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. The inflating costs of advanced imaging outstripped that of any other medical service. These inflating costs resulted in up to $20–30 billion in unnecessary advanced imaging spending each year.

- **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.

- **Limited effectiveness.** Multiple studies suggest that up to a third of advanced imaging procedures fail to contribute to diagnosis or are clinically inappropriate.

- **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 shoulder pain. 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 risk associated with unwarranted patient exposure to radiation and/or contrast media
- Documenting the incidence of a significant positive on advanced imaging tests and aligning with downstream care
PROVEN IMAGING FOR Shoulder Pain (SP)

OVERVIEW: PROVEN IMAGING AUC 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/imaing-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 list at right and pages 5 through 28). Although these Proven Imaging CPMs specifically focus on the appropriate use of advanced imaging, they can rightly 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 in the CPMs (beginning on page 29). 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 relative value units (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:


   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.

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 (the 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
AVN = avascular necrosis
CPM = care process model
CRP = C-reactive protein
CT = computed tomography
ER = external rotation
ESR = erythrocyte sedimentation rate
IV = intravenous
MARS = metal artifact reduction sequences
MRI = magnetic resonance imaging
PCP = primary care provider
PET = positron emission tomography
RVU = relative value units
TSA = total shoulder arthroplasty
WBC = white blood cells

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**Care Pathways**

For each clinical scenario (e.g., chronic shoulder pain and avascular necrosis or osteochondral lesion), there is an algorithmic presentation of the care pathway context for the imaging decisions made. This pathway is not only the appropriate use criteria (AUC) and evidence-based advanced imaging recommendations, but what constitutes significant positive imaging results and downstream care recommendations.

Note the elements of this presentation below and key information provided in each test recommendation box as shown at right. There is also a legend at the bottom of each care pathway page.

Algorithms are grouped as indicated on page 2.

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).

The 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

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

See abbreviations on page 2.
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. Tables indicate if the test is a primary recommendation or alternate recommendation. 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.

### TABLE 1. MRI shoulder without contrast appropriate use indications (PRIMARY recommendation)

<table>
<thead>
<tr>
<th>NOT POST THA (IF ALL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chronic SP + moderate to severe osteoarthritis</td>
</tr>
<tr>
<td>□ Radiographs positive for OA</td>
</tr>
<tr>
<td>□ Morning stiffness in shoulder joint</td>
</tr>
<tr>
<td>□ Limited range of motion</td>
</tr>
<tr>
<td>□ Deep ache without mechanical symptoms</td>
</tr>
<tr>
<td>□ Chronic SP + mild osteoarthritis</td>
</tr>
<tr>
<td>□ Age &gt; 40</td>
</tr>
<tr>
<td>□ Near symmetric motion</td>
</tr>
<tr>
<td>□ No significant strength loss</td>
</tr>
<tr>
<td>□ Deep ache</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ 3 months of failed conservative treatment</td>
</tr>
<tr>
<td>□ Chronic SP + suspected rotator cuff tear/impingement</td>
</tr>
<tr>
<td>□ Radiographs noncontributory or demonstrate coracohumeral arch osteoarthritides</td>
</tr>
<tr>
<td>□ AND ANY OF THESE:</td>
</tr>
<tr>
<td>□ Positive test for bicipital tendinosis</td>
</tr>
<tr>
<td>□ Positive test for shoulder instability</td>
</tr>
<tr>
<td>□ Positive test for rotator cuff pathology</td>
</tr>
<tr>
<td>□ Acromiohumeral/subacromial tenderness</td>
</tr>
<tr>
<td>□ Chronic SP + calcific tendinitis</td>
</tr>
<tr>
<td>□ Painful limited shoulder motion</td>
</tr>
<tr>
<td>□ Resting pain</td>
</tr>
<tr>
<td>□ Radiograph positive for calcium in rotator cuff tendon region</td>
</tr>
<tr>
<td>□ Chronic SP + glenohumeral dislocation</td>
</tr>
<tr>
<td>□ Traumatic mechanism of injury</td>
</tr>
<tr>
<td>□ History of dislocation</td>
</tr>
<tr>
<td>□ Positive apprehension and/or relocation test</td>
</tr>
<tr>
<td>□ Radiographs show appropriate reduction</td>
</tr>
<tr>
<td>□ Chronic SP + suspected rotator cuff re-tear</td>
</tr>
<tr>
<td>□ Post rotator cuff repair</td>
</tr>
<tr>
<td>□ AND ANY OF THESE:</td>
</tr>
<tr>
<td>□ Positive drop arm test</td>
</tr>
<tr>
<td>□ Rotator cuff muscle weakness</td>
</tr>
<tr>
<td>□ Superior migration of humeral head on radiographs</td>
</tr>
<tr>
<td>□ Chronic SP + avascular necrosis or osteochondral lesion</td>
</tr>
<tr>
<td>□ Radiographs positive or equivocal for AVN</td>
</tr>
<tr>
<td>□ Chronic SP + inflammatory/nonspecific arthropathy</td>
</tr>
<tr>
<td>□ Nonspecific joint pain</td>
</tr>
<tr>
<td>□ Limited range of motion w/o history of inflammatory joint disease</td>
</tr>
<tr>
<td>□ Radiograph positive or noncontributory</td>
</tr>
<tr>
<td>□ Lab workup positive for inflammatory arthritis</td>
</tr>
<tr>
<td>□ Acute SP + adhesive capsulitis</td>
</tr>
<tr>
<td>□ Loss of external rotation</td>
</tr>
<tr>
<td>□ Atypical shoulder pain</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Acute SP + bicep rupture/tendinopathy</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ AND ANY OF THESE:</td>
</tr>
<tr>
<td>□ Positive Popeye sign</td>
</tr>
<tr>
<td>□ Bicep weakness</td>
</tr>
<tr>
<td>□ Positive test for bicipital tenosynovitis</td>
</tr>
<tr>
<td>□ Acute SP + rotator cuff tear</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ AND EITHER OF THESE:</td>
</tr>
<tr>
<td>□ Positive drop arm test</td>
</tr>
<tr>
<td>□ Rotator cuff weakness</td>
</tr>
<tr>
<td>□ Acute SP + dislocation post-relocation</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Shoulder has been reduced</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Acute SP + fracture of humerus, clavicle, or scapula</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs equalvocal or do not provide appropriate fracture delineation</td>
</tr>
<tr>
<td>□ Negative CT</td>
</tr>
<tr>
<td>□ Persistent concern for occult fracture</td>
</tr>
</tbody>
</table>

