

# Neuroradiology and Stroke **CLINICAL PATHWAY**

*Presented by:*

Neuroradiology Subspecialty Division

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*The information presented here is not intended to articulate the standard of care applicable to any specific patient presentation, but rather serve as an educational resource for the reader.*

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# STROKE PROCESS IMPROVEMENT PEARLS

- This is a collection of stroke best practices compiled by the RP Neuroradiology Advisory Board.
- It is meant to serve as a reference for practicing radiologists establishing stroke programs at their institutions, as well as a collection of stroke interpretation and reporting pearls.
- Nothing in this guide is a mandate, and local radiologists should work with their facilities and healthcare teams to create policies that work best for their patients.
- National stroke guidelines are constantly being updated, and this guide is current as of March 2023.



RP Radiologists

Condensed quick guides with the presented information for nursing and technologists are available in the [Clinical Pathways section](#) on RadWiki.

Questions or comments? Contact [clinicalvalueteam@radpartners.com](mailto:clinicalvalueteam@radpartners.com).

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*Jump to each section by clicking on underlined headings*

# TRIAGE

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# TRIAGE

- Triage recommendations are to share with stroke coordinators, ER directors and others involved with systems-level stroke care at a facility.
- It is critical an adequate history is provided for stroke patients.
  - “Stroke” or “CVA” is not sufficient.
  - Best to include actual clinical symptom(s), laterality and time of onset, if known.
- The term “code stroke” should be used for up to 24 hours from symptom onset due to the current mechanical thrombectomy guidelines.
- Recommended patients have an IV started prior to the non-contrast head CT.
  - This allows lab draws to occur concurrently with the initial physician evaluation.
  - IV access is needed for contrast-enhanced CTA and for administering tPA.
  - CTA turnaround times are much faster when done immediately after non-contrast head CT.
  - There is limited to no clinical benefit of accelerating non-contrast CT head times if door-to-needle times are not also improved.

# HEAD CT

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# HEAD CT | TECHNOLOGISTS

- Send completed images with sagittal and coronal reformats to PACS immediately upon completion.
  - Even if CTA is bundled, head CT images should be sent before starting CTA using a separate accession number.
  - Reformatted images are useful for measuring hemorrhage in 3-dimensions for accurate volume calculations.
- Head CT images should be flagged in PACS to indicate “code stroke”.
  - Many practices also have a technologist call the reading room.
  - Some flagging options include:
    - Separate order
      - i.e. CT Head vs. CT Head Stroke
      - Dependent on ordering physician and can be used incorrectly for nonacute strokes
    - User assignment
      - Some PACS allow studies to be assigned to a specific user so a code stroke “user” can be created
      - Dependent on CT technologist rather than order entry
      - Can be used for multiple types of exams for the same patient
    - Priority level: Some PACS, including RP Cloud, have a priority level for “code stroke” separate from “stat”.

# STROKE HEAD CT | INTERPRETATION PEARLS

- This list is not meant to be an exhaustive tutorial on stroke head CT interpretation or reporting but rather highlights common issues we have encountered.
- Parenchymal hypodensity on CT does not always equate to "subacute" stroke in terms of modern treatment windows and must be correlated with degree of brain swelling.
  - If brain swelling is present, the stroke may still be relatively acute and a candidate for thrombectomy.
  - Hypodensity can only be called chronic if there is volume loss.
- It is better to recommend head & neck CTA rather than MRI if parenchymal hypodensity is visualized without definite volume loss and symptom onset is within 24 hours.
- Recommending MRI in this setting can lead to patient care delays and possible missed thrombectomy in facilities without 24/7 MRI.



# STROKE HEAD CT | REPORTING PEARLS

- Avoid ambiguous terminology such as “negative” or “positive”.
  - Presumably, “negative” means normal head CT, which can be the most critical for acute stroke as it indicates a possible candidate for tPA.
  - “Positive” may mean hemorrhage or early signs of stroke. These have very different treatment pathways.
- “No acute findings” is only an appropriate Impression if there are no significant chronic findings that could still affect the tPA decision such as:
  - Chronic hematoma or extra-axial collection
  - Large area of hypodensity from subacute to chronic stroke
  - Prior craniotomy (tPA contraindicated if within 3 months)
- ASPECTS:
  - Usage is site dependent and not mandated by Radiology Partners.
  - Currently published stroke guidelines do not require the use of ASPECTS.
  - Alternatively report if areas of parenchymal hypodensity exceed 1/3 of the MCA territory, which roughly corresponds to ASPECTS <6.

