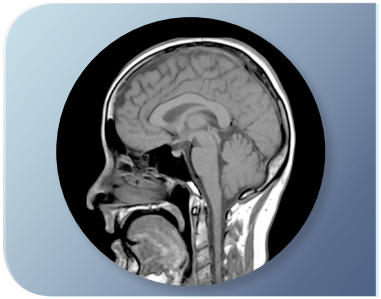

Intermountain Imaging Criteria:

Headache

Through its Intermountain Imaging Criteria Project, Intermountain Healthcare has developed a suite of standardized care process models (CPMs) for the use of advanced imaging procedures in eight priority clinical areas. These evidence-based guidelines are intended to be widely implemented in order to improve patient safety, improve outcomes, and reduce unnecessary medical spending for the Medicare population and the U.S. health system overall.

Why Focus ON INTERMOUNTAIN IMAGING CRITERIA?

Advanced imaging procedures, including MRI, CT, PET, and nuclear medicine, facilitate rapid and accurate detection and/or diagnosis of disease. The volume of advanced imaging procedures prescribed to patients in the U.S. increased three- to four-fold from 1996–2010 as the technologies became widely available.[SMI] The inflating costs of advanced imaging outstripped that of any other medical service.[IGL, GAO] These inflating costs resulted in up to $20–30 billion in unnecessary advanced imaging spending each year.[NYDH]

- **High cost.** Although the spending growth in advanced imaging dropped off after the early 2000s, 2014 costs to Medicare Part B for advanced imaging exceeded $2.4 billion for common conditions alone.[LEV, CMS1]
- **Limited effectiveness.** Multiple studies suggest that up to a third of advanced imaging procedures fail to contribute to diagnosis or are clinically inappropriate.[NYDH]
- **Patient safety.** Advanced diagnostic imaging often exposes the patient to ionizing radiation and/or contrast media, posing additional medical risks that must be weighed against the potential benefits of the imaging procedure.
- **Overdiagnosis and overtreatment.** There is an unrecognized risk of overdiagnosis and subsequent overtreatment that carries associated risks (e.g., drug reactions or unnecessary surgical interventions) if advanced imaging is performed in patients with low pretest probability. The Intermountain Imaging Criteria approach seeks to avoid these risks.

GOALS AND MEASURES

Indicates an Intermountain measure

This CPM was developed by Intermountain clinical experts to outline appropriate use criteria (AUC) for advanced imaging for headache. These guidelines, together with those for other priority clinical areas, will improve the quality of care provided to patients by:

- Increasing adherence to evidence-based AUC for the use of advanced imaging
- Reducing imaging tests that do not conform to AUC or for which there are no guidelines
- Decreasing system-wide spending on unnecessary advanced imaging services
- Reducing the risk of harm from unwarranted radiation exposure
- Documenting the incidence of a significant positive on advanced imaging tests and aligning with downstream care

WHAT'S INSIDE?

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OVERVIEW: INTERMOUNTAIN IMAGING CRITERIA APPROPRIATE USE CRITERIA CONTENT

Intermountain Imaging Criteria appropriate use criteria (AUC) support clinicians in providing evidence-based care to the patients they serve. Although appropriate use of Intermountain Imaging Criteria fulfills compliance requirements under PAMA, patients only fully benefit from their use as they are deployed within the framework of a locally driven quality improvement program. To learn more about Intermountain's process for developing and maintaining AUC, visit: https://intermountainhealthcare.org/services/imaging-services/intermountain-imaging-criteria/.

The care process model approach

Designed as Care Process Models (CPMs), the Intermountain Imaging Criteria AUC content is a blueprint that logically guides the delivery of evidence-based care via an algorithmic visual presentation (see pages 5 through 22). Although these Intermountain Imaging Criteria CPMs specifically focus on the appropriate use of advanced imaging, they can be viewed as portions of broader CPMs that guide not only diagnostic but therapeutic interventions for a specific disease or condition.

Ideally, Intermountain Imaging Criteria CPMs are engaged early in the patient encounter and guide the various considerations that lead to the ultimate decision regarding ordering of an imaging study. Point-of-order checklists are also included (beginning on page 23). These checklist-based guidelines are logically equivalent to the algorithms from which they are derived.

Knowing that local factors will invariably impact decisions about selecting the most appropriate exam, Intermountain Imaging Criteria CPMs specify the generally preferred exam but also provide alternative choices that may be appropriate in certain clinical settings.

Relative imaging cost and radiation risk rankings

To further aid providers, each algorithm includes a ranking of relative costs and radiation risk for each advanced imaging test recommended. The cost scale is derived using global non-facility relative-value units (RVUs) published by the Centers for Medicare and Medicaid Services (CMS) as a surrogate for cost.[CMS2] The radiation risk is derived from data published in 2010 by the Health Physics Society.[ACR, HPS]

Evidentiary review and ranking

Intermountain used the following two conceptual frameworks for evidentiary review of relevant literature:

1. The 2011 revision of the *Oxford Centre for Evidence-Based Medicine (OCEBM) 2011 Levels of Evidence* standard. This standard includes categorical leveling grades relevant to diagnostic studies and rates individual sources of evidence (published papers or other research data) on a five-point scale.[OCE]
2. The extensively used Fryback and Thornbury conceptual framework, which uses six levels for assessing the efficacy of diagnostic imaging.[FRY]

Each algorithmic presentation provides both rankings for the decision node (pairing of AUC and recommended/alternative tests).

Using the algorithms and checklists

Under "Care Pathways" on page 3, there is an annotated algorithmic sample for a typical clinical scenario found in this CPM. Under "Point-of-Order Checklist" on page 4, there is an annotated sample of a typical point-of-order checklist for an imaging procedure recommended within the above sample algorithm.

Abbreviations used in this CPM

AUC = appropriate use criteria
CMS = Centers for Medicare and Medicaid Services
CPG = clinical practice guideline
CPM = care process model
CSF = cerebral spinal fluid
CT = computed tomography
CTA = computed tomographic angiography
ENT = ear, nose, and throat
HA = headache
ICP = intracranial pressure
LP = lumbar puncture
MRA = magnetic resonance angiography
MRI = magnetic resonance imaging
OCEBM = Oxford Centre for Evidence-based Medicine
PCP = primary care provider
PET = positron emission tomography
RVU = relative-value units
TA = temporal arteritis
TN = trigeminal nerve
V1 = ophthalmic nerve
V2 = maxillary nerve
V3 = mandibular nerve

Care pathways

For each clinical scenario included (e.g., headache plus suspected infection), there is an algorithmic presentation of the care pathway context for the imaging decisions made. This pathway contains not only the appropriate use criteria (AUC) and evidence-based advanced imaging recommendations, but also what constitutes significant positive imaging results and downstream care recommendations. **Note that performing neuroimaging studies for chronic but stable headache (i.e., no new features and normal neurologic exam) is not recommended.**

This page presents the elements of the care pathway **below** and key information provided in each test recommendation box **at right**. There is a legend at the bottom of each care pathway page.

The Arabic number in the green box indicates an evidence ranking derived from the OCEBM scale.[OCE] For this scale, the **lower** the number, the stronger the evidence ranking.

The Roman numeral in the orange box indicates an evidence ranking derived from the Fryback & Thornbury scale.[FRY] For this scale, the **higher** the number, the stronger the evidence ranking.

Cost rankings are indicated based on a range developed from the CMS Global Relative Value Units (RVUs) as follows:[CMS2]

$ = 0–5 RVU
$$ = 5–10 RVU
$$$ = 10–15 RVU
$$$$ = 15+ RVU

Radiation risk rankings use the scale developed by the American College of Radiology.[ACR] This rating framework offers the following six levels for adult effective dose range risk:

R0 = 0 mSv
R1 = < 0.1 mSv
R2 = 0.1–1 mSv
R3 = 1–10 mSv
R4 = 10–30 mSv
R5 = 30–100 mSv

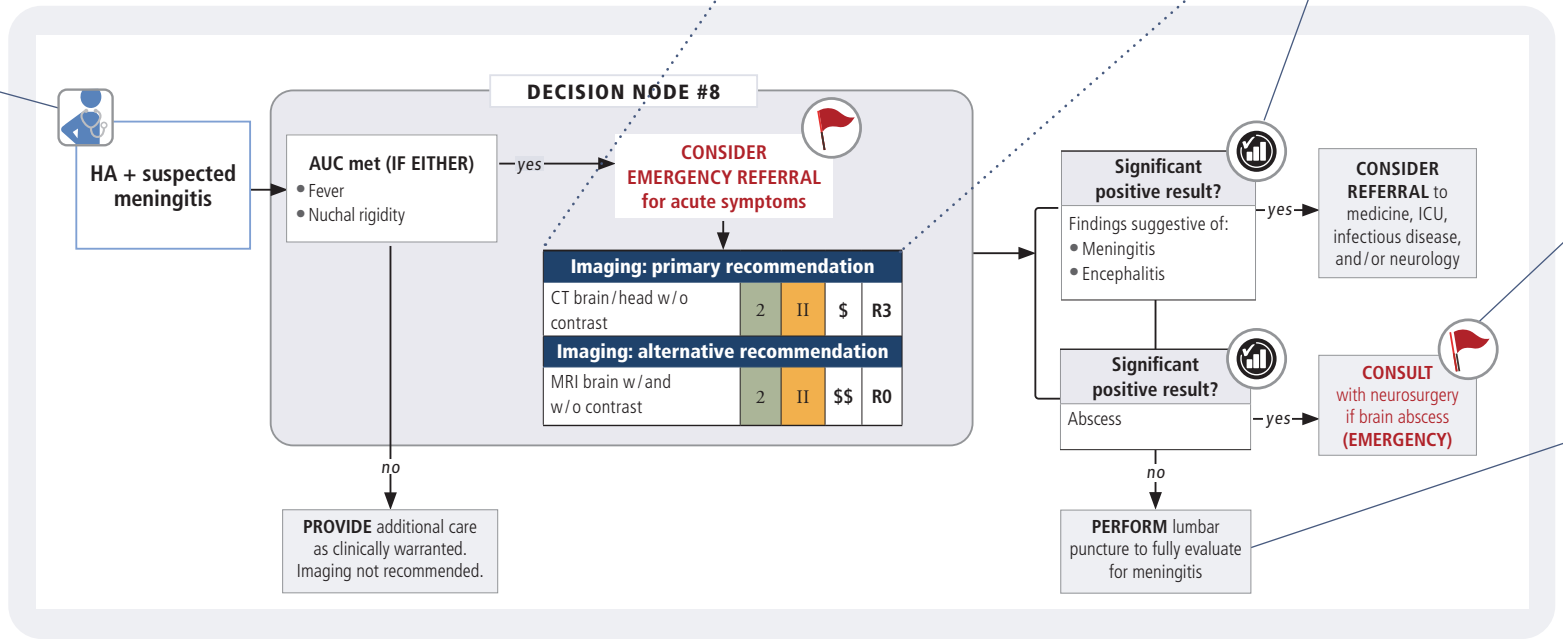
Imaging: primary recommendation				
CT brain/head w/o contrast	2	II	$	R3
Imaging: alternative recommendation				
MRI brain w/and w/o contrast	2	II	$$	R0

An alternate imaging recommendation has been included for when the primary recommendation is contraindicated or the alternative recommendation may be clinically appropriate.