See abbreviations on page 2.
### PROVEN IMAGING FOR Shoulder Pain (SP)

#### SHOULDER PAIN (SP) CARE PATHWAY ALGORITHMS:
**POST TOTAL SHOULDER ARTHROPLASTY (TSA)**

For patients who have had a total shoulder arthroplasty (TSA) and present with shoulder pain, clinical scenarios are grouped as either **chronic** or **acute**. Common **chronic pain** scenarios are covered on pages 5–6. Common **acute pain** scenarios begin on page 7.

![Decision Node #1 Diagram](chart.png)

**DECISION NODE #1 KEY EVIDENCE**


*(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)*

---

**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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**DECISION NODE #2**

**Chronic SP + suspected component loosening (POST TSA)**

- **AUC met (IF ALL)?**
  - Persistent pain in shoulder/proximal humerus
  - Radiographs noncontributory

- **Imaging: primary recommendation**
  - **CT shoulder w/o contrast (MARS)**
    - **5**
    - **1**
    - **$**
    - **R3**

- **Significant positive result?**
  - **yes**
    - REFER to shoulder surgeon
  - **no**

- **AUC met?**
  - Persistent concern for component loosening?
    - **yes**
      - **Bone scan**
        - **1**
        - **II**
        - **$$**
        - **R3**
      - Significant positive result?
        - **yes**
          - COMPONENT LOOSENING
        - **no**
          - **Refer to shoulder surgeon**
    - **no**
      - PROVIDE additional care as clinically warranted
      - MANAGE with conservative measures

---

**DECISION NODE #2 KEY EVIDENCE**


*(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)*
For patients who have had a total shoulder arthroplasty (TSA) and present with shoulder pain, clinical scenarios are grouped as either chronic or acute. Common chronic pain scenarios were covered on pages 5 – 6. Pages 7 – 10 cover common acute pain scenarios.

### DECISION NODE #3

**Acute SP + suspected infection (POST TSA)**

- **AUC met (IF ALL)?**
  - Shoulder pain OR constitutional symptoms
  - Insufficient data from shoulder aspiration
  - Radiographs noncontributory

**Imaging: primary recommendation**

- MRI shoulder w/ and w/o contrast (MARS)
- **R0**

**Imaging: alternative recommendation**

- CT shoulder w/ contrast (MARS)
- **R3**

**Significant positive result?**

- Abscess
- Osteomyelitis

- **yes** REFER to shoulder surgeon
- **no** PROVIDE additional care as clinically warranted

### DECISION NODE #3 KEY EVIDENCE


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**Decision Node #4**

**Acute SP + rotator cuff tear (POST TSA)**

- **AUC met (IF ALL)?**
  - Positive drop arm test OR rotator cuff weakness
  - Radiographs noncontributory

**Imaging: primary recommendation**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Level of Evidence</th>
<th>Level of Evidence</th>
<th>Intermountain Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI shoulder arthrogram (MARS)</td>
<td>3</td>
<td>II</td>
<td>$$</td>
</tr>
<tr>
<td>CT shoulder arthrogram (MARS)</td>
<td>3</td>
<td>II</td>
<td>$</td>
</tr>
</tbody>
</table>

**Imaging: alternative recommendation**

- Rotator cuff tear

**DECISION NODE #4 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
Acute SP + suspected component failure (POST TSA)

