



## Intermountain Imaging Criteria:

# Shoulder Pain

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.<sup>SMI</sup> The inflating costs of advanced imaging outstripped that of any other medical service.<sup>IGL, GAO</sup> These inflating costs resulted in up to \$20–30 billion in unnecessary advanced imaging spending each year.<sup>NYDH</sup>

- **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.<sup>LEV, CMS1</sup>
- **Limited effectiveness.** Multiple studies suggest that up to a third of advanced imaging procedures fail to contribute to diagnosis or are clinically inappropriate.<sup>NYDH</sup>
- **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

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 risk associated with unwarranted patient exposure to radiation and/or contrast media
- Reducing imaging tests that do not conform to AUC or for which there are no guidelines
- Documenting the incidence of a significant positive on advanced imaging tests and aligning with downstream care
- Decreasing system-wide spending on unnecessary advanced imaging services

### ► WHAT'S INSIDE?

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Indicates an Intermountain measure



► **OVERVIEW: INTERMOUNTAIN IMAGING CRITERIA AUC 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 list at right and pages 5 through 28). Although these Intermountain Imaging Criteria 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, 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 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, 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 CMS as a surrogate for cost.

CMS<sup>2</sup> The radiation risk is derived from data published in 2010 by the Health Physics Society.<sup>ACR, HPS</sup>

**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.<sup>OCE</sup>
2. The extensively used Fryback and Thornbury conceptual framework, which uses six levels for assessing the efficacy of diagnostic imaging.<sup>FRY</sup>

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.

**SP ALGORITHMS**

**POST TSA:**

**Chronic SP +/-:**

Suspected infection . . . . .	5
Suspected component loosening . . . . .	6

**Acute SP +/-:**

Suspected infection . . . . .	7
Rotator cuff tear . . . . .	8
Suspected component failure . . . . .	9
Fracture . . . . .	10

**NOT POST TSA:**

**Chronic SP +/-:**

Moderate to severe osteoarthritis . . . . .	11
Mild osteoarthritis . . . . .	12
Labrum tear . . . . .	13
Suspected rotator cuff tear/impingement . . . . .	14
Calcific tendinitis . . . . .	15
Suspected rotator cuff re-tear . . . . .	16
AVN/osteochondral lesion . . . . .	17
Glenohumeral dislocation . . . . .	18
Inflammatory/nonspecific arthropathy . . . . .	19

**Acute SP +/-:**

Adhesive capsulitis . . . . .	20
Septic arthritis . . . . .	21
Labral tear (SLAP tear) . . . . .	22
Brachial plexus neuritis . . . . .	23
Biceps rupture/tendinopathy . . . . .	24
Rotator cuff tear . . . . .	25
Dislocation (post relocation) . . . . .	26
Suspected fracture (humerus, clavicle, or scapula) . . . . .	27
Known fracture (pre-op planning) . . . . .	28

**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

See abbreviations on [page 2](#).

### 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 Arabic number in the green box indicates an evidence ranking derived from the OCEBM scale.<sup>OCE</sup> 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.<sup>Fry</sup> 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:<sup>CMS2</sup>  
 \$ = 0–5 RVU      \$\$\$ = 10–15 RVU  
 \$\$ = 5–10 RVU      \$\$\$\$ = 15+ RVU