The decision node box encompasses recommended advanced imaging based on the presence of evidence-based appropriate use criteria (AUC) or expert consensus (where evidence does not exist).

This symbol indicates an Intermountain internal measure. Intermountain measures incidence of significant positive results on advanced imaging tests.

This symbol indicates a common clinical scenario.



This red flag signifies an urgent or emergency situation (sometimes this red flag indicates a scenario that may require bypassing the AUC logic).

Downstream care recommendations are general guidelines and are subject to the discretion of individual healthcare providers and the providers' system protocols.

Point-of-order checklists

See abbreviations on page 2.

For each advanced imaging test (e.g., MRI and CT), there is a checklist that compiles all of the appropriate use criteria from each clinical scenario (shown in the care pathways) for that test. These are presented in a checklist format for the provider to select the appropriate scenario AND the criteria that apply to the patient's situation.

Tables included on pages 23 through 28 indicate if the test is a primary recommendation or alternative recommendation.

TABLE 8. MRI cervical spine **WITHOUT CONTRAST** (trauma protocol) appropriate use indications

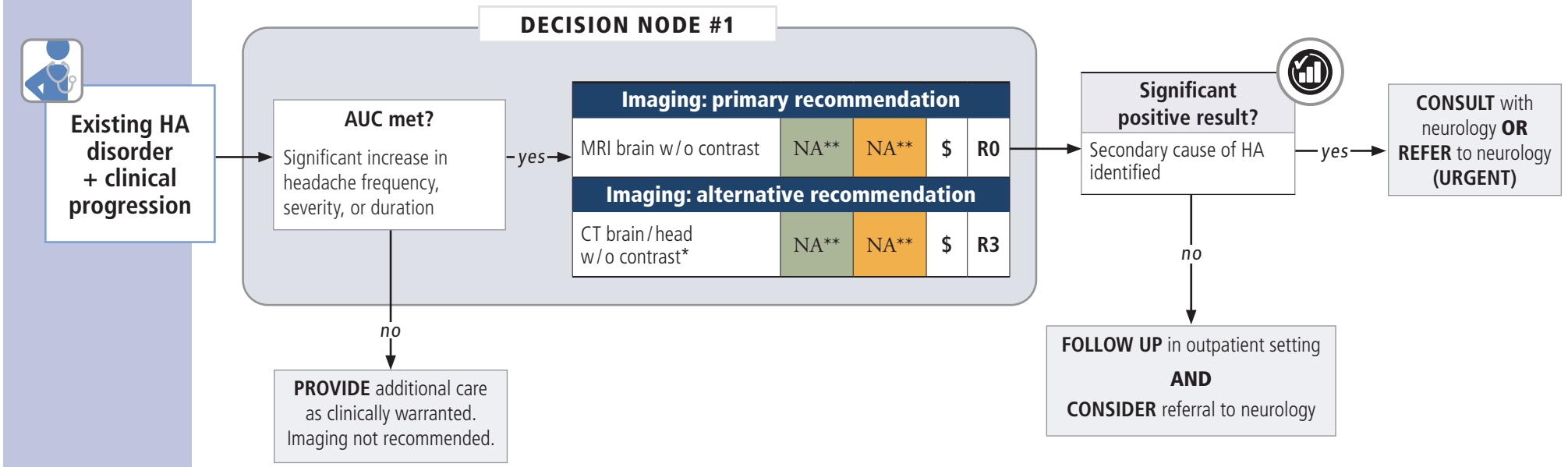
(PRIMARY recommendation)

☐ **HA + head and/or neck trauma (WITHOUT suspicion of cervical artery trauma):**
- ☐ CT brain/head or CT cervical spine completed

(WITH ANY OF THE FOLLOWING):
- ☐ Suspected brain contusion
- ☐ Suspicion for occult fracture or ligamentous injury
- ☐ Known spondyloarthropathy (AS or DISH)
- ☐ Persistent neurologic deficit

HEADACHE (HA) CARE PATHWAY ALGORITHMS

See abbreviations on page 2.



* MRI rather than CT should be performed for HA, except in emergency situations or when MRI is contraindicated.

** Based on expert opinion in the absence of literature-based evidence.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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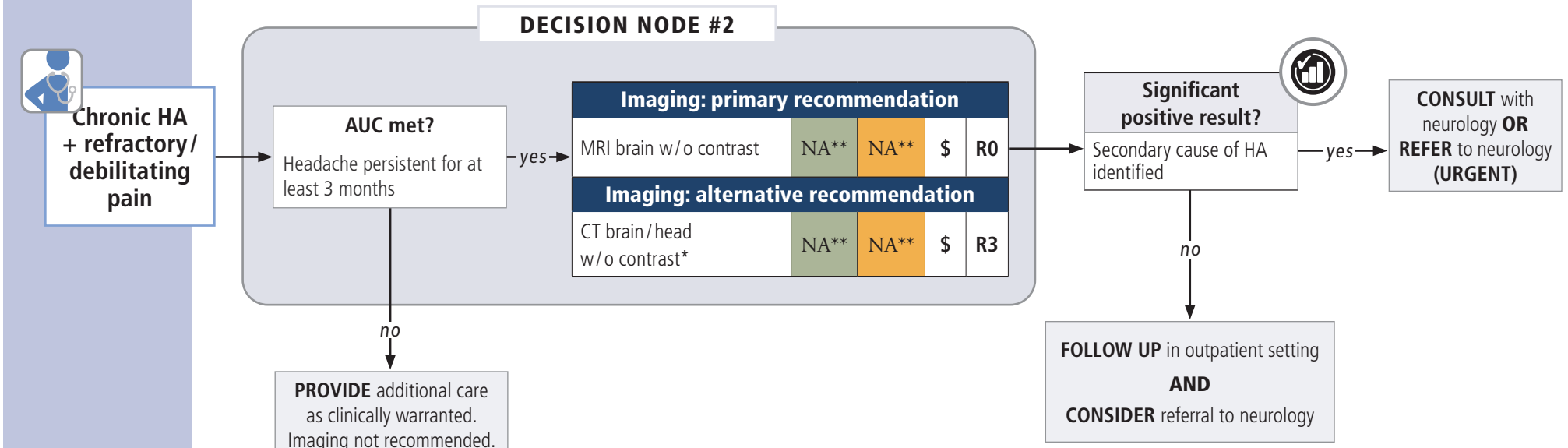
See abbreviations on page 2.



* MRI rather than CT should be performed for HA, except in emergency situations or when MRI is contraindicated.

** Based on expert opinion in the absence of literature-based evidence.

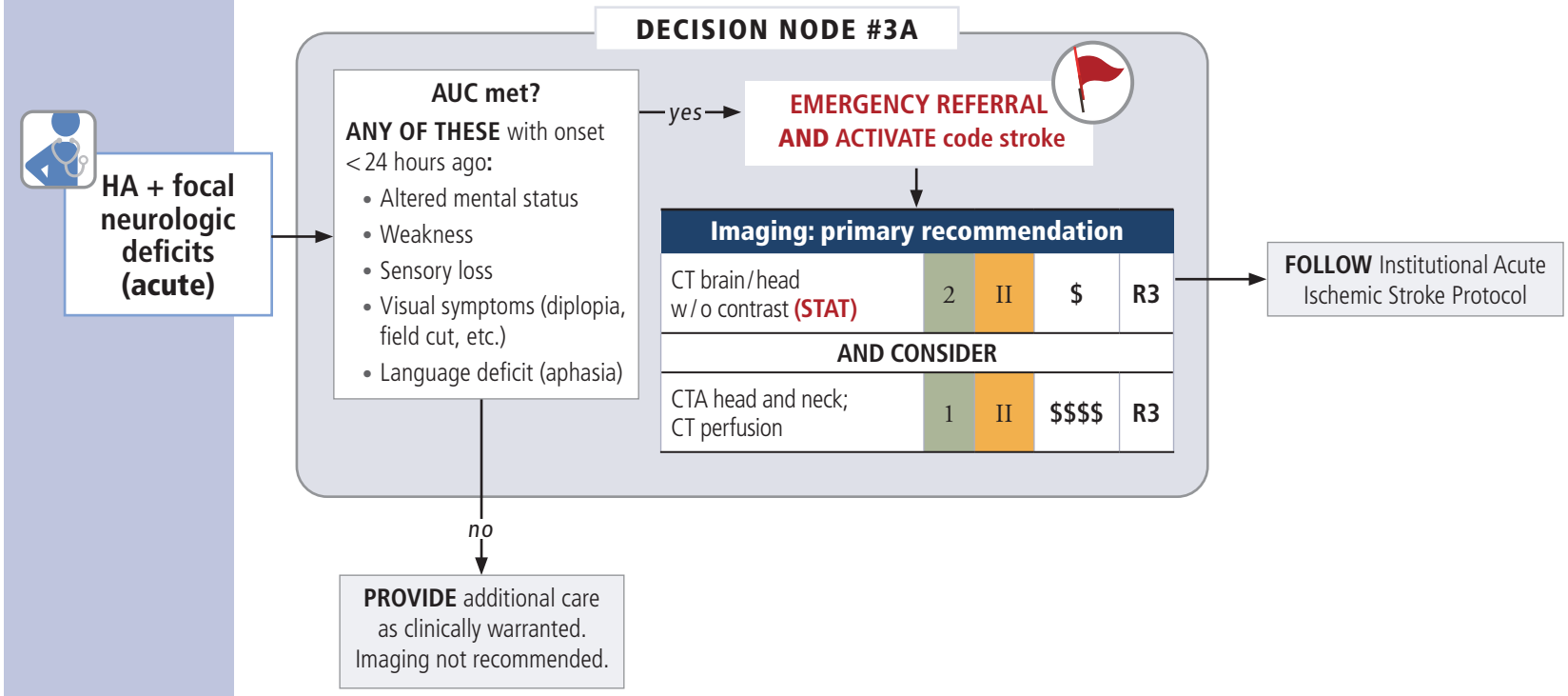
LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

Focal neurologic deficits are considered in conjunction with headache as EITHER "**acute**" (onset < 24 hours ago) as indicated below OR "**not acute**" (onset > 24 hours ago or persistent) as indicated on page 8.

See abbreviations on page 2.



DECISION NODE #3A KEY EVIDENCE

Forsyth PA, Posner JB. Headaches in patients with brain tumors: A study of 111 patients. *Neurology.* 1993;43(9):1678-1683.

Suwanwela N, Phanthumchinda K, Kaoropthum S. Headache in brain tumor: A cross-sectional study. *Headache.* 34(7):435-438.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

See abbreviations on page 2.

HA + focal neurologic deficits (NOT acute)

DECISION NODE #3B

AUC met?

ANY OF THESE with onset > 24 hours ago or persistent:

- Altered mental status
- Weakness
- Sensory loss
- Visual symptoms (diplopia, field cut, etc.)
- Language deficit (aphasia)

yes → **CONSIDER EMERGENCY REFERRAL**

Imaging: primary recommendation				
MRI brain w/o contrast	2	II	$	R0
AND CONSIDER				
MRA head and neck	4	II	$$$$	R0
Imaging: alternative recommendation				
CT brain/head w/o contrast	2	II	$	R3
AND CONSIDER				
CTA head and neck*	1	II	$$$$	R3

Significant positive result?

