Through its Proven Imaging 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 PROVEN IMAGING?**

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.\(^{18}\) The inflating costs of advanced imaging outstripped that of any other medical service.\(^{IGLE, GAO}\) 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 Proven Imaging approach seeks to avoid these risks.

**GOALS AND MEASURES**

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
OVERVIEW: PROVEN IMAGING APPROPRIATE USE CRITERIA CONTENT

Intermountain Proven Imaging Appropriate Use Criteria (AUC) support clinicians in providing evidence-based care to the patients they serve. Although appropriate use of Proven Imaging 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/proven-imaging/.

The care process model approach

Designed as Care Process Models (CPMs), the Proven Imaging AUC content is a blueprint that logically guides the delivery of evidence-based care via an algorithmic visual presentation (see pages 5 through 25). Although these Proven Imaging 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, Proven Imaging 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 26). 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, Proven Imaging 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 RVUs published by CMS as a surrogate for cost. The radiation risk is derived from data published in 2010 by the Health Physics Society.

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 (OCEMB) 2011 Levels of Evidence standard. This standard includes categorical levelling grades relevant to diagnostic studies and rates individual sources of evidence (published papers or other research data) on a five-point scale.

2. The extensively used Fryback and Thornbury conceptual framework, which uses six levels for assessing the efficacy of diagnostic imaging.

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

Using the algorithms and checklists

Under “Care Pathway” 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
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
TA = temporal arteritis
TN = trigeminal nerve
V1 = ophthalmic nerve
V2 = maxillary nerve
V3 = mandibular nerve
Proven Imaging for Headache (HA)

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 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).

Cost rankings are indicated based on a range developed from the CMS Global Relative Value Units (RVUs) as follows:
- $ = 0 – 5 RVU
- $$ = 5 – 10 RVU
- $$$ = 10 – 15 RVU
- $$$$ = 15+ RVU

Radiation risk rankings use the scale developed by the American College of Radiology. 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

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

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
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 25 through 30 indicate if the test is a primary recommendation or alternative recommendation.

| TABLE 5. MRI cervical spine WITHOUT CONTRAST (trauma protocol) 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 |
|   AND EITHER |
|   □ Negative CT AND high suspicion of brain contusion |
|   OR |
|   □ High clinical suspicion for occult fracture or ligamentous injury |
HEADACHE (HA) CARE PATHWAY ALGORITHMS

**DECISION NODE #1**

**Existing HA disorder + clinical progression**

**AUC met (IF BOTH)?**
- Existing HA disorder
- Significant increase in headache frequency, severity, or duration

**Imaging: primary recommendation**
- MRI brain w/o contrast: NA** NA** $ R0

**Imaging: alternative recommendation**
- CT brain/head w/o contrast*: NA** NA** $ R3

**Significant positive result?**
- Secondary cause of HA identified

- yes → **CONSULT** with neurology, OR **REFER** to neurology (URGENT)

- no → **FOLLOW UP** in outpatient setting, AND **CONSIDER** referral to neurology

**PROVIDE** additional care as clinically warranted

---

**LEGEND**

- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure

- RO (0 mSv) $0–5 RVUs
- R3 (1–10 mSv) $5–10 RVUs
- R4 (10–30 mSv) $10–15 RVUs
- $15+ RVUs

---

* 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

See abbreviations on page 2.
PROVEN IMAGING FOR Headache (HA)

**DECISION NODE #2**

**Chronic HA + refractory/debilitating pain**

**AUC met (IF BOTH)?**
- Headache persistent for at least 3 months
- Refractory or debilitating pain

**yes**
- **Imaging: primary recommendation**
  - MRI brain w/o contrast
    - NA**
    - NA**
    - $ R0

**no**
- **FOLLOW UP** in outpatient setting,
  - AND
  - **CONSULT** with neurology, OR
  - **REFER** to neurology (URGENT)

**Imaging: alternative recommendation**
- CT brain/head w/o contrast*
  - NA**
  - NA**
  - $ R3

**Significant positive result?**
- Secondary cause of HA identified

**yes**
- **CONSULT** with neurology, OR
  - **REFER** to neurology (URGENT)

**no**
- **FOLLOW UP** in outpatient setting,
  - AND
  - **CONSULT** with neurology, OR
  - **REFER** to neurology (URGENT)

**PROVIDE** additional care as clinically warranted

---

**LEGEND**
- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure
  - R0 (0 mSv)
  - $ (0–5 RVUs)
- R3 (1–10 mSv)
  - $ $ (5–10 RVUs)
- R4 (10–30 mSv)
  - $ $ $ (10–15 RVUs)
- R4 (15+ mSv)
  - $ $ $ $ (15+ RVUs)

---

See abbreviations on page 2.
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.