**DECISION NODE #5**

**AUC met (IF ALL)?**
- History of trauma
- Radiographs indicate component failure or fracture or are equivocal

**Imaging: primary recommendation**
- **yes**
  - CT shoulder w/o contrast (MARS)
  - Level of Evidence: 2
  - Intermountain Measure: $ (0 – 5 RVUs)
  - $ (5 – 10 RVUs)
  - $ (10 – 15 RVUs)
  - (15+ RVUs)
  - R3

**Significant positive result?**
- **yes**
  - Component failure
  - Fracture
  - REFER to shoulder surgeon

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

- **no**
  - CONSIDER referral to shoulder surgeon

**DECISION NODE #5 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)

---

**LEGEND**

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

**RO** (0 mSv)  **R3** (1 – 10 mSv)  **R4** (10 – 30 mSv)

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

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**Acute SP + fracture (POST TSA)**

- **AUC met (IF ALL)?**
  - History of trauma
  - Radiographs positive or equivocal for fracture
  - Shoulder pain OR visible deformity
  - **yes**

  **Imaging: primary recommendation**
  - CT shoulder w/o contrast (MARS)
  - 5
  - 1
  - $ (0 – 5 RVUs)
  - R3

  **yes**

  **Significant positive result?**
  - **yes**
  - REFER to shoulder surgeon

  **no**

  **CONSIDER referral to shoulder surgeon**

  **Provide** additional care as clinically warranted

---

**DECISION NODE #6 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
PROVEN IMAGING FOR Shoulder Pain (SP)

SHOULDER PAIN (SP) CARE PATHWAY ALGORITHMS: NOT POST TOTAL SHOULDER ARTHROPLASTY (TSA)

For patients who have NOT had a total shoulder arthroplasty (TSA) and present with shoulder pain, clinical scenarios are grouped as either chronic or acute. Common chronic pain scenarios are covered on pages 11 – 19. Common acute pain scenarios begin on page 20.

DECISION NODE #7

AUC met (IF ALL)?
- Radiographs positive for OA
- Morning stiffness in shoulder joint
- Limited range of motion
- Deep ache without mechanical symptoms

yes → Imaging: primary recommendation*

MRI shoulder w/o contrast
1  II  $S$  R0

yes → Imaging: alternative recommendation*

CT shoulder arthrogram
1  V  $S$  R3

no → PROVIDE additional care as clinically warranted

Significant positive result?

Moderate to severe articular cartilage loss

yes → DISCUSS treatment options with patient

no → DISCUSS treatment options with patient

DISCUSSION

DECISION NODE #7 KEY EVIDENCE


See abbreviations on page 2.

Consider referral to shoulder surgeon prior to any advanced imaging studies.

(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
PROVEN IMAGING FOR Shoulder Pain (SP)

DEcision Node #8

Chronic SP + mild osteoarthritis

AUC met (IF ALL)?
- Age > 40
- Near symmetric motion
- No significant strength loss
- Deep ache
- Radiographs noncontributory
- 3 months of failed conservative treatment

**Imaging: primary recommendation**
MRI shoulder w/o contrast
1 II $ S$ R0

**Imaging: alternative recommendation**
CT shoulder arthrogram
1 V $ S$ R3

Significant positive result?
- Articular cartilage loss
- Rotator cuff tear

**DECISION NODE #8 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)

**LEGEND**

![Clinical Scenario](image)
![Urgent or Emergency Situation](image)
![OCEBM Level of Evidence](image)
![Fryback & Thornbury Level of Evidence](image)
![Intermountain Measure](image)

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### PROVEN IMAGING FOR Shoulder Pain (SP)

#### DECISION NODE #9

**Chronic SP + labrum tear**

**AUC met (IF ALL)?**
- Age < 35
- Radiographs noncontributory
  - **AND**
  - Subjective complaint of “instability or dislocation”
    - **OR**
    - Positive sulcus sign
      - **OR**
      - Positive apprehension or relocation test

**yes**

**Imaging: primary recommendation**
- MRI shoulder arthrogram
  - Level of Evidence: II
  - Intermountain Measure: $$$
  - Radiation Dose: R0 (0 mSv)

**Imaging: alternative recommendation**
- MRI shoulder* w/o contrast
  - Level of Evidence: II
  - Intermountain Measure: $$
  - Radiation Dose: R0 (0 mSv)
- CT shoulder arthrogram
  - Level of Evidence: II
  - Intermountain Measure: $$
  - Radiation Dose: R3 (1 – 10 mSv)

**no**

**PROVIDE** additional care as clinically warranted

**yes**

**Significant positive result?**
- Labrum tear
- Capsular tear
- Rotator cuff tear

**REFER** to shoulder surgeon

**no**

**MANAGE** with conservative measures

### DECISION NODE #9 KEY EVIDENCE


*Consider 3T magnet if appropriate expertise is available on site*

For a full list of references for all decision nodes, see bibliography on pages 34 through 37.