- Stroke
- Hemorrhage
- Mass lesion(s)
- White matter changes consistent with demyelination

yes → **CONSULT** with neurology

no → **REFER** to neurology

no → **PROVIDE** additional care as clinically warranted. Imaging not recommended.

* Include CT cervical spine reformats from CTA data set.

DECISION NODE #3B KEY EVIDENCE

Forsyth PA, Posner JB. Headaches in patients with brain tumors: A study of 111 patients. *Neurology.* 1993;43(9):1678-1683.

Suwanwela N, Phanthumchinda K, Kaoropthum S. Headache in brain tumor: A cross-sectional study. *Headache.* 34(7):435-438.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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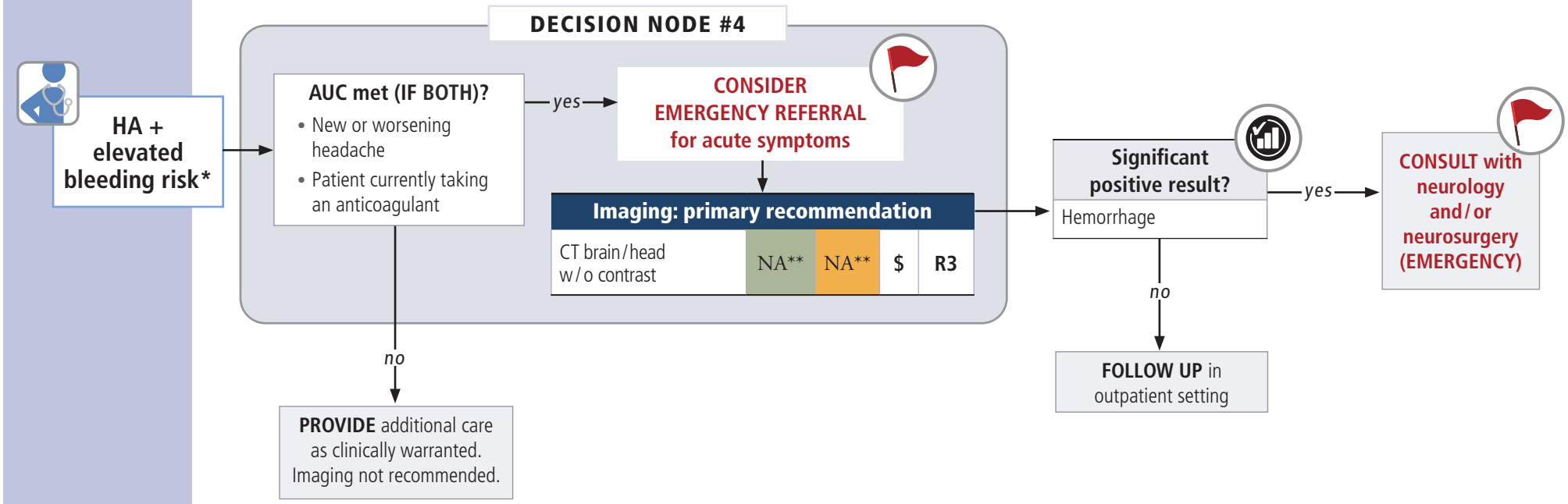
See abbreviations on page 2.



* Risk factors include anticoagulant treatment, low platelets, liver dysfunction, etc.

** Based on expert opinion in the absence of literature-based evidence.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

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DECISION NODE #5

See abbreviations on page 2.

Suspected subarachnoid hemorrhage

AUC met?
- Sudden severe headache

ANY OF THESE:
- Peak pain within 1 hour of onset
- Age > 40 years
- Neck pain or stiffness
- Witnessed loss of consciousness
- Sudden or severe headache triggered by cough / sneeze, Valsalva, sex, or exercise / exertion
- Limited neck flexion on exam

yes → **SYMPTOM ONSET > 6 HOURS?**

no → **CONSIDER EMERGENCY REFERRAL for acute symptoms**

no → **PROVIDE** additional care as clinically warranted

yes → **Imaging: primary recommendation**

CT brain / head w / o contrast **(STAT)**	1	II	$	R3

no → **Imaging: primary recommendation**

CT brain/head w/o contrast AND	1	II	$	R3
CTA head and neck	2	II	$	R3
Imaging: alternative recommendation				
CT brain/head w/o contrast AND	1	II	$	R3
MRA brain/head w/o contrast AND	NA*	NA*	$$	R0
MRA neck w/o contrast	1	II	$$$$	R0
OR				
MRI brain/head w/o contrast AND	2	II	$	R0
MRA brain/head w/o contrast AND	NA*	NA*	$$	R0
MRA neck w/o contrast	1	II	$$$$	R0

Significant positive result?
- Hemorrhage
- Stroke

yes → **CONSULT with neurology and / or neurosurgery (EMERGENCY)**

no → **Presence of both?**
- Negative CT brain/head w/o contrast < 6 hours from onset of symptoms
- Normal neuro exam

yes → No further imaging indicated.** **PROVIDE** additional care as clinically warranted.

no → **CONSIDER** lumbar puncture vs additional imaging. **USE** shared decision making to select the best modality for each patient after weighing the potential for false-positive imaging and the pros and cons associated with lumbar puncture.

AUC met?

ANY OF THESE:
- Negative CT brain/head w/o contrast > 6 hours from onset of symptoms
- Positive CT brain/head w/o contrast
- Abnormal neuro exam
- High clinical suspicion

yes → **Imaging: primary recommendation**

CTA head and neck	2	II	$	R3
Imaging: alternative recommendation				
MRI brain w / o contrast AND	2	II	$	R0
MRA brain / head w / o contrast AND	NA*	NA*	$$	R0
MRA neck w / o contrast	1	II	$$$$	R0

no → **PROVIDE** additional care as clinically warranted

Significant positive result?
- Hemorrhage
- Stroke
- Aneurysm

yes → **CONSULT with neurology and / or neurosurgery (EMERGENCY)**

no → **PROVIDE** additional care as clinically warranted

* Based on expert opinion in the absence of literature-based evidence.

** Normal CT brain w / o contrast (3rd generation scanner) within 6 hours of symptom onset in an ED headache patient with a normal neuro exam can rule out non-traumatic subarachnoid hemorrhage.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

DECISION NODE #5 KEY EVIDENCE

Dubosh NM, Bellolio MF, Rabinstein AA, Edlow JA. Sensitivity of early brain computed tomography to exclude aneurysmal subarachnoid hemorrhage: A systematic review and meta-analysis. *Stroke.* 2016;47(3):750-755.

Jayaraman MV, Mayo-Smith WW, Tung GA, et al. Detection of intracranial aneurysms: Multi-detector row CT angiography compared with DSA. *Radiology.* 2004;230(2):510-518.

Pascual J, Iglesias F, Oterino A, Vázquez-Barquero A, Berciano J. Cough, exertional, and sexual headaches: An analysis of 72 benign and symptomatic cases. *Neurology.* 1996;46(6):1520-1524.

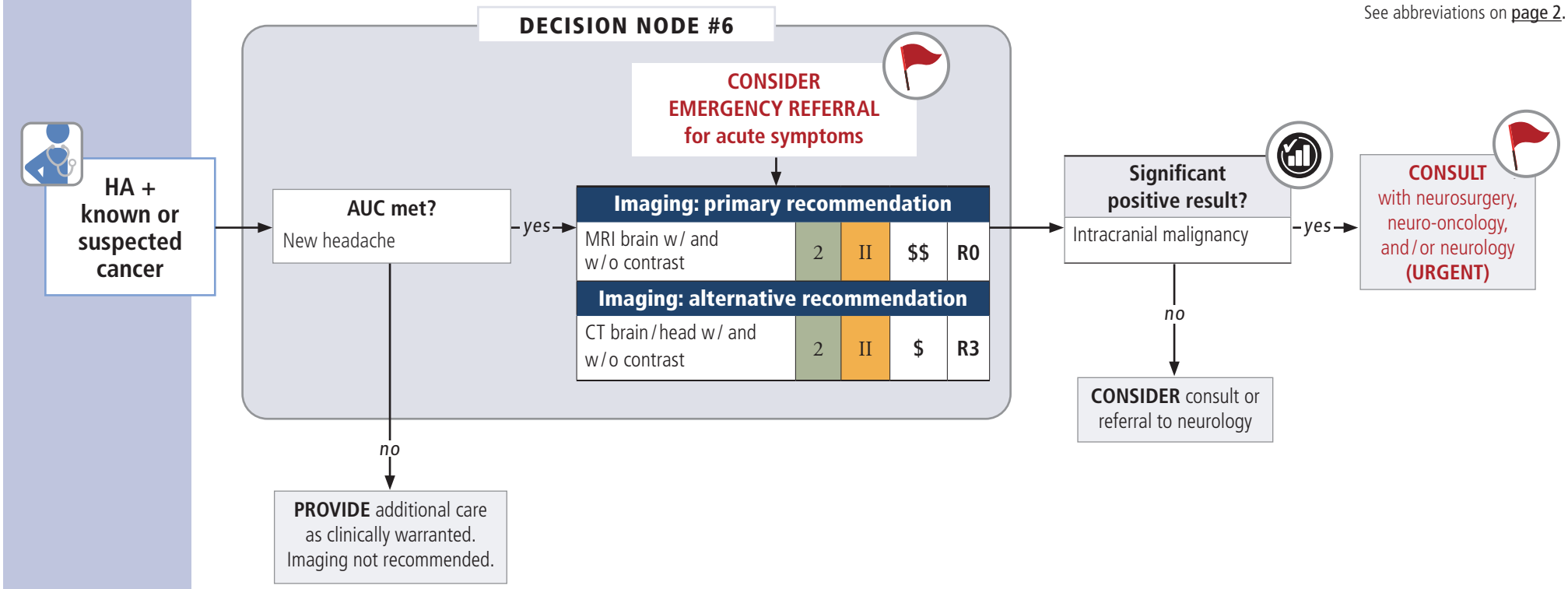
For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R 3** (1–10 mSv) **R 4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$ $** (5–10 RVUs) **$ $ $** (10–15 RVUs) **$ $ $ $ (15+ RVUs)

See abbreviations on page 2.



DECISION NODE #6 KEY EVIDENCE

Jin J, Zhou X, Liang X, et al. A study of patients with brain metastases as the initial manifestation of their systemic cancer in a Chinese population. *J Neurooncol.* 2011;103(3):649-655.