**DECISION NODE #3A**

HA + neurologic deficits (acute)  

AUC met?  

- **yes**: EMERGENCY REFERRAL AND activate code stroke  
  - Imaging: primary recommendation  
    - CT brain/head w/ o contrast (STAT)  
      - 2  
      - II  
      - $  
      - R3

Significant positive result?  

- Stroke  
- Hemorrhage

Significant positive result?  

- Mass lesion(s)  
- White matter changes concerning for demyelination

Refer to neurology

For a full list of references for all decision nodes, see bibliography on page 32.


Proven Imaging for Headache (HA)

DECISION NODE #3B

HA + focal neurologic deficits (NOT acute)

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)

CONSIDER EMERGENCY REFERRAL

ConSIdER

EMERGENCY REFERRAL

yes

Significant positive result?

no

yes

CONSULT with neurology

no

REFER to neurology

PROVIDE additional care as clinically warranted

DECISION NODE #3B KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 2.
PROVEN IMAGING FOR Headache (HA)

DECISION NODE #4

AUC met (IF BOTH)?
- New or worsening headache
- Patient currently taking an anticoagulant

yes → CONSIDER EMERGENCY REFERRAL

Imaging: primary recommendation
CT brain/head w/o contrast
"NA** NA** $ R3"

no → PROVIDE additional care as clinically warranted

yes → Significant positive result?
Hemorrhage

no → FOLLOW UP in outpatient setting

CONSULT with neurology and/or neurosurgery (EMERGENCY)

HA + elevated bleeding risk*

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

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

See abbreviations on page 2.
PROVEN IMAGING FOR Headache (HA)

AUC met?
Sudden or severe headache triggered by ANY OF THESE:
- Cough/sneeze
- Valsalva
- Sex
- Exercise/exertion

**DECISION NODE #5**

**Imaging: primary recommendation**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI brain w/o contrast</td>
<td>II</td>
<td>S $ R0</td>
</tr>
</tbody>
</table>

**AND consider**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRA brain/head w/o contrast</td>
<td>NA*</td>
<td>NA* $ R0</td>
</tr>
</tbody>
</table>

**Imaging: alternative recommendation**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT brain/head w/o contrast</td>
<td>II</td>
<td>$ R3</td>
</tr>
</tbody>
</table>

**AND consider**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA brain/head</td>
<td>II</td>
<td>$ S $ R3</td>
</tr>
</tbody>
</table>

**Significant positive result?**

- Hemorrhage
- Stroke

**DECISION NODE #5 KEY EVIDENCE**


For a full list of references for all decision nodes, see bibliography on page 32.)

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

See abbreviations on page 2.
**PROVEN IMAGING FOR HEADACHE (HA)**

**DECISION NODE #6**

**HA + thunderclap onset**

- AUC met (IF BOTH)?
  - Sudden severe headache
  - Peak pain within 60 seconds of onset

  **yes** → **EMERGENCY REFERRAL**

  **Imaging: primary recommendation**
  - CT brain / head w/o contrast (STAT)  
    $1\ II\ $  
    $0\ mSv$  

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

  **yes** → **Significant positive result?**
  - Hemorrhage  
    **yes** → **CONSIDER** lumbar puncture* and further imaging,** AND **CONSULT** with neurology

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

---

**DECISION NODE #6 KEY EVIDENCE**


---

For a full list of references for all decision nodes, see bibliography on page 32.

---

* Perform cell count on 2 tubes.
** CTA brain/head to evaluate for aneurysm(s) and/or vasospasm.
PROVEN IMAGING FOR **Headache (HA)**

**DECISION NODE #7**

**AUC met (IF BOTH)?**
- New headache
- Known or suspected cancer

**Imaging: primary recommendation**
- MRI brain w/ and w/o contrast
  - Level of Evidence: 2
  - OCEBM Level: II
  - Intermountain Measure: $ (0 – 5 RVUs)
  - Radiation Dose: R0 (0 mSv)

**Imaging: alternative recommendation**
- CT brain/ head w/ and w/o contrast
  - Level of Evidence: 2
  - OCEBM Level: II
  - Intermountain Measure: $ (5 – 10 RVUs)
  - Radiation Dose: R3 (1 – 10 mSv)

**Significant positive result?**
- Intracranial malignancy

**DECISION NODE #7 KEY EVIDENCE**


For a full list of references for all decision nodes, see bibliography on page 32.)