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Chronic SP + suspected rotator cuff tear / impingement

DECISION NODE #10

AUC met (IF ANY)?
- Radiographs noncontributory or demonstrate coracoacromial arch osteophytes
AND ANY:
- Positive test for bicipital tendinosis
- Positive test for shoulder instability
- Positive test for rotator cuff pathology
- Acromioclavicular / subacromial tenderness

yes → Imaging: primary recommendation
MRI shoulder w/o contrast

1 II $$$ R0

no → PROVIDE additional care as clinically warranted

yes → Significant positive result?
- Labrum tear
- Coracoacromial arch impingement

no → MANAGE with conservative measures

DECISION NODE #10 KEY EVIDENCE


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**DECISION NODE #11**

**Chronic SP + calcific tendinitis**

- **AUC met (IF ANY)?**
  - Painful limited shoulder motion
  - Resting pain
  - Radiograph positive for calcium in rotator cuff tendon region

- **Imaging: primary recommendation**
  - Yes: MRI shoulder w/o contrast
  - No: PROVIDE additional care as clinically warranted

**Significant positive result?**

- Yes: REFER to shoulder surgeon
- No: MANAGE with conservative measures

**DECISION NODE #11 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
### DECISION NODE #12

**Chronic SP + suspected rotator cuff re-tear**

- **AUC met?**
  - Yes:
    - Imaging: primary recommendation
    - MRI shoulder w/o contrast
    - Level of Evidence: II
    - Cost: $$
    - Radiation: R0 (0 mSv)
    - Refer to Shoulder surgeon
  - No:
    - **MANAGE** with conservative measures

- **No**:
  - PROVIDE additional care as clinically warranted

---

#### DECISION NODE #12 KEY EVIDENCE


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**DECISION NODE #13**

**Imaging: primary recommendation**
- MRI shoulder w/o contrast
  - Level of Evidence: II
  - Measure: $ (0 – 5 RVUs)
  - Radiation dose: R0 (0 mSv)

**Imaging: alternative recommendation**
- CT shoulder arthrogram
  - Level of Evidence: V
  - Measure: $ (5 – 10 RVUs)
  - Radiation dose: R3 (1 – 10 mSv)

---

**DECISION NODE #13 KEY EVIDENCE**


---

*(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)*
**DECISION NODE #14**

**Chronic SP + glenohumeral dislocation**

**AUC met (IF ALL)?**
- Traumatic mechanism of injury
- History of dislocation
- Positive apprehension and/or relocation test
- Radiographs show appropriate reduction

**Imaging: primary recommendation**
- MRI shoulder w/o contrast
  - Level of Evidence: 2
  - Measure: $ (0 – 5 RVUs)
  - Dose: R0 (0 mSv)

**Imaging: alternative recommendation**
- CT shoulder w/o contrast
  - Level of Evidence: 4
  - Measure: $ (5 – 10 RVUs)
  - Dose: R3 (1 – 10 mSv)

**Significant positive result?**
- Glenoid insufficiency
- Fracture
- Capsular failure
- Rotator cuff tear
- Labral injury

**First dislocation?**
- yes
  - REFER to shoulder surgeon
  - no
  - CONSIDER referral to shoulder surgeon

**Provide additional care as clinically warranted**

---

**DECISION NODE #14 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**Decision Node #15**

**AUC met (IF ALL)?**
- Nonspecific joint pain
- Limited range of motion w/ or w/o history of inflammatory joint disease
- Radiograph positive or noncontributory
- Lab workup positive for inflammatory arthritis

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

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

**Significant positive result?**
- • Synovitis
- • Articular cartilage loss

**Patient already under care by rheumatologist?**
- yes
- no

**Decision Node #15 Key Evidence**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
For patients who have NOT had a total shoulder arthroplasty (TSA) and present with shoulder pain, clinical scenarios are grouped as either chronic or acute. Common chronic pain scenarios were covered on pages 11–19. Pages 20–28 cover common acute pain scenarios.

DECISION NODE #16

AUC met (IF ALL)?
- Loss of external rotation
- Atypical shoulder pain
- Radiograph noncontributory

if yes

Imaging: primary recommendation
MRI shoulder w/o contrast

1 II $ S$ R0

if no

PROVIDE additional care as clinically warranted

DECISION NODE #16 KEY EVIDENCE


* Consider MRI with contrast if relevant expertise is available on site.

FOR A FULL LIST OF REFERENCES FOR ALL DECISION NODES, SEE BIBLIOGRAPHY ON PAGES 34 THROUGH 37.
**Acute SP + septic arthritis**

- Atypical shoulder pain
- Constitutional symptoms
- Radiographs noncontributory
- Aspiration negative or not viable with persistent clinical concern
- Elevated ESR or CRP or WBC

**DECISION NODE #17**

**AUC met (IF ALL)?**
- Yes: MRI shoulder with and without contrast

**Imaging: primary recommendation**

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>RVUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>$$$</td>
</tr>
<tr>
<td>R0</td>
<td>$</td>
</tr>
<tr>
<td>R3</td>
<td>$</td>
</tr>
<tr>
<td>R4</td>
<td>$</td>
</tr>
</tbody>
</table>