Yokoi K, Kamiya N, Matsuguma H, et al. Detection of brain metastasis in potentially operable non-small cell lung cancer: a comparison of CT and MRI. *Chest.* 1999;115(3):714-719.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

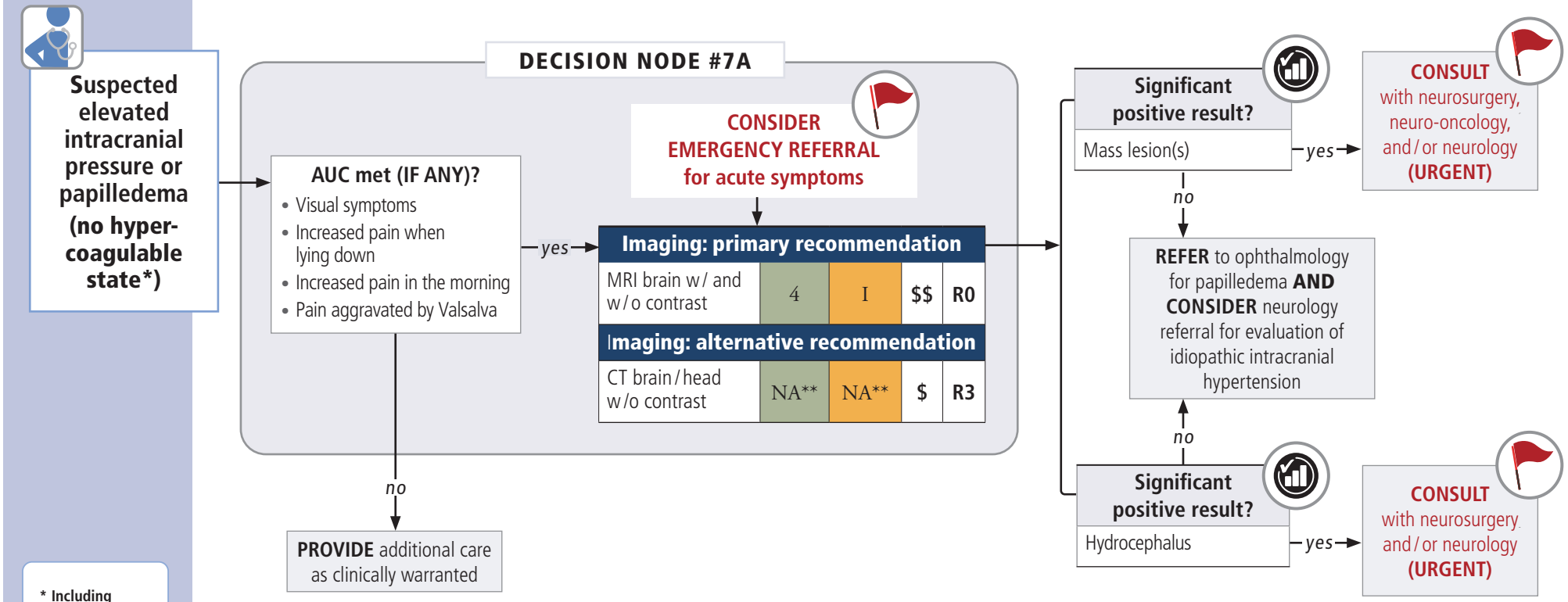
Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

Intermountain Healthcare

Headache with elevated intracranial pressure (ICP) or papilledema are considered in terms of chronicity – EITHER acute or subacute / chronic (see below) – AND in terms of known or suspected hypercoagulable state (see page 14).

See abbreviations on page 2.



* Including dehydration.

** Based on expert opinion in the absence of literature-based evidence.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **$** (0–5 RVUs) **R3** (1–10 mSv) **$$** (5–10 RVUs) **R4** (10–30 mSv) See page 2–3 for explanation. **$$$** (10–15 RVUs) **$$$$** (15+ RVUs)

See abbreviations on page 2.

HA + suspected elevated intracranial pressure or papilledema (known or suspected hyper-coagulable state*)

DECISION NODE #7B

AUC met (IF ANY)?

- Visual symptoms
- Increased pain when lying down
- Increased pain in the morning
- Pain aggravated by Valsalva

yes →

Imaging: primary recommendation				
MRI brain w/ and w/o contrast	4	I	$$	R0
AND				
MR venogram brain/head w/ and w/o contrast	4	I	$$$	R0
Imaging: alternative recommendation				
CT brain/head w/o contrast	NA**	NA**	$	R3
AND				
CT venogram brain/head	5	I	$$	R3

Significant positive result?

Venous sinus thrombosis

yes → **CONSULT** with neurology **(EMERGENCY)**

no → **REFER** to ophthalmology for papilledema, **AND CONSIDER** neurology referral

no → **PROVIDE** additional care as clinically warranted. Imaging not recommended.

* Including dehydration.

** Based on expert opinion in the absence of literature-based evidence.

DECISION NODE #7 KEY EVIDENCE

Chiewvit P, Piyapittayanan S, Poungvarin N. Cerebral venous thrombosis: Diagnosis dilemma. *Neurol Int.* 2011;3(3):e13.

Kumral E, Polat F, Uzunköprü C, Callı C, Kitis Ö. The clinical spectrum of intracerebral hematoma, hemorrhagic infarct, non-hemorrhagic infarct, and non-lesional venous stroke in patients with cerebral sinus-venous thrombosis. *Eur J Neurol.* 2012;19(4):537-543.

Zafar A, Ali Z. Pattern of magnetic resonance imaging and magnetic resonance venography changes in cerebral venous sinus thrombosis. *J Ayub Med Coll Abbottabad.* 24(1):63-67.

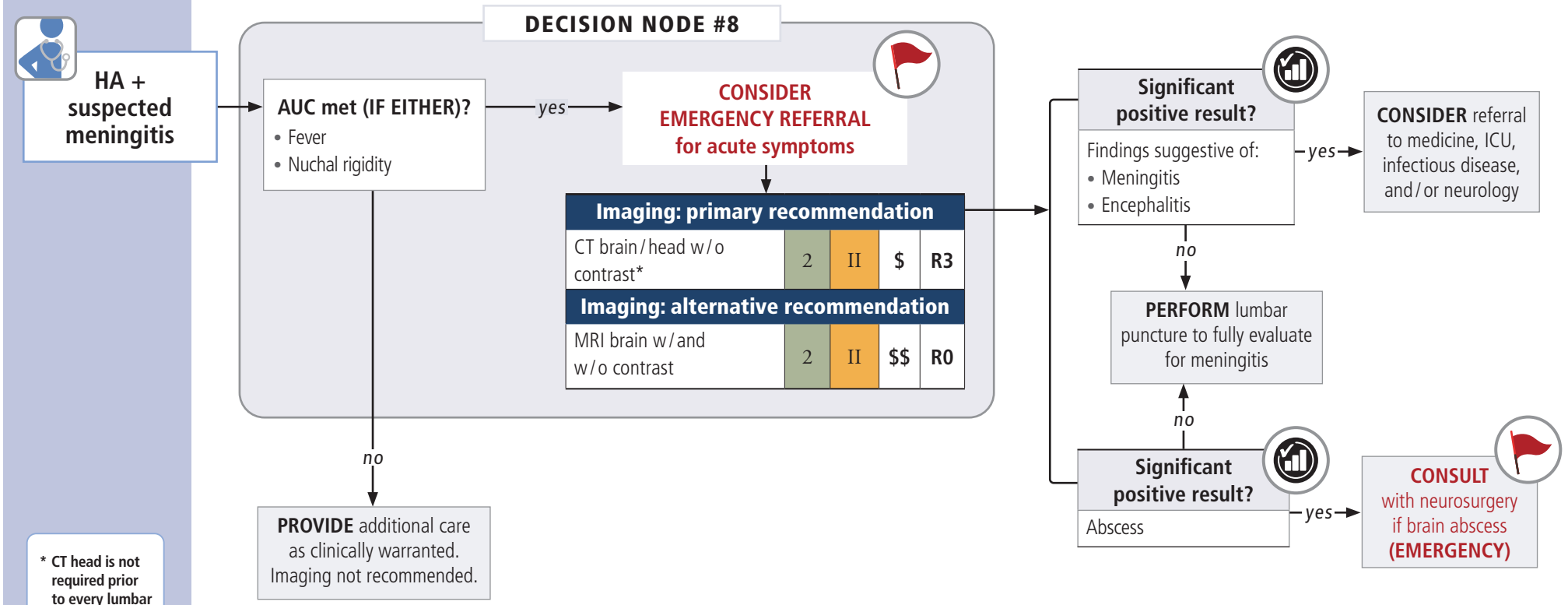
For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

See abbreviations on page 2.



* **CT head is not required prior to every lumbar puncture, but is recommended if have clinical suspicion of elevated intracranial pressure or altered mental status.**

DECISION NODE #8 KEY EVIDENCE

Hasbun R, Abrahams J, Jekel J, Quagliarello VJ. Computed tomography of the head before lumbar puncture in adults with suspected meningitis. *N Engl J Med.* 2001;345(24):1727-1733.

Zhang J, Hu X, Hu X, et al. Clinical features, Outcomes and molecular profiles of drug resistance in tuberculous meningitis in non-HIV patients. *Sci Rep.* 2016;6(1):19072.

For a full list of references for all decision nodes, see bibliography on page 30.)

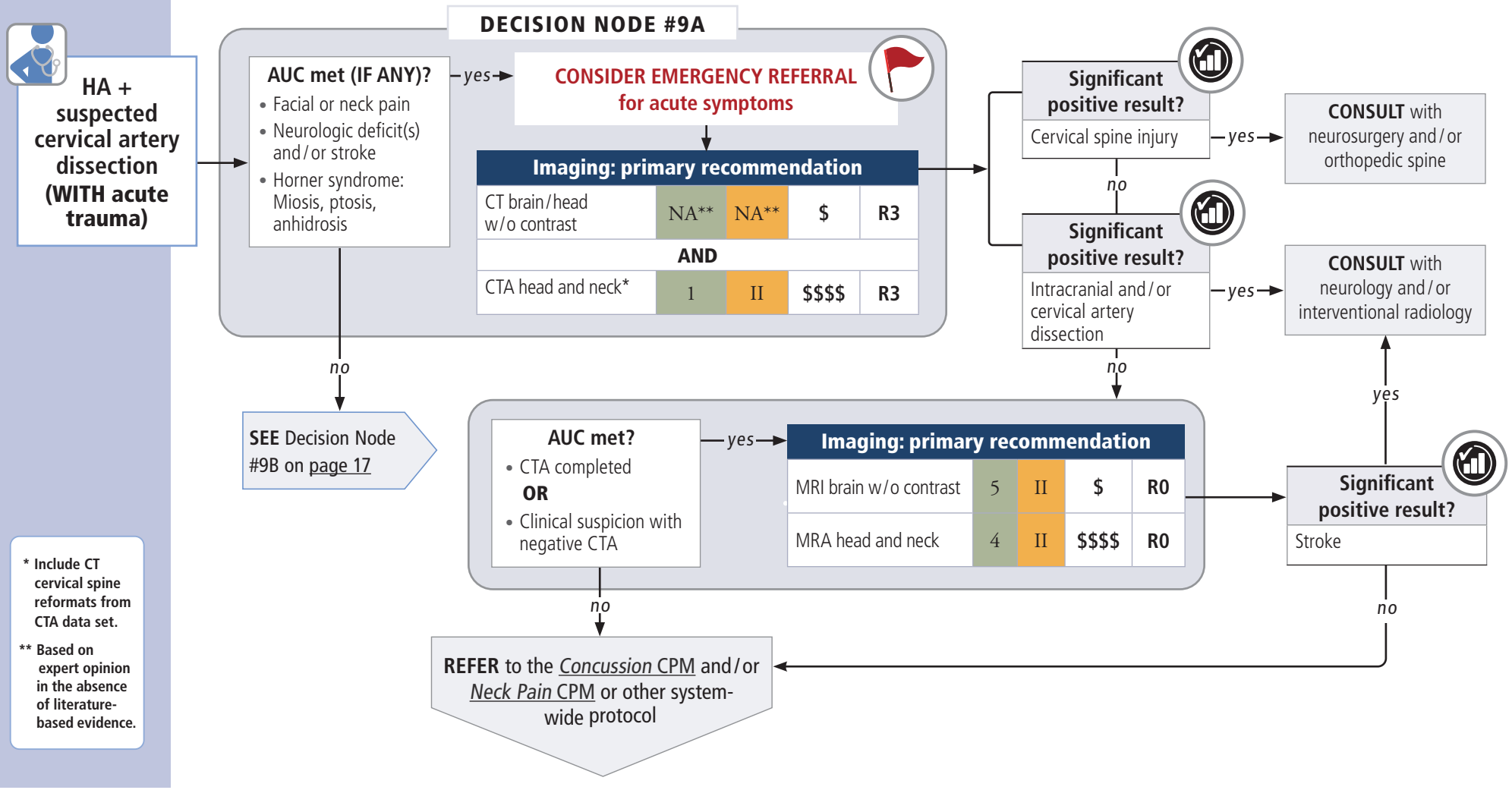
LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

Headache in conjunction with suspected cervical artery dissection is considered EITHER "with acute trauma" (see below) OR "without acute trauma" (see page 17).