**LEGEND**

- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure
- R0 (0 mSv) $ (0 – 5 RVUs)
- R3 (1 – 10 mSv) $ $ (5 – 10 RVUs)
- R4 (10 – 30 mSv) $ $$ (10 – 15 RVUs)
- $ $$ $ $ $  (15+ RVUs)
Headache with elevated intracranial pressure (ICP) or papilledema are considered in terms of chronicity – EITHER “new” (see below) OR subacute/chronic (see page 14) – AND in terms of known or suspected hypercoagulable state (see page 15).

DECISION NODE #8A

AUC met?
- New headache
- AND ANY OF THESE:
  - Visual symptoms
  - Increased pain when lying down
  - Increased pain in the morning
  - Pain aggravated by Valsalva

yes

CONSIDER EMERGENCY REFERRAL

**Imaging: primary recommendation**
- CT brain / head w/o contrast

NA**
NA**

$ R0

Significant positive result?
- Mass lesion(s)

yes

CONSULT with neurosurgery, neuro-oncology, and/or neurology (URGENT)

no

Significant positive result?
- Hydrocephalus

yes

CONSULT with neurosurgery and/or neurology (URGENT)

no

REFER to ophthalmology for papilledema, AND CONSIDER neurology referral for evaluation of idiopathic intracranial hypertension

SEE Decision Node #8B on page 14

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

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PROVEN IMAGING FOR Headache (HA)

Subacute/chronic HA + suspected elevated intracranial pressure or papilledema (no hypercoagulable state *)

**DECISION NODE #8B**

AUC met?
- Subacute/chronic headache
- AND ANY OF THESE:
  - Visual symptoms
  - Increased pain when lying down
  - Increased pain in the morning
  - Pain aggravated by Valsalva

**Imaging: primary recommendation**
- MRI brain w/ and w/o contrast

**Imaging: alternative recommendation**
- CT brain/head w/o contrast

**Significant positive result?**
- Mass lesion(s)

**Significant positive result?**
- Hydrocephalus

**CONSULT** with neurosurgery, neuro-oncology, and/or neurology (URGENT)

**CONSULT** with neurosurgery and/or neurology (URGENT)

**REFER** to ophthalmology for papilledema AND CONSIDER neurology referral for evaluation of idiopathic intracranial hypertension

---

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

---

**LEGEND**

Clinical Scenario | Urgent or Emergency Situation | OCEBM Level of Evidence | 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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PROVEN IMAGING FOR Headache (HA)

DECISION NODE #8C

**AUC met?**
- Known or suspected hypercoagulable state
- AND ANY OF THESE:
  - 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
  - 1
  - $5
  - R0
- MR venogram brain/head w/ and w/o contrast
  - 4
  - 1
  - $$$
  - R0

**Significant positive result?**
- Venous sinus thrombosis

**yes**

**CONSULT** with neurology (EMERGENCY)

**no**

**Imaging: alternative recommendation**
- CT brain/head w/o contrast
  - NA**
  - NA**
  - $R3
- CT venogram brain/head
  - 5
  - 1
  - $$
  - R3

**DECISION NODE #8 KEY EVIDENCE**


*For a full list of references for all decision nodes, see bibliography on page 32.*

---

**LEGEND**

- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure
- $ (0 – 5 RVUs)
- $$(5 – 10 RVUs)
- $$$ (10 – 15 RVUs)
- $$$$$ (15+ RVUs)

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**PROVEN IMAGING FOR Headache (HA)**

**DECISION NODE #9**

**HA + suspected infection***
- Fever
- Nuchal rigidity

**Imaging: primary recommendation**
- CT brain/head w/o contrast**
  - Level of Evidence: 2
  - Measure: $ (0 – 5 RVUs)
  - Radiation: 0 mSv (R0)

**Imaging: alternative recommendation**
- MRI brain w/ and w/o contrast
  - Level of Evidence: 2
  - Measure: $$ (5 – 10 RVUs)
  - Radiation: 0 mSv (R0)