# STROKE HEAD CT | REPORTING PEARLS

- Follow-up recommendations
  - If there is concern for acute to early subacute stroke (within 24 hours), recommend CTA not MRI for initial follow-up.
    - CTA will better guide possible thrombectomy.
    - Recommending MRI in this setting can lead to patient care delays and possible missed thrombectomy in facilities without 24/7 MRI.
  - If there is a known severe iodinated contrast allergy, non-contrast MRA can be recommended instead of CTA.
- Communication of findings
  - Every institution may have a slightly different process:
    - Doc-to-doc
    - Dedicated stroke nurse phone number
    - Radiology call service
  - Choose a notification process that is reliable and fast to ensure timely tPA administration (current guidelines aim for door-to-needle time of < 30 minutes).

# HEAD & NECK CTA

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# HEAD & NECK CTA | TECHNOLOGISTS

- IV should ideally be started prior to non-contrast head CT, and CTA should be performed back-to-back without taking the patient off the table.
- Contrast should be preloaded in the injector as soon as a code stroke is announced, which can be prior to patient arrival at the facility.
- Do not delay exam waiting for lab results in a patient with acute stroke symptoms.
- If there is a known documented allergy to iodinated contrast, non-contrast MRA can be performed instead of CTA.

# HEAD & NECK CTA | TECHNOLOGISTS

- Include thin axials ( $\leq 1\text{mm}$  thick) through the head and neck in a single stack.
- Post processing
  - Eliminate 3D images in the acute setting.
    - Post processing time results in delays to patient care.
    - This can still be performed offline if they do not delay initial interpretation.
  - Instead of 3D images, recommend thick maximum intensity projection images (MIPs) in 3 planes through the head (10mm thick x 2-3mm spacing) and at least coronal and sagittal planes through the neck.
    - MIPs fulfill the CTA billing requirements.
    - MIPs can be performed directly on most scanners without a separate workstation.
    - MIPs have less technologist variability compared to 3D images.
    - MIPs are much more useful diagnostically than 3D for finding pathology, particularly in smaller branches.

# HEAD & NECK CTA | TECHNOLOGISTS

- Head & Neck CTA images should be flagged in PACS to indicate “code stroke”.
  - Many practices also have a technologist call the reading room.
  - Some flagging options include:
    - Separate order
      - i.e. CTA Head vs CTA Head Stroke
      - Dependent on ordering physician and can be used incorrectly for nonacute strokes
    - User assignment
      - Some PACS allow studies to be assigned to a specific user so a code stroke “user” can be created
      - Dependent on CT technologist rather than order entry
      - Can be used for multiple types of exams for the same patient
  - Priority level: Some PACS, including RP Cloud, have a priority level for “code stroke” separate from “stat”.

# STROKE HEAD & NECK CTA | INTERPRETATION REPORTING PEARLS

- This list is not meant to be an exhaustive tutorial on head & neck CTA interpretation or reporting but rather highlights common issues we have encountered.
- Time is brain! Prioritize turnaround time.
- Excessive thoroughness is detrimental to patient care if it results in a prolonged turnaround time. Do not delay dictation describing small thyroid nodules or spinal degeneration.
- For complicated dictations that need more time:
  - Report any occlusions by phone as quickly as possible before completing the dictation.
  - Document the time of the phone call in the final dictation.
- Work with local clinicians to decide when direct communication is necessary:
  - Every code stroke CTA
  - Only CTAs with occlusions needing thrombectomy
  - Any abnormal findings such as occlusion, stenosis, aneurysm, etc.