See abbreviations on page 2.



* Include CT cervical spine reformats from CTA data set.

** Based on expert opinion in the absence of literature-based evidence.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

Intermountain® Healthcare

See abbreviations on page 2.

HA with neck / facial pain + suspected cervical artery dissection (WITHOUT acute trauma)

DECISION NODE #9B

AUC met (IF ANY)?
- Neurologic deficit(s) and / or stroke
- Horner syndrome: Miosis, ptosis, anhidrosis

yes →

Consider EMERGENCY referral

Imaging: primary recommendation

CTA head and neck*	1	II	$$$$	R3

→ **Significant positive result?**
Intracranial and / or cervical artery dissection

yes → **CONSULT** with neurology and / or interventional radiology

no → **SEE** Decision Node #10 on page 19

no →

AUC met (IF ANY)?
- CTA completed
- Clinical suspicion with negative CTA

yes →

Imaging: primary recommendation

MRI brain w / o contrast	5	II	$	R0
MRA head and neck	4	II	$$$$	R0

→ **Significant positive result?**
Stroke

yes → **CONSULT** with neurology and / or interventional radiology

no → **REFER** to the *Concussion* CPM and / or *Neck Pain* CPM or other system-wide protocol

no → **REFER** to the *Concussion* CPM and / or *Neck Pain* CPM or other system-wide protocol

***Include CT cervical spine reformats from CTA data set.**

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

DECISION NODE #9 KEY EVIDENCE

Bromberg WJ, Collier BC, Diebel LN, et al. Blunt cerebrovascular injury practice management guidelines: The Eastern Association for the Surgery of Trauma. *J Trauma.* 2010;68(2):471-477.

Manabe H, Yonezawa K, Kato T, Toyama K, Haraguchi K, Ito T. Incidence of intracranial arterial dissection in non-emergency outpatients complaining of headache: Preliminary investigation with MRI/MRA examinations. *Acta Neurochir Suppl.* 2010;107:41-44.

Patterson BO, Holt PJ, Cleanthis M, et al. Imaging vascular trauma. *Br J Surg.* 2012;99(4):494-505.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R 3** (1–10 mSv) **R 4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$ $** (5–10 RVUs) **$ $ $** (10–15 RVUs) **$ $ $ $ (15+ RVUs)

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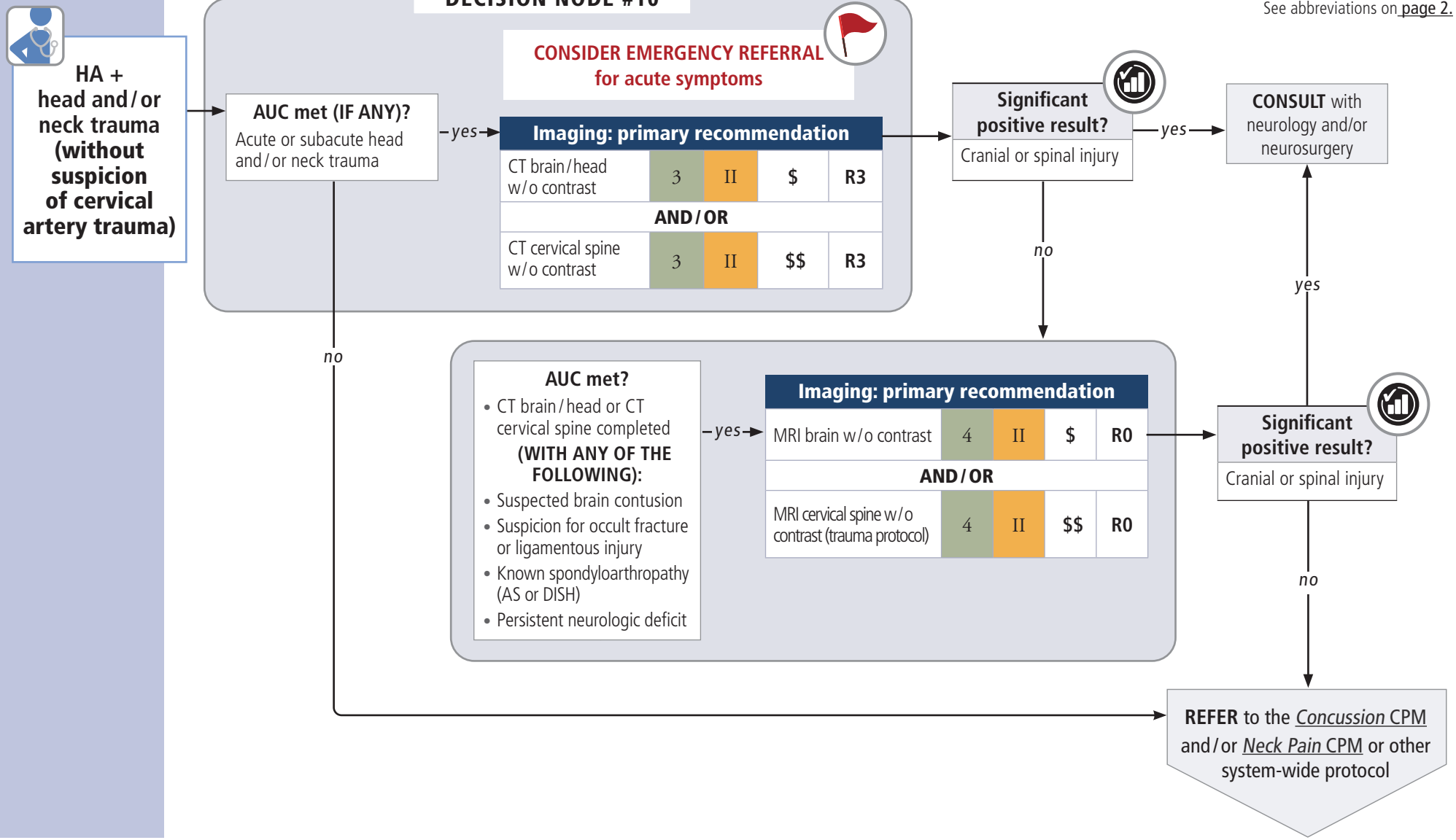


See abbreviations on page 2.

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

DECISION NODE #10 KEY EVIDENCE

Abdul Rahman YS, Al Den ASS, Maull KI. Prospective study of validity of neurologic signs in predicting positive cranial computed tomography following minor head trauma. *Prehosp Disaster Med.* 25(1):59-62.

Schwedt TJ, Chong CD, Peplinski J, Ross K, Berisha V. Persistent post-traumatic headache vs. migraine: An MRI study demonstrating differences in brain structure. *J Headache Pain.* 2017;18(1):87.

For a full list of references for all decision nodes, see bibliography on page 30.)

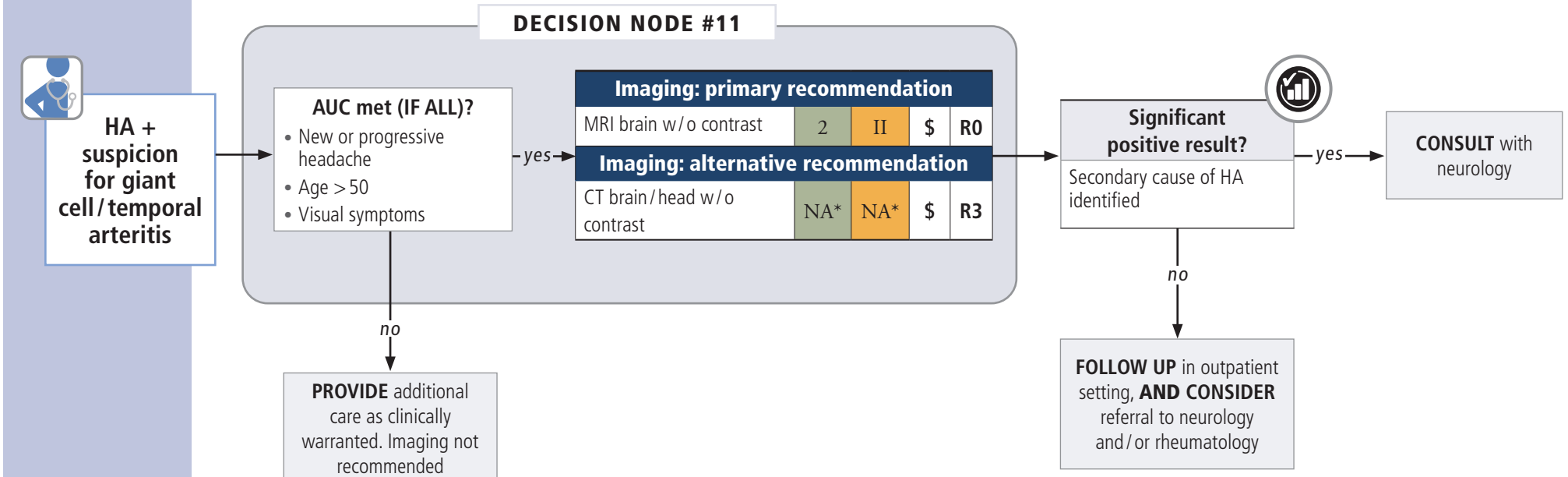
LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.

$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

See abbreviations on page 2.



* **Based on expert opinion in the absence of literature-based evidence.**

DECISION NODE #11 KEY EVIDENCE

Bley TA, Reinhard M, Hauenstein C, et al. Comparison of duplex sonography and high-resolution magnetic resonance imaging in the diagnosis of giant cell (temporal) arteritis. *Arthritis Rheum.* 2008;58(8):2574-2578.

