Imaging for Pediatric Headache: 
Clinical Algorithms to Guide Imaging Decision Making

Developed and Contributed by:
Emory University School of Medicine
Emory University Department of Radiology and Imaging Sciences
Children’s Healthcare of Atlanta (Egleston), Department of Radiology

Algorithm Development Background

Nadja Kadom, MD
Associate Professor, Emory University School of Medicine
Director of Pediatric Neuroradiology and Director of Quality, Department of Radiology at Children’s Healthcare of Atlanta (CHOA, Egleston)

Our goal for this project is to guide imaging use in children with headaches through visual representation of evidence-based clinical algorithms. We identified three types of headache in need of guidance: general, trauma, infection, and sinus headaches. We developed an algorithm for each type based on existing consensus statements and clinical practice guidelines by professional medical societies, including the American College of Radiology Appropriateness Criteria®. The information was conveyed as visual algorithms featuring clinical yes-no decision trees that ultimately lead to either an imaging recommendation or an alternative workup without imaging.

Each algorithm was reviewed by a specialist in the field at our institution: neurology for the general algorithms, emergency medicine for the trauma algorithm, otolaryngology for the sinus algorithm, and neuroradiology for all algorithms. These specialists along with community pediatricians and pediatric specialists provided feedback that resulted in modifications and ultimately algorithm approval.

We are sharing the initial and the adapted algorithms as a starting point for practitioners throughout the U.S. who would like to adapt these to their local practice needs. The algorithms represent the state of evidence in 2019 and a process for continuous monitoring of emerging evidence and changes to the algorithms should be implemented. The algorithms incorporate clinical as well as radiologic information, cover a broad spectrum of pediatric headache, and can be adapted to multiple practice contexts (e.g., primary care office, emergency department, inpatient). For example, during our adaptation process the “infection” algorithm was folded into the general algorithm because the next step would be imaging or a lumbar puncture and those procedures are not performed in our community pediatrician offices and would require referral to the hospital as the next step. Also, we modified red flags for headache according to our neurologists’ practice preferences, although some of these changes are not supported (yet) by scientific evidence.

The adapted algorithms are currently part of a quality improvement project in our community where we are tracking various interventions geared towards improved imaging use, starting with educating referring physicians and providing access to these algorithms. I encourage other pediatric radiologists to consider similar projects within their healthcare setting to include using an R-SCAN quality improvement project to track progress.
Algorithm Disclaimer

The algorithms in their current form are not intended for clinical use, instead they should be reviewed and adapted to local practice needs and local expert opinions. Both the original algorithms and the post-interdisciplinary team review adopted algorithms are presented to demonstrate changes that may result from working with a multi-disciplinary team on local adaption.

Implementing the Tools

Algorithms:
• Assemble interdisciplinary teams
• Review and revise algorithms as desired
• Implement as guidance materials

Associated Quality Improvement Project:
• Set SMART goals: Specific, Measurable, Attainable, Relevant and Timely
• Measure baseline and outcomes after algorithm implementation and adoption by all stakeholders
• Use continuous improvement methodology to achieve the desired results
• Use an R-SCAN QI Project template to track progress for participants to earn 20 performance improvement CME. Contact: rscaninfo@acr.org for more information.
**References**


Have symptoms been present continuously for 90 or more days?

Medical/adenoid management failed?

Does patient meet criteria for acute bacterial sinusitis?

Invasive fungal sinusitis suspected?

Orbital and/or CNS complications suspected?

Recurrent episode?

CT sinus with contrast. Include orbits and head if complications are suspected.

Medical/adenoid management for chronic rhinosinusitis

CT sinus, non-contrast (detect obstructive conditions or planning for endoscopic sinus surgery)

Medical management for acute bacterial sinusitis

Symptomatic treatment. Consider migraine with autonomic symptoms as headache etiology.