**Significant positive result?**
- Findings suggestive of:
  - Meningitis
  - Encephalitis

**Significant positive result?**
- Abscess

**FOLLOW UP** in outpatient setting

**DECISION NODE #9 KEY EVIDENCE**


* Including meningitis, encephalitis, or abscess
**For the most accurate assessment of suspected CNS infection, MRI provides the most detailed information. However, a head CT without contrast allows timely exclusion of mass effect prior to lumbar puncture.*

**CONSIDER REFERRAL to medicine, ICU, infectious disease, and/or neurology**

**CONSULT with neurosurgery if brain abscess (EMERGENCY)**

For a full list of references for all decision nodes, see bibliography on page 32.)
Headache in conjunction with suspected cervical artery dissection is considered EITHER "with acute trauma" (see below) OR "without acute trauma" (see page 19).

**DECISION NODE #10A**

- **AUC met (IF BOTH)?**
  - Yes
    - **Consider EMERGENCY referral**
  - No
    - **AUC met?**
      - Yes
        - **Significant positive result?**
          - Yes
            - **CONSULT** with neurology and/or interventional radiology
          - No
            - **MRI brain w/o contrast**
              - **Imaging: primary recommendation**
                - R0 (0 mSv) $0 – 5 RVUs)
                - R3 (1 – 10 mSv) $5 – 10 RVUs)
                - R4 (10 – 30 mSv) $10 – 15 RVUs)
                - R5 (30 + mSv) $15 + RVUs)
      - No
        - **REFER** to the Concussion CPM and/or Neck Pain CPM or other system-wide protocol

**Imaging: primary recommendation**

- **CT brain/head w/o contrast**
  - NA**
  - $R3$
- **CTA head and neck**
  - 1
  - II
  - $SSSS$
  - R3

---

* Include CT cervical spine reformat from CTA data set

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

---

See abbreviations on page 2.
**DECISION NODE #10B**

**HA + suspected cervical artery dissection (without acute trauma)**

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

**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**

**Consensus**

**AUC met (IF ANY)?**
- Questionable CTA findings
- High clinical suspicion with negative CTA

**Imaging: primary recommendation**
- MRI brain w/o contrast
  - 5
  - II
  - $
  - R0

**Significant positive result?**
- Stroke
  - yes

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

**Consensus**

**Refer to** the Concussion CPM and/or Neck Pain CPM or other system-wide protocol
DECISION NODE #10 KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.
PROVEN IMAGING FOR Headache (HA)

DECISION NODE #11 KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.
PROVEN IMAGING FOR Headache (HA)

DECISION NODE #12A

AUC met (IF ALL)?
- Headache worse when upright or at end of day
- Failed conservative management
- Failed high volume epidural blood patch

**Imaging: primary recommendation**
MRI brain w/ and w/o contrast (include MR cisternogram) 4 1 $ R0

**Imaging: alternative recommendation**
MRI lumbar spine w/o contrast (include MRI myelography) 4 1 $$$ R0

CT myelogram spine NA** NA** $$$$ R4
CT cisternogram NA** NA** $ R3

**Significant positive result?**
- Findings suggestive of intracranial hypotension
- Cranial source of CSF leak identified

**Consult** with...
- Neurology
- Neurosurgery
- ENT
- Neurology

**Provide** additional care as clinically warranted

DECISION NODE #12A KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.

LEGEND
- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure

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PROVEN IMAGING FOR Headache (HA)

DECISION NODE #12B

HA + suspected intracranial hypotension without provocation*

AUC met (IF EITHER)?
* Headache worse when upright or at end of day
* Positional component to headache without clear provocation

yes → Imaging: primary recommendation
MRI brain w/ and w/o contrast (include MR cisternogram)
2 II $ R0

no → PROVIDE additional care as clinically warranted

AUC met (IF ANY)?
* Severe symptoms
* Negative MRI brain with high suspicion

yes → Imaging: primary recommendation
MRI cervical, thoracic, and lumbar spine w/o contrast (include MRI myelography)
2 II $$$$ R0

no → Imaging: alternative recommendation
CT myelogram spine NA** NA** $$$$ R4
AND/OR
CT cisternogram NA** NA** $ R3

no → DECISION NODE #12B KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.

See abbreviations on page 2.