# STROKE HEAD & NECK CTA | INTERPRETATION REPORTING PEARLS

- "Large vessel occlusion" is an ambiguous term and becoming outdated as better clot retrieval devices become available.
- Recommend reporting any and all occlusions, particularly to the level 3 branches of the anterior, middle and posterior cerebral arteries.
- Remember to look for prior exams to assess if occlusion is chronic.
- Avoid use of phrases such as "possible occlusion" or "may be occluded".
  - Definitive diagnosis helps throughput for acute stroke patients.
  - It is better to err on overcalling if there is clinical concern so that a patient can be evaluated in the angiography lab.
- Report and grade vascular stenoses (mild, moderate or severe). Although stenoses do not lead to thrombectomy, they will affect downstream medical management.
- For carotid stenosis, use NASCET criteria – diameter at stenosis compared to diameter of distal normal vessel with parallel walls.



# CEREBRAL PERFUSION CT

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# CEREBRAL PERFUSION CT | TECHNOLOGISTS

- Post processing
  - Color maps are not sufficient for modern stroke care.
  - Be able to calculate core and penumbra volumes with software such as aidoc, RAPID or Viz.
- Perfusion CT images should be flagged in PACS to indicate “code stroke”.
  - Many practices also have a technologist call the reading room.
  - Some flagging options include:
    - Separate order
      - i.e. CT Perfusion vs CT Perfusion Stroke
      - Dependent on ordering physician and can be used incorrectly for nonacute strokes
    - User assignment
      - Some PACS allow studies to be assigned to a specific user so a code stroke “user” can be created
      - Dependent on CT technologist rather than order entry
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# CEREBRAL PERFUSION CT | TECHNOLOGISTS

- When to perform
  - Some sites perform for all code strokes.
    - Helps diagnose distal occlusions, e.g. M2
    - Increases speed of CTA interpretation
  - Some sites only perform if between 6-24 hours from last known well.
    - Current American Stroke Association guideline
    - Reduces extra radiation and contrast exposure
- Sequencing
  - This can be controversial due to legacy habits.
  - Recommend performing CTP after CTA.
    - Results in less venous contamination on CTA
    - CTP is calculated on relative changes in contrast so circulating contrast has minimal effect on final result

# CEREBRAL PERFUSION CT | INTERPRETATION PEARLS

- This must be read with knowledge of head CT and head & neck CTA findings.
  - Subacute infarction with hypodensity on CT can result in false negative core if there is reperfusion.
  - Site of occlusion on CTA can help determine if a finding on perfusion is real or artifactual.
- Ensure that arterial and venous bolus curves are adequate.
  - Should peak above 150 HU
  - Must return to a flat baseline
- In the first hour from symptom onset, CBF<20% is a better predictor of core than CBF<30% (ghost infarct core).
- Seizure can make the ipsilateral side hyperperfused, which makes the contralateral side look relatively hypoperfused and results in false positive.

# BRAIN MRI/MRA

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# BRAIN MRI/MRA

- These have a limited role in acute stroke except at highly specialized centers with 24-hour availability.
- MRI may be more accurate than CT perfusion to measure core infarction size in posterior circulation strokes.
  - If used for acute time-dependent treatment decisions, such as for mechanical thrombectomy, consider an abbreviated stroke protocol MRI.
  - Avoid abbreviated stroke protocol MRI in other scenarios as standard brain MRI offers a more complete evaluation for stroke mimics.
- Stroke protocol MRI includes:
  - Axial DWI/ADC
  - Axial FLAIR
  - Axial GRE
- If there is a known documented allergy to iodinated contrast, non-contrast MRA can be performed instead of CTA.

# IMPACT MEASUREMENT

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# IMPACT MEASUREMENT

- Recommend active participation in stroke committees to show the positive impact of radiology.
- If updating protocols at a new site:
  - Measure door-to-needle times before and after changes are implemented.
  - Look at door-to-groin puncture times for mechanical thrombectomy patients.
- For any radiology-related stroke fallouts, get granular data to better understand where problems arise and how to address them:
  - Time from arrival until patient is on the scanner (ED)
  - Time from patient on the scanner until completed exam is available on the worklist (radiology technologist)
  - Time from study on the worklist till findings reported and/or called (radiologist)





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