Klink T, Geiger J, Both M, et al. Giant cell arteritis: diagnostic accuracy of MR imaging of superficial cranial arteries in initial diagnosis: Results from a multicenter trial. *Radiology.* 2014;273(3):844-852.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

See abbreviations on page 2.

HA + trigeminal distribution*

DECISION NODE #12

AUC met?
Positive neurologic symptoms (including but not limited to altered sensation)**

yes →

Imaging: primary recommendation				
MRI brain w/ and w/o contrast (trigeminal protocol)	2	II	$$	R0

Imaging: primary recommendation				
CT brain/head w/ and w/o contrast***	2	II	S	R3

no →

PROVIDE additional care as clinically warranted. Imaging not recommended

Significant positive result?
Secondary cause of trigeminal pain identified

yes → **CONSULT** with neurology and/or neurosurgery

no →

FOLLOW UP in outpatient setting **AND CONSIDER** referral to neurology for medically refractory TN

no →

Significant positive result?
Intracranial complication of sinusitis/mastoiditis

yes → **CONSULT** with ENT/neurosurgery

* **V1: Orbital, periorbital, frontal/ethmoid sinuses.**

** **Imaging not generally needed in patients with TN symptoms and a normal exam. Consider alternative diagnoses (sinusitis, mastoiditis, and/or dental pathology).**

*** **MRI rather than CT should be performed for HA, except in emergency situations or when MRI is contra-indicated.**

DECISION NODE #12 KEY EVIDENCE

Antonini G, Di Pasquale A, Cruccu G, et al. Magnetic resonance imaging contribution for diagnosing symptomatic neurovascular contact in classical trigeminal neuralgia: A blinded case-control study and meta-analysis. *Pain.* 2014;155(8):1464-1471.

For a full list of references for all decision nodes, see bibliography on page 30.)

LEGEND

Clinical Scenario | Urgent or Emergency Situation | 2 OCEBM Level of Evidence | II Fryback & Thornbury Level of Evidence | Intermountain Measure

R0 (0 mSv) **R3** (1–10 mSv) **R4** (10–30 mSv) See page 2–3 for explanation.
$** (0–5 RVUs) **$$** (5–10 RVUs) **$$$** (10–15 RVUs) **$$$$ (15+ RVUs)

POINT-OF-ORDER CHECKLISTS

See abbreviations on page 2.

The provider must check BOTH:

1. The box next to the relevant clinical scenario
2. **EACH** AUC box that applies to the patient's situation

TABLE 1. MRI brain WITHOUT CONTRAST appropriate use indications

(PRIMARY recommendation)

☐ **Existing HA disorder + clinical progression:**
- ☐ Significant increase in headache frequency, severity, or duration

☐ **Chronic HA + refractory / debilitating pain:**
- ☐ Headache persistent for at least 3 months

☐ **HA + focal neurologic deficits (NOT acute):**

ANY OF THESE: with onset > 24 hours ago or persistent:
- ☐ Altered mental status
- ☐ Weakness
- ☐ Sensory loss
- ☐ Visual symptoms (diplopia, field cut, etc.)
- ☐ Language deficit (aphasia)

☐ **HA + suspected cervical artery dissection (WITH ACUTE trauma) (IF ANY):**
- ☐ Facial or neck pain
- ☐ Neurologic deficit(s) and / or stroke
- ☐ Horner syndrome: Miosis, ptosis, anhidrosis

AND EITHER:
- ☐ CTA completed

OR
- ☐ Clinical suspicion with negative CTA

☐ **HA + head and / or neck trauma (WITHOUT suspicion of cervical artery trauma):**
- ☐ CT brain / head or CT cervical spine completed

(WITH ANY OF THE FOLLOWING):
- ☐ Suspected brain contusion
- ☐ Suspicion for occult fracture or ligamentous injury
- ☐ Known spondyloarthropathy (AS or DISH)
- ☐ Persistent neurologic deficit

☐ **HA + suspicion for giant cell / temporal arteritis (IF ALL):**
- ☐ New or progressive headache
- ☐ Age > 50
- ☐ Visual symptoms

☐ **HA w/ neck / facial pain + suspected cervical artery dissection (WITHOUT acute trauma):**
- ☐ Neurologic deficit(s) and / or stroke
- ☐ Horner syndrome: Miosis, ptosis, anhidrosis

AND EITHER:
- ☐ CTA completed

OR
- ☐ Clinical suspicion with negative CTA

(ALTERNATIVE recommendation)

☐ **Suspected subarachnoid hemorrhage (symptom onset > 6 hours)**
- ☐ Sudden severe headache

AND ANY OF THESE:
- ☐ Peak pain within 1 hour of onset
- ☐ Age > 40 years
- ☐ Neck pain or stiffness
- ☐ Witnessed loss of consciousness
- ☐ Sudden or severe headache triggered by cough/sneeze, Valsalva, sex, or exercise/exertion
- ☐ Limited neck flexion on exam

☐ **Suspected subarachnoid hemorrhage (IF ANY):**
- ☐ Negative CT brain/head w/o contrast > 6 hours from onset of symptoms
- ☐ Positive CT brain/head w/o contrast
- ☐ Abnormal neuro exam
- ☐ High clinical suspicion

POINT-OF-ORDER CHECKLISTS, CONTINUED

See abbreviations on page 2.

TABLE 2. MRA head and neck appropriate use indications

(PRIMARY recommendation)

- ☐ **HA + focal neurologic deficits (NOT acute) (ANY OF THESE with onset >24 hours ago or persistent):**
  - ☐ Altered mental status
  - ☐ Weakness
  - ☐ Sensory loss
  - ☐ Visual symptoms (diplopia, field cut, etc.)
  - ☐ Language deficit (aphasia)
- ☐ **HA + suspected cervical artery dissection (WITH acute trauma) (IF ANY):**
  - ☐ Facial or neck pain
  - ☐ Neurologic deficit(s) and/or stroke
  - ☐ Horner syndrome: Miosis, ptosis, anhidrosis

  AND EITHER:
  - ☐ CTA completed

  OR
  - ☐ Clinical suspicion with negative CTA
- ☐ **HA + suspected cervical artery dissection (WITHOUT acute trauma) (IF ANY):**
  - ☐ Neurologic deficit(s) and/or stroke
  - ☐ Horner syndrome: Miosis, ptosis, anhidrosis

  AND EITHER:
  - ☐ CTA completed

  OR
  - ☐ Clinical suspicion with negative CTA

TABLE 3. MRA brain/head WITHOUT CONTRAST appropriate use indications

(ALTERNATIVE recommendation)

- ☐ **Suspected subarachnoid hemorrhage (symptom onset > 6 hours)**
  - ☐ Sudden severe headache

  AND ANY OF THESE:
  - ☐ Peak pain within 1 hour of onset
  - ☐ Age > 40 years
  - ☐ Neck pain or stiffness
  - ☐ Witnessed loss of consciousness
  - ☐ Sudden or severe headache triggered by cough/sneeze, Valsalva, sex, or exercise/exertion
  - ☐ Limited neck flexion on exam
- ☐ **Suspected subarachnoid hemorrhage (IF ANY):**
  - ☐ Negative CT brain/head w/o contrast >6 hours from onset of symptoms
  - ☐ Positive CT brain/head w/o contrast
  - ☐ Abnormal neuro exam
  - ☐ High clinical suspicion

TABLE 4. MRA neck WITHOUT CONTRAST appropriate use indications

(ALTERNATIVE recommendation)

- ☐ **Suspected subarachnoid hemorrhage (symptom onset > 6 hours)**
  - ☐ Sudden severe headache

  AND ANY OF THESE:
  - ☐ Peak pain within 1 hour of onset
  - ☐ Age > 40 years
  - ☐ Neck pain or stiffness
  - ☐ Witnessed loss of consciousness
  - ☐ Sudden or severe headache triggered by cough/sneeze, Valsalva, sex, or exercise/exertion
  - ☐ Limited neck flexion on exam
- ☐ **Suspected subarachnoid hemorrhage (IF ANY):**
  - ☐ Negative CT brain/head w/o contrast >6 hours from onset of symptoms
  - ☐ Positive CT brain/head w/o contrast
  - ☐ Abnormal neuro exam
  - ☐ High clinical suspicion

POINT-OF-ORDER CHECKLISTS, CONTINUED

See abbreviations on page 2.

TABLE 5. MRI brain WITH AND WITHOUT CONTRAST appropriate use indications

(PRIMARY recommendation)	(ALTERNATIVE recommendation)
☐ **HA + known or suspected cancer:** ☐ New headache ☐ **Suspected elevated ICP or papilledema (NO hypercoagulable state)* (IF ANY):** ☐ Visual symptoms ☐ Increased pain when lying down ☐ Increased pain in the morning ☐ Pain aggravated by Valsalva ☐ **HA + suspected elevated ICP or papilledema (known or suspected hypercoagulable state)* (IF ANY):** ☐ Visual symptoms ☐ Increased pain when lying down ☐ Increased pain in the morning ☐ Pain aggravated by Valsalva	☐ **HA + suspected meningitis (IF EITHER):** ☐ Fever ☐ Nuchal rigidity
TRIGEMINAL PROTOCOL ☐ **HA + trigeminal distribution**:** ☐ Positive neurologic symptoms (including but not limited to altered sensation***)	

* Including dehydration.
** V1: Orbital, periorbital, frontal/ethmoid sinuses; V2: Cheek, maxillary sinus, upper teeth; V3: Jaw, lower teeth.
*** Imaging not generally needed in patients with TN symptoms and a normal exam. Consider alternative diagnoses (sinusitis, mastoiditis, and/or dental pathology).

TABLE 6. MR venogram brain/head WITH AND WITHOUT CONTRAST appropriate use indications

(PRIMARY recommendation)

☐ **HA + suspected elevated ICP or papilledema (known or suspected hypercoagulable state)* (IF ANY):**
- ☐ Visual symptoms
- ☐ Increased pain when lying down
- ☐ Increased pain in the morning
- ☐ Pain aggravated by Valsalva

TABLE 7. MRI cervical spine WITHOUT CONTRAST (trauma protocol) appropriate use indications

(PRIMARY recommendation)

☐ **HA + head and/or neck trauma (WITHOUT suspicion of cervical artery trauma):**
- ☐ CT brain/head or CT cervical spine completed

(WITH ANY OF THE FOLLOWING):
- ☐ Suspected brain contusion
- ☐ Suspicion for occult fracture or ligamentous injury
- ☐ Known spondyloarthropathy (AS or DISH)
- ☐ Persistent neurologic deficit

POINT-OF-ORDER CHECKLISTS, CONTINUED

See abbreviations on page 2.