**Significant positive result?**
- Yes: Abscess, Osteomyelitis, Synovitis

**DECISION NODE #17 KEY EVIDENCE**


(providing additional care as clinically warranted)

See abbreviations on page 2.
### Proven Imaging for Shoulder Pain (SP)

#### Decision Node #18

**AUC met (IF ALL)?**
- Age < 35
- Radiographs noncontributory
- Positive test for bicipital tenosynovitis/labral tear or shoulder instability
- Long head of the biceps tenderness and weakness

**Imaging: Primary Recommendation**
- MRI shoulder arthrogram
  - Level of Evidence: II
  - RVUs: $$$
  - Dose: RO

**Imaging: Alternative Recommendation**
- MRI shoulder w/o contrast*
  - Level of Evidence: II
  - RVUs: $$
  - Dose: RO

**Significant Positive Result?**
- Labrum tear
- Rotator cuff tear

**No**
- Manage with conservative measures

**Yes**
- Refer to shoulder surgeon

**Provide** additional care as clinically warranted

---

**Decision Node #18 Key Evidence**


---

*Consider 3T magnet if appropriate expertise is available on site*

---

(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**DECISION NODE #19**

**Acute SP + brachial plexus neuritis**
- Severe atypical pain
- Painful / limited active motion
- Failed conservative treatment

---

**AUC met (IF ALL)?**

- **yes**
  - **Imaging: primary recommendation**
    - MRI brachial plexus w/ and w/o contrast
    - **Level of Evidence:** II
    - **RO:** $0 - 5$ RVUs
    - **SSS:** $10 - 15$ RVUs

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

---

**Significant positive result?**

- **yes**
  - REFER to shoulder surgeon

- **no**
  - **MANAGE with conservative measures**

---

**DECISION NODE #19 KEY EVIDENCE**


---

**LEGEND**

- Clinical Scenario
- Urgent or Emergency Situation
- OCEBM Level of Evidence
- Fryback & Thornbury Level of Evidence
- Intermountain Measure
- RO: (0 mSv)
- R: (1 – 10 mSv)
- S: (0 – 5 RVUs)
- S$: (5 – 10 RVUs)
- $S$: (10 – 15 RVUs)
- $SS$: (15+ RVUs)

---

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PROVEN IMAGING FOR Shoulder Pain (SP)

**DECISION NODE #20**

Acute SP + bicep rupture/tendinopathy

AUC met (IF ALL)?
- History of trauma
- Radiographs noncontributory
AND ANY:
- Positive Popeye sign
- Bicep weakness
- Positive test for bicipital tenosynovitis

---

**Imaging: primary recommendation**

<table>
<thead>
<tr>
<th>R0 (0 mSv)</th>
<th>R3 (1 – 10 mSv)</th>
<th>R4 (10 – 30 mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ (0 – 5 RVUs)</td>
<td>$ (5 – 10 RVUs)</td>
<td>$$$ (10 – 15 RVUs)</td>
</tr>
</tbody>
</table>

---

Significant positive result?
- Long head bicep tendon tear
- Rotator cuff tear

no

**MANAGE with conservative measures**

yes

**REFER to shoulder surgeon**

---

**DECISION NODE #20 KEY EVIDENCE**


---

(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**PROVEN IMAGING FOR Shoulder Pain (SP)**

**DECISION NODE #21**

**Acute SP + rotator cuff tear**

<table>
<thead>
<tr>
<th>AUC met (IF ALL)?</th>
<th>Imaging: primary recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• History of trauma</td>
<td>MRI shoulder w/ o contrast 1 II $ $ R0</td>
</tr>
<tr>
<td>• Radiographs noncontributory</td>
<td>CT shoulder arthrogram 2 II $ $ R3</td>
</tr>
</tbody>
</table>

**AND EITHER:**

<table>
<thead>
<tr>
<th>Clinical Scenario</th>
<th>Imaging: alternative recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Positive drop arm test</td>
<td></td>
</tr>
<tr>
<td>• Rotator cuff weakness</td>
<td></td>
</tr>
</tbody>
</table>

**DECISION NODE #21 KEY EVIDENCE**


**Significant positive result?**

- Labrum tear
- Rotator cuff tear

**REFER to shoulder surgeon**

**MANAGE with conservative measures**

**PROVIDE additional care as clinically warranted**

(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**Acute SP + dislocation (post relocation)**

**DECISION NODE #22**

- **AUC met (IF ALL)?**
  - History of trauma with dislocation
  - Shoulder has been reduced
  - Radiographs noncontributory
  - yes → **Imaging: primary recommendation**
    - MRI shoulder w/o contrast
    - Level of Evidence: II
    - Measure: $\$ (5 – 10 RVUs)
    - Radiation dose: 0 mSv
  - no → PROVIDE additional care as clinically warranted

- **Significant positive result?**
  - yes → REFER to shoulder surgeon
  - no → **First dislocation?**
    - yes → MANAGE with conservative measures
    - no → CONSIDER referral to shoulder surgeon