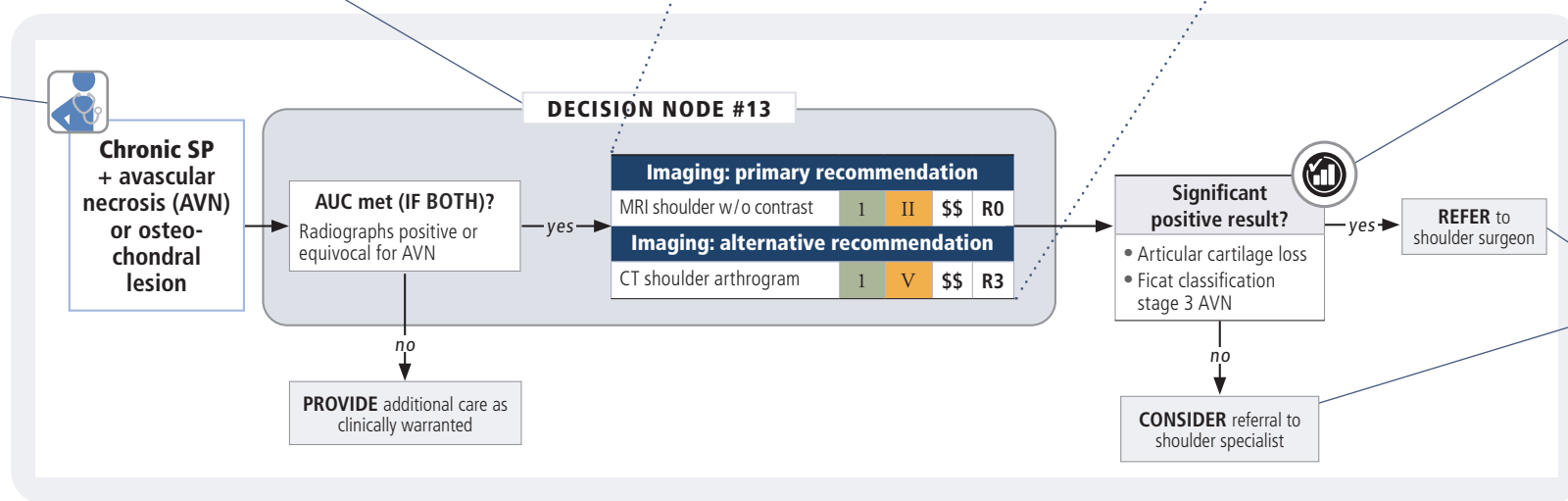
Radiation risk rankings use the scale developed by the [American College of Radiology](#). This rating framework offers the following six levels for adult effective dose range risk:  
 R0 = 0 mSv      R3 = 1–10 mSv  
 R1 = < 0.1 mSv      R4 = 10–30 mSv  
 R2 = 0.1–1 mSv      R5 = 30–100 mSv

Imaging: primary recommendation					
MRI shoulder w/o contrast	1	II	\$\$	R0	
Imaging: alternative recommendation					
CT shoulder arthrogram	1	V	\$\$	R3	

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 a common clinical scenario.



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

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. 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.

Tables included on pages [29 through 32](#) indicate if the test is a primary recommendation or alternative recommendation.

TABLE 1. MRI shoulder <b>without contrast</b> appropriate use indications ( <b>PRIMARY</b> recommendation)		
NOT POST THA (IF ALL)		
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + moderate to severe osteoarthritis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs positive for OA</li> <li><input type="checkbox"/> Morning stiffness in shoulder joint</li> <li><input type="checkbox"/> Limited range of motion</li> <li><input type="checkbox"/> Deep ache without mechanical symptoms</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + mild osteoarthritis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Age &gt; 40</li> <li><input type="checkbox"/> Near symmetric motion</li> <li><input type="checkbox"/> No significant strength loss</li> <li><input type="checkbox"/> Deep ache</li> <li><input type="checkbox"/> Radiographs noncontributory</li> <li><input type="checkbox"/> 3 months of failed conservative treatment</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + suspected rotator cuff tear/ impingement</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs noncontributory or demonstrate coracoacromial arch osteophytes</li> </ul> <p><b>AND ANY OF THESE:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive test for bicipital tendinosis</li> <li><input type="checkbox"/> Positive test for shoulder instability</li> <li><input type="checkbox"/> Positive test for rotator cuff pathology</li> <li><input type="checkbox"/> Acromioclavicular / subacromial tenderness</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + calcific tendinitis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Painful limited shoulder motion</li> <li><input type="checkbox"/> Resting pain</li> <li><input type="checkbox"/> Radiograph positive for calcium in rotator cuff tendon region</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + glenohumeral dislocation</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Traumatic mechanism of injury</li> <li><input type="checkbox"/> History of dislocation</li> <li><input type="checkbox"/> Positive apprehension and/or relocation test</li> <li><input type="checkbox"/> Radiographs show appropriate reduction</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + suspected rotator cuff re-tear</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Post rotator cuff repair</li> </ul> <p><b>AND ANY OF THESE:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive drop arm test</li> <li><input type="checkbox"/> Rotator cuff muscle weakness</li> <li><input type="checkbox"/> Superior migration of humeral head on radiographs</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + avascular necrosis or osteochondral lesion</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs positive or equivocal for AVN</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + inflammatory/nonspecific arthropathy</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Nonspecific joint pain</li> <li><input type="checkbox"/> Limited range of motion w/ or w/o history of inflammatory joint disease</li> <li><input type="checkbox"/> Radiograph positive or noncontributory</li> <li><input type="checkbox"/> Lab workup positive for inflammatory arthritis</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + adhesive capsulitis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Loss of external rotation</li> <li><input type="checkbox"/> Atypical shoulder pain</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Acute SP + bicep rupture/tendinopathy</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> History of trauma</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> <p><b>AND ANY OF THESE:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive Popeye sign</li> <li><input type="checkbox"/> Bicep weakness</li> <li><input type="checkbox"/> Positive test for bicipital tenosynovitis</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + rotator cuff tear</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> History of trauma</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> <p><b>AND EITHER OF THESE:</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive drop arm test</li> <li><input type="checkbox"/> Rotator cuff weakness</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + dislocation post-relocation</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> History of trauma</li> <li><input type="checkbox"/> Shoulder has been reduced</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + fracture of humerus, clavicle, or scapula</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> History of trauma</li> <li><input type="checkbox"/> Radiographs equivocal or do not provide appropriate fracture delineation</li> <li><input type="checkbox"/> Negative CT</li> <li><input type="checkbox"/> Persistent concern for occult fracture</li> </ul> </li> </ul>