TABLE 8. CT brain / head WITHOUT CONTRAST appropriate use indications*

(PRIMARY recommendation)

- ☐ **HA + elevated bleeding risk** (IF BOTH):**
  - ☐ New or worsening headache
  - ☐ Patient currently taking an anticoagulant
- ☐ **HA + suspected meningitis*** (IF EITHER):**
  - ☐ Fever
  - ☐ Nuchal rigidity
- ☐ **HA + suspected cervical artery dissection (WITH ACUTE trauma) (IF ANY):**
  - ☐ Facial or neck pain
  - ☐ Neurologic deficit(s) and / or stroke
  - ☐ Horner syndrome: Miosis, ptosis, anhidrosis
- ☐ **HA+ head and / or neck trauma (WITHOUT suspicion of cervical artery trauma):**
  - ☐ Acute or subacute head and / or neck trauma

STAT

- ☐ **HA + focal neurologic deficits (ACUTE): ANY OF THESE (with onset < 24 hours ago):**
  - ☐ Altered mental status
  - ☐ Weakness
  - ☐ Sensory loss
  - ☐ Visual symptoms (diplopia, field cut, etc.)
  - ☐ Language deficit (aphasia)
- ☐ **Suspected subarachnoid hemorrhage:**
  - ☐ Sudden severe headache

  AND ANY OF THESE:
  - ☐ Peak pain within 1 hour of onset
  - ☐ Age > 40
  - ☐ Neck pain or stiffness
  - ☐ Witnessed loss of consciousness
  - ☐ Sudden or severe headache triggered by: cough / sneeze, Valsalva, sex, or exercise / exertion
  - ☐ Limited neck flexion on exam

(ALTERNATIVE recommendation)

- ☐ **Existing HA disorder + clinical progression*:**
  - ☐ Significant increase in headache frequency, severity, or duration
- ☐ **Chronic HA + refractory / debilitating pain:**
  - ☐ Headache persistent at least 3 months
- ☐ **HA + focal neurologic deficits (NOT acute): ANY OF THESE:** with onset > 24 hours ago or persistent:
  - ☐ Altered mental status
  - ☐ Weakness
  - ☐ Sensory loss
  - ☐ Visual symptoms (diplopia, field cut, etc.)
  - ☐ Language deficit (aphasia)
- ☐ **Suspected subarachnoid hemorrhage (sympton onset > 6 hours):**
  - ☐ Sudden severe headache

  AND ANY OF THESE:
  - ☐ Peak pain within 1 hour of onset
  - ☐ Age > 40
  - ☐ Neck pain or stiffness
  - ☐ Witnessed loss of consciousness
  - ☐ Sudden or severe headache triggered by: cough / sneeze, Valsalva, sex, or exercise / exertion
  - ☐ Limited neck flexion on exam
- ☐ **Suspected elevated ICP or papilledema (NO hypercoagulable state)**** (IF ANY):**
  - ☐ Visual symptoms
  - ☐ Increased pain when lying down
  - ☐ Increased pain in the morning
  - ☐ Pain aggravated by Valsalva
- ☐ **HA + suspected elevated ICP or papilledema (known or suspected hypercoagulable state)**** (IF ANY):**
  - ☐ Visual symptoms
  - ☐ Increased pain when lying down
  - ☐ Increased pain in the morning
  - ☐ Pain aggravated by Valsalva
- ☐ **HA + suspicion for giant cell / temporal arteritis (IF ALL):**
  - ☐ New or progressive headache
  - ☐ Age > 50
  - ☐ Visual symptoms

* MRI rather than CT should be performed for headache, except in emergency situations or when MRI is contraindicated.

** Risk factors include anticoagulant treatment, low platelets, liver dysfunction. etc.

*** CT head is not required prior to every lumbar puncture, but is recommended if have clinical suspicion of elevated intracranial pressure or altered mental status.

**** Including dehydration.

POINT-OF-ORDER CHECKLISTS, CONTINUED

See abbreviations on page 2.

TABLE 9. CTA head and neck, CT perfusion appropriate use indications

(PRIMARY recommendation)

- ☐ **HA +focal neurologic deficits (ACUTE):**
  ANY OF THESE (with onset < 24 hours ago):
  - ☐ Altered mental status
  - ☐ Weakness
  - ☐ Sensory loss
  - ☐ Visual symptoms (diplopia, field cut, etc.)
  - ☐ Language deficit (aphasia)

TABLE 10. CTA head and neck appropriate use indications

(PRIMARY recommendation)

- ☐ **Suspected subarachnoid hemorrhage (symptom onset > 6 hours**
  - ☐ Sudden severe headache
  AND ANY OF THESE:
  - ☐ Peak pain within 1 hour of onset
  - ☐ Age > 40
  - ☐ Neck pain or stiffness
  - ☐ Witnessed loss of consciousness
  - ☐ Sudden or severe headache triggered by: cough / sneeze, Valsalva, sex, or exercise / exertion
  - ☐ Limited neck flexion on exam
- ☐ **Suspected subarachnoid hemorrhage (IF ANY):**
  - ☐ Negative CT brain/head w/o contrast > 6 hours from onset of symptoms
  - ☐ Positive CT brain/head w/o contrast
  - ☐ Abnormal neuro exam
  - ☐ High clinical suspicion
- ☐ **HA + suspected cervical artery dissection (WITH ACUTE trauma)* (IF ANY):**
  - ☐ Facial or neck pain
  - ☐ Neurologic deficit(s) and / or stroke
  - ☐ Horner syndrome: Miosis, ptosis, anhidrosis
- ☐ **HA + suspected cervical artery dissection (WITHOUT ACUTE trauma)* (IF ANY):**
  - ☐ Neurologic deficit(s) and / or stroke
  - ☐ Horner syndrome: Miosis, ptosis, anhidrosis

* Include CT cervical spine reformats from CTA data set.

TABLE 11. CTA head and neck appropriate use indications*

(ALTERNATIVE recommendation)

- ☐ **HA + focal neurologic deficits (NOT acute):**
  ANY OF THESE (with onset >24 hours ago or persistent):
  - ☐ Altered mental status
  - ☐ Weakness
  - ☐ Sensory loss
  - ☐ Visual symptoms (diplopia, field cut, etc.)
  - ☐ Language deficit (aphasia)

TABLE 12. CT brain / head WITH AND WITHOUT CONTRAST appropriate use indications*

(ALTERNATIVE recommendation)

- ☐ **HA + known or suspected cancer**
  - ☐ New headache

TRIGEMINAL PROTOCOL

- ☐ **HA + trigeminal distribution**:**
  - ☐ Positive neurologic symptoms (including but not limited to altered sensation***)

* MRI rather than CT should be performed for headache, except in emergency situations or when MRI is contraindicated.

** V1: Orbital, periorbital, frontal / ethmoid sinuses; V2: Cheek, maxillary sinus, upper teeth; V3: Jaw, lower teeth.

*** Imaging not generally needed in patients with TN symptoms and a normal exam. Consider alternative diagnoses (sinusitis, mastoiditis, and / or dental pathology).

POINT-OF-ORDER CHECKLISTS, CONTINUED

See abbreviations on page 2.

TABLE 13. CT venogram brain/head appropriate use indications

(ALTERNATIVE recommendation)

- ☐ **HA + suspected elevated ICP or papilledema (known or suspected hypercoagulable state)* (IF ANY):**
  - ☐ Visual symptoms
  - ☐ Increased pain when lying down
  - ☐ Increased pain in the morning
  - ☐ Pain aggravated by Valsalva

* Including dehydration.

TABLE 14. CT cervical spine **WITHOUT CONTRAST** appropriate use indications

(PRIMARY recommendation)

- ☐ **HA + head and/or neck trauma (WITHOUT suspicion of cervical artery trauma):**
  - ☐ Acute or subacute head and/or neck trauma

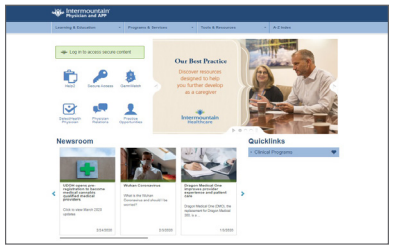
RESOURCES

Intermountain provides educational materials designed to support providers in their efforts to care for, educate, and engage patients and their families.

Intermountain's patient education materials complement and reinforce clinical team interventions by providing a means for patients to reflect and learn in another mode and at their own pace.

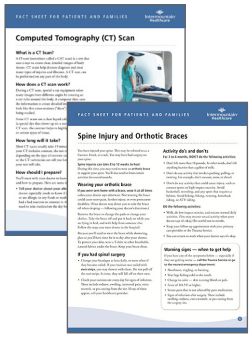
Intermountain's Care Process Models (CPMs) outline evidence-based guidelines for patient care. In addition to the suite of Intermountain Imaging Criteria CPMs, Intermountain provides topical CPMs that have been developed by expert clinical teams. They can be accessed by navigating to http://www.intermountainphysician.org and selecting **Care Process Models** in the **Tools & Resources** drop down menu.

To access Intermountain's Imaging Criteria CPMs and supporting materials, visit: https://intermountainhealthcare.org/services/imaging-services/intermountain-imaging-criteria/.



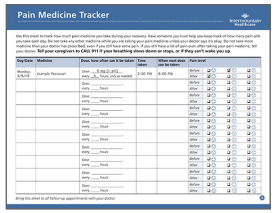
http://www.intermountainphysician.org

Intermountain Imaging Criteria web page



Fact sheets:

- *Computed Tomography (CT) Scan* (English) / (Spanish)
- *Spine Injury and Orthotic Braces* (English) / (Spanish)



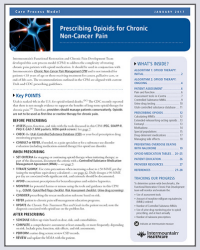
Patient education:

- *Managing Chronic Pain* (English)
- *Pain Medicine Tracker* (English) / (Spanish)

Related Care Process Models (CPMs):

Concussion CPM

Neck Pain CPM



Prescribing Opioids for Chronic Non-Cancer Pain CPM

Imaging Radiation Exposure CPM

BIBLIOGRAPHY

NODE #1

Recommendations based on expert opinion in the absence of literature-based evidence.

NODE #2

Recommendations based on expert opinion in the absence of literature-based evidence.

NODE #3

1. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
2. Forsyth PA, Posner JB. Headaches in patients with brain tumors: A study of 111 patients. *Neurology.* 1993;43(9):1678-1683.
3. Suwanwela N, Phanthumchinda K, Kaoropthum S. Headache in brain tumor: A cross-sectional study. *Headache.* 34(7):435-438.

NODE #4

Recommendations based on expert opinion in the absence of literature-based evidence.