---

**DECISION NODE #22 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
Acute SP + suspected fracture of humerus, clavicle, or scapula

**DECISION NODE #23**

AUC met (IF ALL)?
- History of trauma
- Radiographs equivocal or do not provide appropriate fracture delineation

**Imaging: primary recommendation**
- CT shoulder w/o contrast

**AUC met?** Persistent concern for occult fracture?
- yes
- Imaging: primary recommendation
  - MRI shoulder w/o contrast

**Significant positive result?**
- yes
  - REFER to shoulder surgeon
- no
  - MANAGE per clinical judgement

**DECISION NODE #23 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
**PROVEN IMAGING FOR Shoulder Pain (SP)**

**DECISION NODE #24**

**Acute SP + known fracture (pre-op planning)?**
- History of trauma
- Radiograph or MRI positive for fracture

**AUC met (IF ALL)?**
- yes: **Imaging: primary recommendation**
  - CT shoulder w/o contrast
  
- no: PROVIDE additional care as clinically warranted

**Significant positive result?**
- yes: REFER for surgical management
- no: CONSIDER referral for non-surgical management

**DECISION NODE #24 KEY EVIDENCE**


(For a full list of references for all decision nodes, see bibliography on pages 34 through 37.)
### TABLE 1. MRI shoulder without contrast appropriate use indications (PRIMARY recommendation)

<table>
<thead>
<tr>
<th>NOT POST TSA (IF ALL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chronic SP + moderate to severe osteoarthritis</td>
</tr>
<tr>
<td>□ Radiographs positive for OA</td>
</tr>
<tr>
<td>□ Morning stiffness in shoulder joint</td>
</tr>
<tr>
<td>□ Limited range of motion</td>
</tr>
<tr>
<td>□ Deep ache without mechanical symptoms</td>
</tr>
<tr>
<td>□ Chronic SP + mild osteoarthritis</td>
</tr>
<tr>
<td>□ Age &gt; 40</td>
</tr>
<tr>
<td>□ Near symmetric motion</td>
</tr>
<tr>
<td>□ No significant strength loss</td>
</tr>
<tr>
<td>□ Deep ache</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ 3 months of failed conservative treatment</td>
</tr>
<tr>
<td>□ Chronic SP + suspected rotator cuff tear / impingement</td>
</tr>
<tr>
<td>□ Radiographs noncontributory or demonstrate coracoacromial arch osteophytes</td>
</tr>
<tr>
<td>□ Positive test for bicipital tendinosis</td>
</tr>
<tr>
<td>□ Positive test for shoulder instability</td>
</tr>
<tr>
<td>□ Positive test for rotator cuff pathology</td>
</tr>
<tr>
<td>□ Acromioclavicular/Subacromial tenderness</td>
</tr>
<tr>
<td>□ Chronic SP + calcific tendinitis</td>
</tr>
<tr>
<td>□ Painful limited shoulder motion</td>
</tr>
<tr>
<td>□ Resting pain</td>
</tr>
<tr>
<td>□ Radiograph positive for calcium in rotator cuff tendon region</td>
</tr>
<tr>
<td>□ Chronic SP + glenohumeral dislocation</td>
</tr>
<tr>
<td>□ Traumatic mechanism of injury</td>
</tr>
<tr>
<td>□ History of dislocation</td>
</tr>
<tr>
<td>□ Positive apprehension and/or relocation test</td>
</tr>
<tr>
<td>□ Radiographs show appropriate reduction</td>
</tr>
<tr>
<td>□ Chronic SP + suspected rotator cuff re-tear</td>
</tr>
<tr>
<td>□ Post rotator cuff repair</td>
</tr>
<tr>
<td>□ Positive test for bicipital tendinosis</td>
</tr>
<tr>
<td>□ Positive test for shoulder instability</td>
</tr>
<tr>
<td>□ Rotator cuff muscle weakness</td>
</tr>
<tr>
<td>□ Superior migration of humeral head on radiographs</td>
</tr>
<tr>
<td>□ Chronic SP + avascular necrosis or osteochondral lesion</td>
</tr>
<tr>
<td>□ Radiographs positive or equivocal for AVN</td>
</tr>
<tr>
<td>□ Chronic SP + inflammatory/nonspecific arthropathy</td>
</tr>
<tr>
<td>□ Non-specific joint pain</td>
</tr>
<tr>
<td>□ Limited range of motion w/o history of inflammatory joint disease</td>
</tr>
<tr>
<td>□ Radiograph positive or noncontributory</td>
</tr>
<tr>
<td>□ Lab workup positive for inflammatory arthritis</td>
</tr>
<tr>
<td>□ Acute SP + adhesive capsulitis</td>
</tr>
<tr>
<td>□ Loss of external rotation</td>
</tr>
<tr>
<td>□ Atypical shoulder pain</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Acute SP + bicep rupture/tendinopathy</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Positive Popeye sign</td>
</tr>
<tr>
<td>□ Bicep weakness</td>
</tr>
<tr>
<td>□ Positive test for bicipital tenosynovitis</td>
</tr>
<tr>
<td>□ Acute SP + rotator cuff tear</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Positive drop arm test</td>
</tr>
<tr>
<td>□ Rotator cuff weakness</td>
</tr>
<tr>
<td>□ Chronic SP + inflammatory/arthropathy</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Shoulder has been reduced</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Acute SP + dislocation post-relocation</td>
</tr>
<tr>
<td>□ History of trauma</td>
</tr>
<tr>
<td>□ Radiographs equivocal or do not provide appropriate fracture delineation</td>
</tr>
<tr>
<td>□ Negative CT</td>
</tr>
<tr>
<td>□ Persistent concern for occult fracture</td>
</tr>
</tbody>
</table>