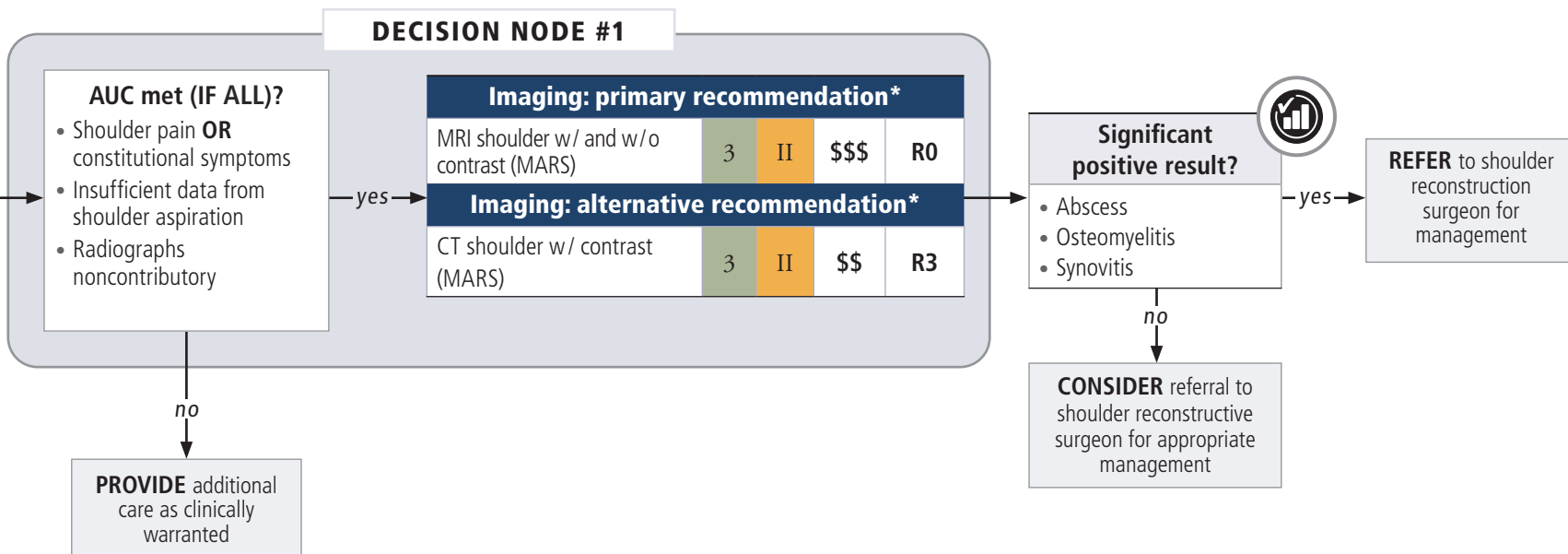
▶ **SHOULDER PAIN (SP) CARE PATHWAY ALGORITHMS:  
POST TOTAL SHOULDER ARTHROPLASTY (TSA)**

See abbreviations on [page 2](#).

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](#).



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



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

**DECISION NODE #1 KEY EVIDENCE**

Cyteval C, Bourdon A. Imaging orthopedic implant infections. *Diagn Interv Imaging*. 2012;93(6):547-557.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® Imaging after shoulder arthroplasty. *J Am Coll Radiol*. 2016;13(11):1324-1336.

Jiang MH, He C, Feng JM, et al. Magnetic resonance imaging parameter optimizations for diagnosis of periprosthetic infection and tumor recurrence in artificial joint replacement patients. *Sci Rep*. 2016;6:36995.

Verberne SJ, Raijmakers PG, Temmerman OP. The Accuracy of imaging techniques in the assessment of periprosthetic hip infection. *J Bone Joint Surg Am*. 2016;98(19):1638-1645.

