombolysis, especially if the patient is sent to the scanner without an accompanying treatment-ready team.

Routine Use of CT Angiography and Perfusion Imaging (6)

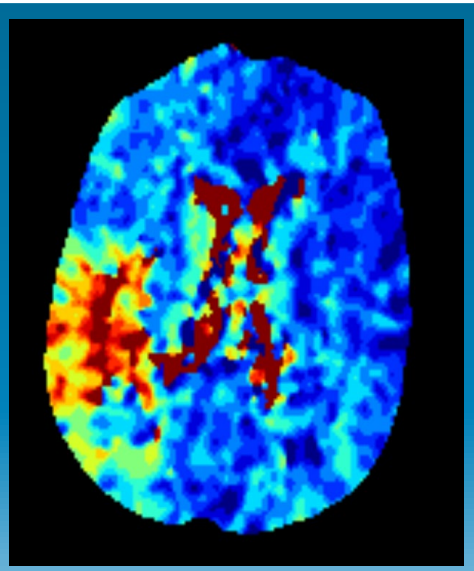
- However, best practice strategies described in AHA Target Stroke Phase III include starting thrombolysis in the CT scanner after the non-contrast cranial CT is performed to rule out intracranial hemorrhage if the team is otherwise ready.
  - Once thrombolysis is started, CT angiography and perfusion imaging can begin immediately because the patient remains on the CT scanner.
  - This is preferred over protocols that require the patient to leave the scanner for thrombolysis and return for CT angiography and perfusion imaging. In pooled patient-level data from 5 clinical trials, the odds of better disability outcomes at 90 days with mechanical thrombectomy declined with longer time from symptom onset to arterial puncture, from 2.79 (95% CI, 1.96–3.98) at 3 hours to 1.98 (95% CI, 1.30–3.00) at 6 hours and 1.57 (95% CI, 0.86–2.88) at 8 hours.
  - Given this finding, the AHA/ASA guidelines recommend avoiding any cause for delay to perfusion imaging and mechanical thrombectomy, such as observing for a clinical response after intravenous thrombolytic therapy.

Routine Use of CT Angiography and Perfusion Imaging (6)

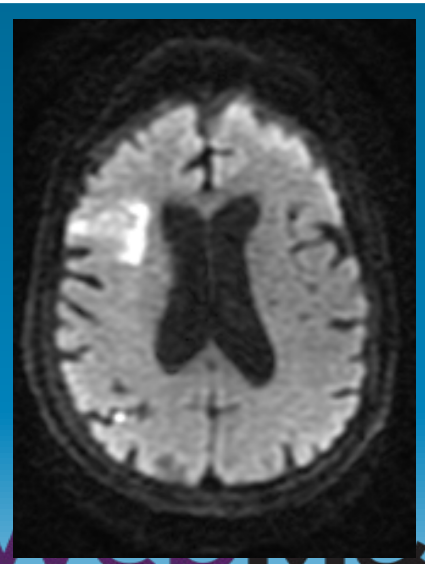
An acute ischemic stroke is absent on non-contrast head CT in the right hemisphere.

CT angiogram demonstrates the right middle cerebral artery is occluded, causing a large vessel occlusion stroke.

CT perfusion demonstrates a large area of right middle cerebral artery territory brain tissue at risk for infarction.



MRI after endovascular therapy demonstrates a small right middle cerebral artery stroke. Most of the brain tissue that was at risk of infarction was saved by emergency endovascular treatment.



COMMUNICATION AND HANDOFFS

Communication and Handoffs (1)

- The delayed diagnosis of LVO stroke in this case may be partially attributed to poor communication and diffusion of responsibility among the members of the three teams involved (emergency medicine, general neurology, and stroke neurology).
  - Both the emergency medicine and general neurology teams might have reasonably assumed that the work-up was progressing appropriately after consultation with the stroke neurology team.
  - Consultation with the stroke neurology team may have inappropriately taken the place of stroke alert activation, thereby eliminating the opportunity for rapid CT angiography and perfusion imaging and dedicated mobilization of treatment resources.
  - AHA/ASA guidelines recommend implementation of acute clinical assessment teams, imaging protocols, and handoff procedures targeted specifically towards suspected stroke patients.

Communication and Handoffs (2)

- Since the approval of alteplase for stroke, the demand for in-hospital stroke alert assessments around-the-clock has outpaced the supply of neurologists.
- This situation facilitated the growth of the neurohospitalist specialty and the rise of telestroke systems of care.
- Neurologists have long offered diagnostic and therapeutic recommendations per stroke alert protocols over the telephone to hospitals without local expertise, to increase treatment access in rural and underserved communities.

Communication and Handoffs (3)

- In many places, this consultative service has been replaced by telestroke systems that include high-quality videoconferencing for patient assessments and remote review of images. In this way, a stroke neurologist can guide management of a patient, informed by other providers' examinations, information in the electronic health record, and "teleradiology" assessment of images.
  - A systematic review and meta-analysis found no difference in mortality or in functional independence at 3 months between telestroke-guided and stroke center–managed patients with acute ischemic stroke, due in part to safe and timely administration of intravenous thrombolysis with both systems.
  - However, the hospital in this case had a stroke neurology team, so the decision to obtain non-acute MRI/MRA imaging rather than acute CT angiography and perfusion imaging suggests a diagnostic error (unless additional information contributed to the course of action taken).

Communication and Handoffs (4)

- Finally, this case highlights the importance of a team approach involving serial neurologic assessment by clinicians who are communicating regularly with each other.
  - A repeat neurological examination probably would have demonstrated that the left hemispheric symptoms were not improving as expected for a postictal state, prompting earlier cerebrovascular imaging.
  - If the diagnosis of ischemic stroke had been established in a timely manner, close monitoring for signs of neurological worsening would have been recommended to detect brain swelling or hemorrhagic conversion.

TAKE HOME POINTS

Take-Home Points (1)

- Neurological examination findings can be similar for postictal deficits and LVO strokes. The initial evaluation should therefore focus on time-sensitive and treatable neurological emergencies such as acute ischemic stroke (with and without LVO), intracranial hemorrhage, meningoencephalitis, and status epilepticus.

- Stroke alert protocols should be activated as soon as possible for patients presenting with new neurological deficits who were last known to be at their neurological baseline within the previous 24 hours.

Take-Home Points (2)

- Stroke alert imaging should routinely include non-contrast cranial CT with CT angiography and perfusion imaging.

- Findings from non-contrast cranial CT can appear normal in early acute ischemic stroke and this technology is primarily used to rule out intracranial hemorrhage. Hypodensities can alert clinicians to the presence of ischemic stroke, but their absence should not remove it from the differential diagnosis when the history and examination findings are otherwise compatible with stroke.

Take-Home Points (3)

- For patients with no known kidney disease and suspected LVO stroke, CT angiography and perfusion imaging should not be delayed awaiting results of serum creatinine measurement because the benefit of endovascular therapy for LVO stroke outweighs the potential harm associated with contrast administration in most cases.
- Neurological emergencies require collaboration among members of the ED team and one or more neurology teams. Clear communication and standardization of clinical, imaging, consultation, and handoff protocols are recommended.
- When an on-site stroke team is not available, telestroke-guided care by a remote stroke neurologist with the ability to review CT images can achieve similar patient outcomes.

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