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 2. MRI shoulder without contrast appropriate use indications (ALTERNATIVE recommendation)

### NOT POST TSA (IF ALL)

- Chronic SP + labrum tear
  - Age < 35
  - Radiographs noncontributory
  - AND
  - Subjective complaint of "instability or dislocation"

- Acute SP + labral tear (SLAP tear)
  - Age < 35
  - Radiographs noncontributory
  - AND EITHER OF THESE:
    - Positive sulcus sign
    - Positive apprehension or relocation test

## TABLE 3. MRI shoulder with and without contrast appropriate use indications (PRIMARY recommendation)

### POST TSA (IF ALL)

- Chronic SP + suspected infection
  - Shoulder pain OR constitutional symptoms
  - Insufficient data from shoulder aspiration
  - Radiographs noncontributory

- Acute SP + suspected infection
  - Shoulder pain OR constitutional symptoms
  - Insufficient data from shoulder aspiration
  - Radiographs noncontributory

### NOT POST TSA (IF ALL)

- Acute SP + septic arthritis
  - Atypical shoulder pain
  - Constitutional symptoms
  - Radiographs noncontributory
  - Aspiration negative or not viable with persistent clinical concern
  - Elevated ESR or CRP or WBC

## TABLE 4. MRI shoulder arthrogram appropriate use indications (PRIMARY recommendation)

### POST TSA (IF ALL)

- Acute SP + rotator cuff tear
  - Positive drop arm test OR rotator cuff weakness
  - Radiographs noncontributory

### NOT POST TSA (IF ALL)

- Chronic SP + labrum tear
  - Age < 35
  - Radiographs noncontributory
  - AND
  - Subjective complaint of "instability or dislocation"

- Acute SP + labral tear (SLAP tear)
  - Age < 35
  - Radiographs noncontributory
  - AND EITHER OF THESE:
    - Positive test for bicipital tenosynovitis/labral tear or shoulder instability
    - Long head of the biceps tenderness and weakness
## POINT-OF-ORDER CHECKLISTS, CONTINUED

### TABLE 5. CT shoulder without contrast appropriate use indications (PRIMARY recommendation)

<table>
<thead>
<tr>
<th>POST TSA (IF ALL)</th>
<th>NOT POST TSA (IF ALL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chronic SP + suspected component loosening</td>
<td></td>
</tr>
<tr>
<td>□ Persistent pain in shoulder/proximal humerus</td>
<td></td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
<td></td>
</tr>
<tr>
<td>□ Acute SP + suspected component failure</td>
<td></td>
</tr>
<tr>
<td>□ History of trauma</td>
<td></td>
</tr>
<tr>
<td>□ Radiographs indicate component failure or fracture or are equivocal</td>
<td></td>
</tr>
<tr>
<td>□ Acute SP + fracture</td>
<td></td>
</tr>
<tr>
<td>□ History of trauma</td>
<td></td>
</tr>
<tr>
<td>□ Radiographs positive or equivocal for fracture</td>
<td></td>
</tr>
<tr>
<td>□ Shoulder pain or visible deformity</td>
<td></td>
</tr>
<tr>
<td>□ Acute SP + suspected fracture of humerus, clavicle, or scapula</td>
<td></td>
</tr>
<tr>
<td>□ History of trauma</td>
<td></td>
</tr>
<tr>
<td>□ Radiographs equivocal or do not provide appropriate fracture delineation</td>
<td></td>
</tr>
<tr>
<td>□ Acute SP + known fracture (pre-op planning)</td>
<td></td>
</tr>
<tr>
<td>□ History of trauma</td>
<td></td>
</tr>
<tr>
<td>□ Radiographs or MRI positive for fracture</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 6. CT shoulder without contrast appropriate use indications (ALTERNATIVE recommendation)