* Such as lumbar puncture or epidural
** Based on expert opinion in the absence of literature-based evidence

DECISION NODE #12B KEY EVIDENCE

Findings suggestive of intracranial hypotension

yes → CONSULT with neurology

Significant positive result?
Cranial source of CSF leak identified

no → CONSULT with neurosurgery and/or ENT

yes → REFER to neurology

no → PROVIDE additional care as clinically warranted

CONSULT with neurology

CONSULT with neurosurgery and/or ENT

REFER to neurology

** Based on expert opinion in the absence of literature-based evidence
PROVEN IMAGING FOR Headache (HA)

DECISION NODE #13

HA + suspicion for giant cell/temporal arteritis

AUC met (IF ALL)?
- New or progressive headache
- Age > 50
- Visual symptoms

yes → Imaging: primary recommendation
MRI brain w/o contrast
Level of Evidence II
Level of Evidence R0

no → PROVIDE additional care as clinically warranted

yes → Imaging: primary recommendation
MRI brain w/o contrast
Level of Evidence II
Level of Evidence R0

Significant positive result?

yes → CONSULT with neurology

no → Imaging: alternative recommendation
CT brain/head w/o contrast
Level of Evidence NA
Level of Evidence R3

Secondary cause of HA identified

no → FOLLOW UP in outpatient setting, AND CONSIDER referral to neurology and/or rheumatology

DECISION NODE #13 KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.)
PROVEN IMAGING FOR Headache (HA)

DECISION NODE #14

**HA + trigeminal distribution***

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

* 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).

**HA + trigeminal distribution***

** **Imaging: primary recommendation**

MRI brain w/ and w/o contrast (trigeminal protocol)

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Fryback &amp; Thornbury Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>$ (0 – 5 RVUs)</td>
<td>$ (5 – 10 RVUs)</td>
</tr>
<tr>
<td>(10 – 15 RVUs)</td>
<td>$ (10 – 15 RVUs)</td>
<td>$ (15+ RVUs)</td>
</tr>
</tbody>
</table>

DECISION NODE #14 KEY EVIDENCE


For a full list of references for all decision nodes, see bibliography on page 32.)

See abbreviations on page 2.

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### POINT-OF-ORDER CHECKLISTS

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>
<thead>
<tr>
<th>TABLE 1. MRI brain WITHOUT CONTRAST appropriate use indications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(PRIMARY recommendation)</strong></td>
<td><strong>(PRIMARY recommendation)</strong></td>
</tr>
<tr>
<td>□ Existing HA disorder + clinical progression (IF BOTH):</td>
<td>□ Triggered headache:</td>
</tr>
<tr>
<td>□ Existing headache disorder</td>
<td>□ Sudden or severe headache triggered by ANY OF THESE:</td>
</tr>
<tr>
<td>□ Significant increase in headache frequency, severity, or duration</td>
<td>□ Cough / sneeze</td>
</tr>
<tr>
<td>□ Chronic HA + refractory / debilitating pain (IF BOTH):</td>
<td>□ Valsalva</td>
</tr>
<tr>
<td>□ Headache persistent for at least 3 months</td>
<td>□ Sex</td>
</tr>
<tr>
<td>□ Refractory or debilitating pain</td>
<td>□ Exercise / exertion</td>
</tr>
<tr>
<td>□ HA + focal neurologic deficits (NOT acute):</td>
<td>□ HA + head and/or neck trauma (WITHOUT suspicion of cervical artery trauma):</td>
</tr>
<tr>
<td>ANY OF THESE: with onset &gt; 24 hours ago or persistent:</td>
<td>□ Acute or subacute head and/or neck trauma</td>
</tr>
<tr>
<td>□ Altered mental status</td>
<td>AND EITHER</td>
</tr>
<tr>
<td>□ Weakness</td>
<td>□ Negative CT AND high suspicion of brain contusion</td>
</tr>
<tr>
<td>□ Sensory loss</td>
<td>OR</td>
</tr>
<tr>
<td>□ Visual symptoms (diplopia, field cut, etc.)</td>
<td>□ High clinical suspicion for occult fracture or ligamentous injury</td>
</tr>
<tr>
<td>□ Language deficit (aphasia)</td>
<td>□ HA + suspicion for giant cell / temporal arteritis (IF ALL):</td>
</tr>
<tr>
<td>□ HA + suspected cervical artery dissection (WITH ACUTE trauma) (IF BOTH):</td>
<td>□ New or progressive headache</td>
</tr>
<tr>
<td>□ Acute head and/or neck trauma</td>
<td>□ Age &gt; 50</td>
</tr>
<tr>
<td>□ Facial or neck pain</td>
<td>□ Visual symptoms</td>
</tr>
<tr>
<td>AND EITHER:</td>
<td>□ HA + suspected cervical artery dissection (WITHOUT ACUTE trauma) (IF ANY):</td>
</tr>
<tr>
<td>□ Questionable CTA findings</td>
<td>□ Headache or facial pain</td>
</tr>
<tr>
<td>OR</td>
<td>□ Neurologic deficit(s) and/or stroke</td>
</tr>
<tr>
<td>□ High clinical suspicion with negative CTA</td>
<td>□ Horner syndrome: Miosis, ptosis, anhidrosis</td>
</tr>
</tbody>
</table>