NODE #5

1. Cheng YC, Kuo KH, Lai TH. A common cause of sudden and thunderclap headaches: Reversible cerebral vasoconstriction syndrome. *J Headache Pain.* 2014;15(1):13.
2. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
3. Dubosh NM, Bellolio MF, Rabinstein AA, Edlow JA. Sensitivity of early brain computed tomography to exclude aneurysmal subarachnoid hemorrhage: A systematic review and meta-analysis. *Stroke.* 2016;47(3):750-755.
4. Grooters GS, Sluzewski M, Tijssen CC. How often is thunderclap headache caused by the reversible cerebral vasoconstriction syndrome? *Headache.* 2014;54(4):732-735.
5. Pascual J, Iglesias F, Oterino A, Vázquez-Barquero A, Berciano J. Cough, exertional, and sexual headaches: An analysis of 72 benign and symptomatic cases. *Neurology.* 1996;46(6):1520-1524.
6. Jayaraman MV, Mayo-Smith WW, Tung GA, et al. Detection of intracranial aneurysms: Multi-detector row CT angiography compared with DSA. *Radiology.* 2004;230(2):510-518.
7. Linn FH, Wijdicks EF, van der Graaf Y, Weerdesteyn-van Vliet FA, Bartelds AI, van Gijn J. Prospective study of sentinel headache in aneurysmal subarachnoid haemorrhage. *Lancet.* 1994;344(8922):590-593.
8. Lledo A, Calandre L, Martinez-Menendez B, Perez-Sempere A, Portera-Sanchez A. Acute headache of recent onset and subarachnoid hemorrhage: A prospective study. *Headache.* 1994;34(3):172-174.
9. Silbert PL, Mokri B, Schievink WI. Headache and neck pain in spontaneous internal carotid and vertebral artery dissections. *Neurology.* 1995;45(8):1517-1522.
10. Suarez JI, Tarr RW, Selman WR. Aneurysmal subarachnoid hemorrhage. *N Engl J Med.* 2006;354(4):387-396.
11. van der Wee N, Rinkel GJ, Hasan D, van Gijn J. Detection of subarachnoid haemorrhage on early CT: Is lumbar puncture still needed after a negative scan? *J Neurol Neurosurg Psychiatry.* 1995;58(3):357-359.

NODE #6

1. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
2. Jin J, Zhou X, Liang X, et al. A study of patients with brain metastases as the initial manifestation of their systemic cancer in a Chinese population. *J Neurooncol.* 2011;103(3):649-655.
3. Yokoi K, Kamiya N, Matsuguma H, et al. Detection of brain metastasis in potentially operable non-small cell lung cancer: A comparison of CT and MRI. *Chest.* 1999;115(3):714-719.

NODE #7

1. Chiewvit P, Piyapittayanan S, Poungvarin N. Cerebral venous thrombosis: Diagnosis dilemma. *Neurol Int.* 2011;3(3):e13.
2. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
3. Filippidis A, Kapsalaki E, Patramani G, Fountas KN. Cerebral venous sinus thrombosis: Review of the demographics, pathophysiology, current diagnosis, and treatment. *Neurosurg Focus.* 2009;27(5):E3.
4. Kumral E, Polat F, Uzunköprü C, Callı C, Kitis Ö. The clinical spectrum of intracerebral hematoma, hemorrhagic infarct, non-hemorrhagic infarct, and non-lesional venous stroke in patients with cerebral sinus-venous thrombosis. *Eur J Neurol.* 2012;19(4):537-543.
5. Leach JL, Fortuna RB, Jones B V, Gaskill-Shipley MF. Imaging of cerebral venous thrombosis: Current techniques, spectrum of findings, and diagnostic pitfalls. *Radiographics.* 2006;26 Suppl 1(suppl_1):S19-41; discussion S42-43.
6. Zafar A, Ali Z. Pattern of magnetic resonance imaging and magnetic resonance venography changes in cerebral venous sinus thrombosis. *J Ayub Med Coll Abbottabad.* 24(1):63-67.

BIBLIOGRAPHY, CONTINUED

NODE #8

1. Chu KH, Howell TE, Keijzers G, et al. Acute headache presentations to the emergency department: A statewide cross-sectional study. *Acad Emerg Med.* 2017;24(1):53-62.
2. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
3. Hasbun R, Abrahams J, Jekel J, Quagliarello VJ. Computed tomography of the head before lumbar puncture in adults with suspected meningitis. *N Engl J Med.* 2001;345(24):1727-1733.
4. Zhang J, Hu X, Hu X, et al. Clinical features, Outcomes and molecular profiles of drug resistance in tuberculous meningitis in non-HIV patients. *Sci Rep.* 2016;6(1):19072.

NODE #9

1. Biffl WL, Egglin T, Benedetto B, Gibbs F, Cioffi WG. Sixteen-slice computed tomographic angiography is a reliable noninvasive screening test for clinically significant blunt cerebrovascular injuries. *J Trauma.* 2006;60(4):745-751; discussion 751-752.
2. Bromberg WJ, Collier BC, Diebel LN, et al. Blunt cerebrovascular injury practice management guidelines: The Eastern Association for the Surgery of Trauma. *J Trauma.* 2010;68(2):471-477.
3. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
4. Eastman AL, Chason DP, Perez CL, McAnulty AL, Minei JP. Computed tomographic angiography for the diagnosis of blunt cervical vascular injury: Is it ready for primetime? *J Trauma.* 2006;60(5):925-929; discussion 929.
5. Manabe H, Yonezawa K, Kato T, Toyama K, Haraguchi K, Ito T. Incidence of intracranial arterial dissection in non-emergency outpatients complaining of headache: Preliminary investigation with MRI/MRA examinations. *Acta Neurochir Suppl.* 2010;107:41-44.
6. Patterson BO, Holt PJ, Cleanthis M, et al. Imaging vascular trauma. *Br J Surg.* 2012;99(4):494-505.

NODE #10

1. Abdul Rahman YS, Al Den ASS, Maull KI. Prospective study of validity of neurologic signs in predicting positive cranial computed tomography following minor head trauma. *Prehosp Disaster Med.* 25(1):59-62.
2. Ahmadi K, Hashemian A, Pishbin E, Taheriniya A, Jafarpour S, Rahimi-movaghar V. Role of headache management in minor head injury before performing brain CT scan—Can intravenous morphine sulfate predict intracranial injury? *Turkish J Trauma Emerg Surg.* 2014;20(6):432-436.
3. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
4. Schwedt TJ, Chong CD, Peplinski J, Ross K, Berisha V. Persistent post-traumatic headache vs. migraine: An MRI study demonstrating differences in brain structure. *J Headache Pain.* 2017;18(1):87.
5. Sheehan A, Batchelor JS. A retrospective cohort study to re-evaluate clinical correlates for intracranial injury in minor head injury. *Emerg Med J.* 2012;29(11):899-901.
6. Shetty VS, Reis MN, Aulino JM, et al. ACR Appropriateness Criteria® Head Trauma. *J Am Coll Radiol.* 2016;13(6):668-679.

NODE #11

1. Bley TA, Reinhard M, Hauenstein C, et al. Comparison of duplex sonography and high-resolution magnetic resonance imaging in the diagnosis of giant cell (temporal) arteritis. *Arthritis Rheum.* 2008;58(8):2574-2578.
2. Bley TA, Uhl M, Carew J, et al. Diagnostic value of high-resolution MR imaging in giant cell arteritis. *Am J Neuroradiol.* 2007;28(9):1722-1727.
3. Bley TA, Wieben O, Uhl M, Thiel J, Schmidt D, Langer M. High-resolution MRI in giant cell arteritis: Imaging of the wall of the superficial temporal artery. *Am J Roentgenol.* 2005;184(1):283-287.
4. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
5. Klink T, Geiger J, Both M, et al. Giant cell arteritis: diagnostic accuracy of MR imaging of superficial cranial arteries in initial diagnosis: Results from a multicenter trial. *Radiology.* 2014;273(3):844-852.

NODE #12

1. Antonini G, Di Pasquale A, Cruccu G, et al. Magnetic resonance imaging contribution for diagnosing symptomatic neurovascular contact in classical trigeminal neuralgia: A blinded case-control study and meta-analysis. *Pain.* 2014;155(8):1464-1471.
2. Cai J, Xin ZX, Zhang YQ, Sun J, Lu JL, Xie F. Diagnostic value of 3D time-of-flight MRA in trigeminal neuralgia. *J Clin Neurosci.* 2015;22(8):1343-1348.
3. Douglas AC, Wippold FJ, Broderick DF, et al. ACR Appropriateness Criteria® Headache. *J Am Coll Radiol.* 2014;11(7):657-667.
4. Goh BT, Poon CY, Peck RH. The importance of routine magnetic resonance imaging in trigeminal neuralgia diagnosis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2001;92(4):424-429.
5. Gronseth G, Cruccu G, Alksne J, et al. Practice parameter: The diagnostic evaluation and treatment of trigeminal neuralgia (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology and the European Federation of Neurological Societies. *Neurology.* 2008;71(15):1183-1190.
6. Majoie CB, Hulsmans FJ, Castelijns JA, et al. Symptoms and signs related to the trigeminal nerve: Diagnostic yield of MR imaging. *Radiology.* 1998;209(2):557-562.
7. Majoie CB, Hulsmans FJ, Verbeeten B, et al. Trigeminal neuralgia: Comparison of two MR imaging techniques in the demonstration of neurovascular contact. *Radiology.* 1997;204(2):455-460.

REFERENCES (from pages 1 and 2)

ACR American College of Radiology. *ACR Appropriateness Criteria® Radiation Dose Assessment Introduction.* https://www.acr.org/~/media/ACR/Documents/AppCriteria/RadiationDoseAssessmentIntro.pdf. Accessed July 26, 2017.

CMS1 Centers for Medicare & Medicaid Services (CMS). Medicare claims data set. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Appropriate-Use-Criteria-Program/data.html. Published 2016. Accessed June 27, 2017.

CMS2 Centers for Medicare & Medicaid Services (CMS). Physician fee schedule. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched/. Published July 17, 2017. Accessed August 8, 2017.

FRY Fryback DG, Thornbury JR. The efficacy of diagnostic imaging. *Med Decis Making* 1991;11(2):88-94.

GAO United States Government Accountability Office (GAO). Medicare Part B imaging services: Rapid spending growth and shift to physician offices indicate need for CMS to consider additional management practices. 2008;(GAO-08-452). http://www.gao.gov/products/GAO-08-452. Accessed June 13, 2017.

HPS Health Physics Society. *Radiation Exposure from Medical Exams and Procedures: Fact Sheet.* https://hps.org/documents/Medical_Exposures_Fact_Sheet.pdf. Accessed July 31, 2017.

IGL Iglehart JK. Health insurers and medical-imaging policy—A work in progress. *N Engl J Med.* 2009;360(10):1030-1037.

LEV Levin DC, Parker L, Palit CD, Rao VM. After nearly a decade of rapid growth, use and complexity of imaging declined, 2008-14. *Health Aff (Millwood).* 2017;36(4):663-670.

NYDH New York State Department of Health (NYDH). Advanced diagnostic imaging: Background on use, patient safety, costs and implications for the health care industry definition of advanced medical imaging. https://www.health.ny.gov/facilities/public_health_and_health_planning_council/meetings/2013-07-17/docs/2013-07-03_adv_diag_imag_backgrnd_papers.pdf. Accessed June 21, 2017.

OCE OCEBM Levels of Evidence Working Group; Oxford Centre for Evidence-Based Medicine. The Oxford 2011 Levels of Evidence. http://www.cebm.net/index.aspx?o=5653. Accessed July 31, 2017.

SMI Smith-Bindman R, Miglioretti DL, Johnson E, et al. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems, 1996-2010. *JAMA.* 2012;307(22):2400-2409.

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This CPM presents a model of best care based on the best available scientific evidence at the time of publication. It is not a prescription for every physician or every patient, nor does it replace clinical judgment. All statements, protocols, and recommendations herein are viewed as transitory and iterative. Although physicians are encouraged to follow the CPM to help focus on and measure quality, deviations are a means for discovering improvements in patient care and expanding the knowledge base.

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