<table>
<thead>
<tr>
<th>NOT POST TSA (IF ALL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chronic SP + glenohumeral dislocation</td>
</tr>
<tr>
<td>□ Traumatic mechanism of injury</td>
</tr>
<tr>
<td>□ History of dislocation</td>
</tr>
<tr>
<td>□ Positive apprehension and/or relocation test</td>
</tr>
<tr>
<td>□ Radiographs show appropriate reduction</td>
</tr>
<tr>
<td>□ Chronic SP + inflammatory/nonspecific arthropathy</td>
</tr>
<tr>
<td>□ Nonspecific joint pain</td>
</tr>
<tr>
<td>□ Limited range of motion, w/ or w/o history of inflammatory joint disease</td>
</tr>
<tr>
<td>□ Radiograph positive or noncontributory</td>
</tr>
<tr>
<td>□ Lab workup positive for inflammatory arthritis</td>
</tr>
</tbody>
</table>

### TABLE 7. CT shoulder with contrast appropriate use indications (ALTERNATIVE recommendation)

<table>
<thead>
<tr>
<th>POST TSA (IF ALL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Chronic SP + suspected infection</td>
</tr>
<tr>
<td>□ Shoulder pain OR constitutional symptoms</td>
</tr>
<tr>
<td>□ Insufficient data from shoulder aspiration</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
<tr>
<td>□ Acute SP + suspected infection</td>
</tr>
<tr>
<td>□ Shoulder pain OR constitutional symptoms</td>
</tr>
<tr>
<td>□ Insufficient data from shoulder aspiration</td>
</tr>
<tr>
<td>□ Radiographs noncontributory</td>
</tr>
</tbody>
</table>
### TABLE 8. CT shoulder arthrogram appropriate use indications (**ALTERNATIVE** recommendation)

<table>
<thead>
<tr>
<th>POST TSA (IF ALL)</th>
<th>NOT POST TSA (IF ALL)</th>
</tr>
</thead>
</table>
| □ **Acute SP + rotator cuff tear**  
  □ Positive drop arm test OR rotator cuff weakness  
  □ Radiographs noncontributory  |
| □ **Chronic SP + labrum tear**  
  □ Age < 35  
  □ Radiographs noncontributory  
  **AND**  
  □ Subjective complaint of “instability or dislocation”  
  **OR EITHER OF THESE:**  
  □ Positive sulcus sign  
  □ Positive apprehension or relocation test  
  □ **Acute SP + rotator cuff tear**  
  □ History of trauma  
  □ Radiographs noncontributory  
  **AND EITHER OF THESE:**  
  □ Positive drop arm test  
  □ Rotator cuff weakness  |
| □ **Chronic SP + avascular necrosis or osteochondral lesion**  
  □ Radiographs positive or equivocal for AVN  | □ **Chronic SP + moderate to severe osteoarthritis**  
  □ Radiographs positive for OA  
  □ Morning stiffness in shoulder joint  
  □ Limited range of motion  
  □ Deep ache without mechanical symptoms  
  □ **Chronic SP + mild osteoarthritis**  
  □ Age > 40  
  □ Near symmetric motion  
  □ No significant strength loss  
  □ Deep ache  
  □ Radiographs noncontributory  
  □ 3 months of failed conservative treatment |

### TABLE 9. Bone scan appropriate use indications (**PRIMARY** recommendation)

<table>
<thead>
<tr>
<th>POST TSA (IF ALL)</th>
</tr>
</thead>
</table>
| □ **Chronic SP + suspected component loosening**  
  □ Persistent pain in shoulder / proximal humerus  
  □ Radiographs noncontributory  
  □ Negative CT  
  □ Persistent concern for component loosening  |

### TABLE 10. MRI brachial plexus w/ and w/o contrast (**PRIMARY** recommendation)

<table>
<thead>
<tr>
<th>AUC met (IF ALL)? (applicable to both post and not-post TSA)</th>
</tr>
</thead>
</table>
| □ **Acute SP + brachial plexus neuritis**  
  □ Severe atypical pain  
  □ Painful/limited active motion  
  □ Failed conservative treatment |
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. They can be accessed by navigating to intermountainphysician.org and selecting Care Process Models in the Tools and Resources drop-down menu.

To access Intermountain’s Proven Imaging CPMs and supporting materials, visit: https://intermountainhealthcare.org/services/imaging-services/proven-imaging/.

Fact sheets:
- Shoulder Arthroscopy: Preparing for Surgery
- Shoulder Arthroscopy: Recovering at Home
- Shoulder Replacement Surgery: Home Instructions

Fact sheets:
- CT Scan
- Radiation Exposure in Medical Tests
- Intravenous (IV) Contrast Material

Patient education:
- Spine Guide
- Managing Chronic Pain
- Pain Med Tracking Sheet

Related Care Process Models (CPMs):
- Prescribing Opioids for Chronic Pain CPM
- Imaging Radiation Exposure CPM
**BIBLIOGRAPHY**

**NODE #1**


**NODE #2**


BIBLIOGRAPHY, CONTINUED


NODE #6


NODES #7 – 8


NODES #9 – 12


NODE #13


NODE #14


NODE #15


NODE #16


BIBLIOGRAPHY, CONTINUED


NODE #17


NODE #18


BIBLIOGRAPHY, CONTINUED


## REFERENCES (from pages 1 through 3)


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