AND EITHER:

□ Questionable CT findings

OR

□ High clinical suspicion with negative CTA
### TABLE 2. MRI brain WITH AND WITHOUT CONTRAST appropriate use indications

*(PRIMARY recommendation)*

- HA + known or suspected cancer (IF BOTH):
  - New headache
  - Known or suspected cancer
- Subacute/chronic HA + suspected elevated ICP or papilledema (NO hypercoagulable state):
  - Subacute/chronic headache
- AND ANY OF THESE:
  - 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*):
  - Known or suspected hypercoagulable state
- AND ANY OF THESE:
  - Visual symptoms
  - Increased pain when lying down
  - Increased pain in the morning
  - Pain aggravated by Valsalva

**TRIGEMINAL PROTOCOL**

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

### TABLE 3. MRI brain WITH AND WITHOUT CONTRAST including MR cisternogram appropriate use indications

*(PRIMARY recommendation)*

- HA + suspected intracranial hypotension WITH provocation (IF ALL)**:
  - Headache worse when upright or at end of day
  - Failed conservative management
  - Failed high-volume epidural blood patch
- HA + suspected intracranial hypotension WITHOUT provocation**:
  - IF EITHER:
    - Headache worse when upright or at end of day
    - Positional component to headache without clear provocation

### TABLE 4. MRI lumbar spine WITHOUT CONTRAST including MRI myelography appropriate use indications

*(PRIMARY recommendation)*

- HA + suspected intracranial hypotension WITH provocation (IF ALL)**:
  - Headache worse when upright or at end of day
  - Failed conservative management
  - Failed high-volume epidural blood patch
  - AND AT LEAST ONE OF THESE:
    - Unsuccessful high-volume epidural blood patch
    - Severe symptoms
    - Negative MRI brain with high suspicion

### TABLE 5. MRI cervical spine WITHOUT CONTRAST (trauma protocol) 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
  - AND EITHER
    - Negative CT AND high suspicion of brain contusion
  - OR
    - High clinical suspicion for occult fracture or ligamentous injury

---

* Including dehydration.
** Such as lumbar puncture or epidural.
*** 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. MRI C, T, and L spine WITHOUT CONTRAST including MRI myelography appropriate use indications

**PRIMARY recommendation**

- □ HA + suspected intracranial hypotension WITHOUT provocation*:
  - IF EITHER:
    - □ Headache worse when upright or at end of day
    - □ Positional component to headache without clear provocation
  - AND EITHER:
    - □ Severe symptoms
    - □ Negative MRI brain with high suspicion

## TABLE 7. MR venogram brain / head WITH AND WITHOUT CONTRAST appropriate use indications

**PRIMARY recommendation**

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

## TABLE 8. MRI brain WITH AND WITHOUT CONTRAST appropriate use indications

**ALTERNATIVE recommendation**

- □ HA + suspected infection** (IF EITHER):
  - □ Fever
  - □ Nuchal rigidity

## TABLE 9. MRA brain / head WITHOUT CONTRAST appropriate use indications

**PRIMARY recommendation**

- □ Triggered headache:
  - □ Sudden or severe headache triggered by ANY OF THESE:
    - □ Cough/sneeze
    - □ Valsalva
    - □ Sex
    - □ Exercise/exertion

---

* Such as lumbar puncture or epidural.
** Including meningitis, encephalitis, or abscess.
*** Including dehydration.
### Table 10. CT brain/head WITHOUT CONTRAST appropriate use indications*