SINUS HEADACHE*

References

Notes:
• No imaging studies can reliably distinguish viral URI and acute bacterial sinusitis and are thus not recommended for this purpose.1,2,3

a. Seen in immunocompromised patients, especially with hematologic malignancy. Classic presentation is painless septal necrosis.1,2
b. Persistent illness ≥10 days; OR worsening course after initial improvement; OR concurrent purulent nasal discharge and fever for 3+ days.3
c. Signs of orbital complications: proptosis, impaired function or pain of extraocular muscles. Signs of CNS complications: photophobia, seizure, very severe headache, focal neurologic deficit.3
d. Defined as discrete episodes of <30 days, separated by >10 symptom-free days. Some experts only consider 4+ episodes within 1 year to be “recurrent.”3
e. Consider adding CTA or MRA/MRV, either as follow-up or part of initial imaging protocol, if vascular complication (e.g. venous thrombosis, mycotic aneurysm) is suspected.1
f. Antibiotics, topical nasal steroid spray, nasal saline irrigation. Children under 6 may benefit from adenoidectomy, with no prior imaging required.4
g. Oral amoxicillin +/- clavulanate. Follow up after 72h to tailor therapy if necessary and reassess for complications. Use IV cefotaxime or ceftriaxone in acutely ill/toxic patients.3
Nonaccidental trauma suspected?

Refer to CHOA child abuse protocol

No

TRAUMA HEADACHE*

Patient presenting within 24 hours of trauma?

Is GCS 13 or below?

Refer to PECARN rules

Yes

Are any “red flags” present?*

Symptomatic treatment, no imaging necessary. Consider referral to concussion specialist if first-line treatments (NSAIDs, acetaminophen) fail.

CT head without contrast

Emergent: CT head without contrast

Non-emergent: MRI head without contrast

Notes:
- Concussion is a clinical diagnosis, and imaging is only indicated to rule out a more serious condition if red flags are present.
- Most post-traumatic headaches without concerning symptoms meet criteria for a primary headache syndrome, and diagnosis may help guide specific treatment options.

*RED FLAGS2,3,4
- Abnormal neurologic exam
- Cognitive impairment
- Progressive worsening since trauma
- Induced by position change or Valsalva
- Associated with vomiting
- Positive findings on acute CT

References
**ORIGINAL INFECTION HEADACHE ALGORITHM**
*(Prior to multidisciplinary team review)*

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**FEBRILE HEADACHE***

- **STAR**

- **Risk of intracranial complication?**
  - Yes: **Imaging**
  - No: Continue with algorithm

- **Imaging**
  - Imaging abnormal: **Neurology/Neurosurgery consult**
  - Imaging normal: Continue with algorithm

- **Signs of meningitis or encephalitis?**
  - Yes: **Lumbar puncture, blood cultures, empiric treatment**
  - No: Continue with algorithm

- **Lumbar puncture, blood cultures, empiric treatment**
  - Yes: **Signs of meningitis or encephalitis?**
  - No: Continue with algorithm

- **Signs of meningitis or encephalitis?**
  - Yes: Continue with algorithm
  - No: Continue with algorithm

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**References**


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**Notes:**

- Immunocompromise, papilledema, focal neurologic deficit, history of CNS disease (mass lesion, stroke, or focal infection including those associated with CSF shunt, hydrocephalus, trauma, and neurosurgery). Seizures, altered mental status, nausea/vomiting, and palsy of cranial nerve VI or VII may suggest intracranial abscess, but are also seen in meningitis so are not reasons to delay LP if indicated.
- If meningitis suspected, noncontrast CT (to r/o space-occupying lesion before performing LP). If not, MRI with and without contrast.
- Meningitis: nuchal rigidity, stiffness of the hamstring to knee extension (Kernig sign), involuntary hip & knee flexion with passive neck flexion (Brudzinski sign). Encephalitis: acute cognitive dysfunction, behavioral changes, focal neurologic signs, seizures. Specific etiologies may be further suspected based on exposures (e.g. foods, travel, animal contact)
- If encephalitis suspected or if LP findings are benign, add MRI with and without contrast.
For PCP or Office Settings

Pediatric Headache Algorithm

START

Onset within 7 days of head trauma?*

NO

YES

Fever present (≥38°C)