<table>
<thead>
<tr>
<th>(PRIMARY recommendation)</th>
<th>(ALTERNATIVE recommendation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ New HA + suspected elevated ICP or papilledema (NO hypercoagulable state)***:</td>
<td></td>
</tr>
<tr>
<td>□ New headache AND ANY OF THESE:</td>
<td></td>
</tr>
<tr>
<td>□ Visual symptoms</td>
<td></td>
</tr>
<tr>
<td>□ Increased pain when lying down</td>
<td></td>
</tr>
<tr>
<td>□ Increased pain in the morning</td>
<td></td>
</tr>
<tr>
<td>□ Pain aggravated by Valsalva</td>
<td></td>
</tr>
<tr>
<td>□ HA + elevated bleeding risk** (IF BOTH):</td>
<td></td>
</tr>
<tr>
<td>□ New or worsening headache</td>
<td></td>
</tr>
<tr>
<td>□ Patient currently taking an anticoagulant</td>
<td></td>
</tr>
<tr>
<td>□ HA + suspected cervical artery dissection (WITH ACUTE trauma) (IF BOTH):</td>
<td></td>
</tr>
<tr>
<td>□ Acute head and/or neck trauma</td>
<td></td>
</tr>
<tr>
<td>□ Facial or neck pain</td>
<td></td>
</tr>
<tr>
<td>□ HA + suspected infection**** (IF EITHER):</td>
<td></td>
</tr>
<tr>
<td>□ Fever</td>
<td></td>
</tr>
<tr>
<td>□ Nuchal rigidity</td>
<td></td>
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<tr>
<td>STAT</td>
<td></td>
</tr>
<tr>
<td>□ HA + neurologic deficits (ACUTE):</td>
<td></td>
</tr>
<tr>
<td>ANY OF THESE with onset &lt; 24 hours ago:</td>
<td></td>
</tr>
<tr>
<td>□ Altered mental status</td>
<td></td>
</tr>
<tr>
<td>□ Weakness</td>
<td></td>
</tr>
<tr>
<td>□ Sensory loss</td>
<td></td>
</tr>
<tr>
<td>□ Visual symptoms (diplopia, field cut, etc.)</td>
<td></td>
</tr>
<tr>
<td>□ Language deficit (aphasia)</td>
<td></td>
</tr>
<tr>
<td>□ HA + thunderclap onset (IF BOTH):</td>
<td></td>
</tr>
<tr>
<td>□ Sudden severe headache</td>
<td></td>
</tr>
<tr>
<td>□ Peak pain within 60 seconds of onset</td>
<td></td>
</tr>
<tr>
<td>□ Existing HA disorder + clinical progression (IF BOTH):</td>
<td></td>
</tr>
<tr>
<td>□ Significant increase in headache frequency, severity, or duration</td>
<td></td>
</tr>
<tr>
<td>□ Chronic HA + refractory/debilitating pain (IF BOTH):</td>
<td></td>
</tr>
<tr>
<td>□ Headache persistent at least 3 months</td>
<td></td>
</tr>
<tr>
<td>□ Refractory or debilitating pain</td>
<td></td>
</tr>
<tr>
<td>□ HA + focal neurologic deficits (NOT acute):</td>
<td></td>
</tr>
<tr>
<td>ANY OF THESE with onset &gt; 24 hours ago or persistent:</td>
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<td>□ Language deficit (aphasia)</td>
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</tr>
<tr>
<td>□ HA+ head and/or neck trauma (WITHOUT suspicion of cervical artery trauma):</td>
<td></td>
</tr>
<tr>
<td>□ Acute or subacute head and/or neck trauma</td>
<td></td>
</tr>
<tr>
<td>□ Triggered headache:</td>
<td></td>
</tr>
<tr>
<td>□ Sudden or severe headache triggered by ANY OF THESE:</td>
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</tr>
<tr>
<td>□ Valsalva</td>
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</tr>
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<td>□ Exercise/exertion</td>
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<td>□ HA + suspicion for giant cell/temporal arteritis (IF ALL):</td>
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<tr>
<td>□ New or progressive headache</td>
<td></td>
</tr>
<tr>
<td>□ Age &gt; 50</td>
<td></td>
</tr>
<tr>
<td>□ Visual symptoms</td>
<td></td>
</tr>
</tbody>
</table>

*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.

***Including dehydration.

****Including meningitis, encephalitis, or abscess. For the most accurate assessment of suspected CNS infection, MRI provides the most detailed information, but a non-contrast head CT allows timely exclusion of mass effect prior to lumbar puncture.
### POINT-OF-ORDER CHECKLISTS, CONTINUED

**TABLE 11. CTA brain / head appropriate use indications**

(ALTERNATIVE recommendation)

- Triggered headache:
  - Sudden or severe headache triggered by ANY OF THESE:
    - Cough/sneeze
    - Valsalva
    - Sex
    - Exercise/exertion

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

(ALTERNATIVE recommendation)

- HA + known or suspected cancer (IF BOTH)
  - New headache
  - Known or suspected cancer

**TABLE 13. CTA head and neck appropriate use indications**

(PRIMARY recommendation)

- HA + suspected cervical artery dissection (WITH ACUTE trauma)** (IF BOTH):
  - Acute head and/or neck trauma
  - Facial or neck pain

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

---

* MRI rather than CT should be performed for headache, except in emergency situations or when MRI is contraindicated.  
** Include CT cervical spine reformats from CTA data set.
## TABLE 14. CT myelogram spine appropriate use indications

### (ALTERNATIVE recommendation)

- **HA + suspected intracranial hypotension**
  - WITH provocation (IF ALL)*:
    - Headache worse when upright or at end of day
    - Failed conservative management
    - Failed high-volume epidural blood patch
  - AND AT LEAST ONE OF THESE:
    - Unsuccessful high-volume epidural blood patch
    - Severe symptoms
    - Negative MRI brain with high suspicion
- **HA + suspected intracranial hypotension**
  - WITHOUT provocation*:
    - IF EITHER:
      - Headache worse when upright or at end of day
      - Positional component to headache without clear provocation
    - AND EITHER:
      - Severe symptoms
      - Negative MRI brain with high suspicion

*Such as lumbar puncture or epidural.

**Including dehydration.

## TABLE 15. CT cisternogram appropriate use indications

### (ALTERNATIVE recommendation)

- **HA + suspected intracranial hypotension**
  - WITH provocation (IF ALL)*:
    - Headache worse when upright or at end of day
    - Failed conservative management
    - Failed high-volume epidural blood patch
  - AND AT LEAST ONE OF THESE:
    - Unsuccessful high-volume epidural blood patch
    - Severe symptoms
    - Negative MRI brain with high suspicion
- **HA + suspected intracranial hypotension**
  - WITHOUT provocation*:
    - IF EITHER:
      - Headache worse when upright or at end of day
      - Positional component to headache without clear provocation
    - AND EITHER:
      - Severe symptoms
      - Negative MRI brain with high suspicion

## TABLE 16. 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

## TABLE 17. CT venogram brain / head appropriate use indications

### (ALTERNATIVE recommendation)

- **HA + suspected elevated ICP or papilledema** (known or suspected hypercoagulable state**):
  - Known or suspected hypercoagulable state
  - **AND ANY OF THESE:**
    - Visual symptoms
    - Increased pain when lying down
    - Increased pain in the morning
    - Pain aggravated by Valsalva
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 Proven Imaging CPMs, Intermountain provides topical CPMs that have been developed by expert clinical teams. Many of these relate to the Proven Imaging clinical scenarios and can be accessed as described below.

You can access all of the above materials by navigating to http://www.intermountainphysician.org. Click on the “Programs and Services” option in the blue bar at the top. Select “Patient Education Library” in the drop-down list to go to the Proven Imaging Resources web page.

http://www.intermountainphysician.org

Proven Imaging Resources web page

Fact sheets for patients:
• CT Scan
• Radiation Exposure in Medical Tests
• Intravenous (IV) Contrast Material
• MRI (Magnetic Resonance Imaging)

Patient education:
• Managing Chronic Pain
• Pain Med Tracking Sheet

Related Care Process Models (CPMs):
• Concussion CPM
• Neck Pain CPM
• Prescribing Opioids for Chronic 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

Node #4
Recommendations based on expert opinion in the absence of literature-based evidence.

Node #5

Node #6

Node #7

Node #8
BIBLIOGRAPHY, CONTINUED


NODE #9


NODE #10


NODE #11


NODE #12


NODE #13


BIBLIOGRAPHY, CONTINUED

NODE #14


REFERENCES (from pages 1 and 2)


Proven Imaging Development Group
- Jordan Albritton, PhD
- Tom Belnap
- Benjamin Fox, MD
- James Hellewell, MD
- Robert Hoesch, MD
- Jeremy Hopkin, MD
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- Elisabeth Malmberg
- Julie Martinez, MSN, RN, CCRP
- Krista Schonrock
- Laura Sittig, PhD (Medical Writer)
- Stephen Warner, MD
- Keith White, MD

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. Send feedback to ProvenImaging@imail.org.