NO

YES

Red flags?†

YES

Trauma Headache Algorithm

No imaging necessary. Treat infection as indicated, symptomatic treatment of headache

NO

Risk of intracranial abscess*, meningitis or encephalitis?*

YES

Transfer to ED for further assessment

Emergent: CT non-contrast usually appropriate

Non-emergent: MRI non-contrast

Two first degree relatives with aneurysm: add MRA to MRI

Emergent: Needs to be imaged within 24 hours

Non-emergent: Needs to be imaged within 1 month (Expert opinion)

URI symptoms (no signs of worsening or complications)

NO

YES

History or concerns of sinus disease?‡

NO

YES

Signs of allergic rhinitis‡

Sinus Headache Algorithm

Primary headache or migraine likely, no imaging necessary

NO

YES

Treat underlying cause/symptoms

Treat underlying cause/symptoms

Refer to appropriate medical specialty as needed

References


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FINAL APPROVED SINUS HEADACHE ALGORITHM

Sinus Headache Algorithm*

STAR

Is the patient immunocompromised? a

YES

Consider risk of invasive fungal sinusitis and refer for urgent consultation with appropriate specialist

NO

Have symptoms been present continuously for 90 or more days with medical treatment? f

YES

Refer to otolaryngology

NO

Does patient meet criteria for acute bacterial sinusitis? b

YES

Orbital and/or CNS complications suspected? c

NO

Recurrent episode? d

YES

Medical management for acute bacterial sinusitis g

NO

Symptomatic treatment. Consider migraine with autonomic symptoms as headache etiology. 5

CT sinus (orbits, head) with contrast. Consult ENT/ophthalmology/neurosurgery as indicated by findings. e, 1

Note:
No imaging studies can reliably distinguish viral URI and acute bacterial sinusitis and are thus not recommended for this purpose. 1, 2, 3

References

* From the Overall Headache Algorithm question is “history or concerns of sinus disease”? 

a Seen in immunocompromised patients, especially with hematologic malignancy. Classic presentation is painless septal necrosis. 1, 2

b Persistent illness ≥10 days; OR worsening course after initial improvement; OR concurrent purulent nasal discharge and fever for 3+ days. 3

c Signs of orbital complications: proptosis, impaired function or pain of extraocular muscles. Signs of CNS complications: photophobia, seizure, very severe headache, focal neurologic deficit. 3

d Defined as discrete episodes of <30 days, separated by >10 symptom-free days. Some experts only consider 4+ episodes within 1 year to be “recurrent.” 3

e Consider adding CTA or MRA/MRV, either as follow-up or part of initial imaging protocol, if vascular complication (e.g. venous thrombosis, mycotic aneurysm) is suspected. 1

f Antibiotics, topical nasal steroid spray, nasal saline irrigation. Children <6 may benefit from adenoidectomy with no prior imaging required. 4

g Recommend antibiotic treatment. Follow-up after 72 hours to tailor therapy if necessary and reassess for complications. Use IV therapy in acutely ill/toxic patients. 3

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This algorithm is based on the PECARN Pediatric Head Injury Prediction Rule, a well-validated clinical decision aid that allows physicians to safely rule out the presence of clinically important traumatic brain injuries, including those that would require neurosurgical intervention among pediatric head injury patients who meet its criteria without the need for CT imaging.

**Trauma red flags**1,2,3,4 (>2 years of age)
- Abnormal neurologic exam
- Cognitive impairment or not acting normally, GCS <15
- Progressive worsening since trauma or after ED observation
- Induced by position change or Valsalva
- Associated with persistent vomiting
- Occipital parietal or temporal scalp hematoma
- History of LOC >5 sec
- Severe mechanism of injury**
- Multiple vs isolated findings

All of the above plus additional reasons for getting imaging (<2 years of age):
- Age <3 months

**Severe mechanism of injury includes:** motor vehicle crash with patient ejection or death of another passenger; rollover; pedestrian or bicyclist without helmet struck by a motor vehicle; falls of more than 3 ft (<2y) or 5 ft (>2y); head struck by high impact object

References