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

**LEGEND**



Clinical Scenario



Urgent or Emergency Situation



2 OCEBM Level of Evidence



II Fryback & Thornbury Level of Evidence



Intermountain Measure

**R0** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

**R4** (10–30mSv)

**\$\$\$\$** (10–15 RVUs)

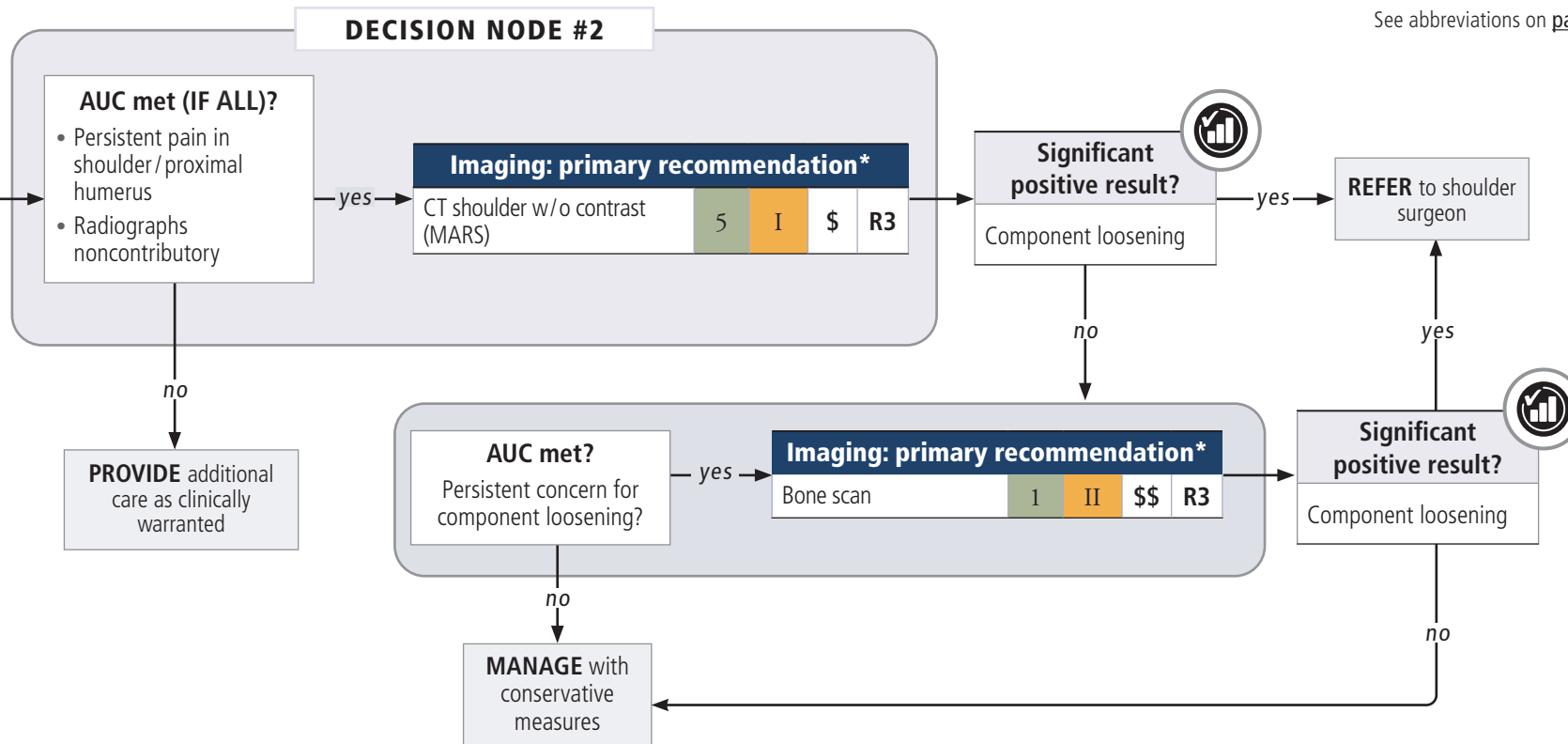
See page 2–3 for explanation.

**\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



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



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

**DECISION NODE #2 KEY EVIDENCE**

Eichinger JK, Galvin JW. Management of complications after total shoulder arthroplasty. *Curr Rev Musculoskelet Med.* 2015;8(1):83-91.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® imaging after shoulder arthroplasty. *J Am Coll Radiol.* 2016;13(11):1324-1336.

Temmerman OP, Raijmakers PG, Berkhof J, Hoekstra OS, Teule GJ, Heyligers IC. Accuracy of diagnostic imaging techniques in the diagnosis of aseptic loosening of the femoral component of a hip prosthesis: a meta-analysis. *J Bone Joint Surg Br.* 2005;87(6):781-785.

Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

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

**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.

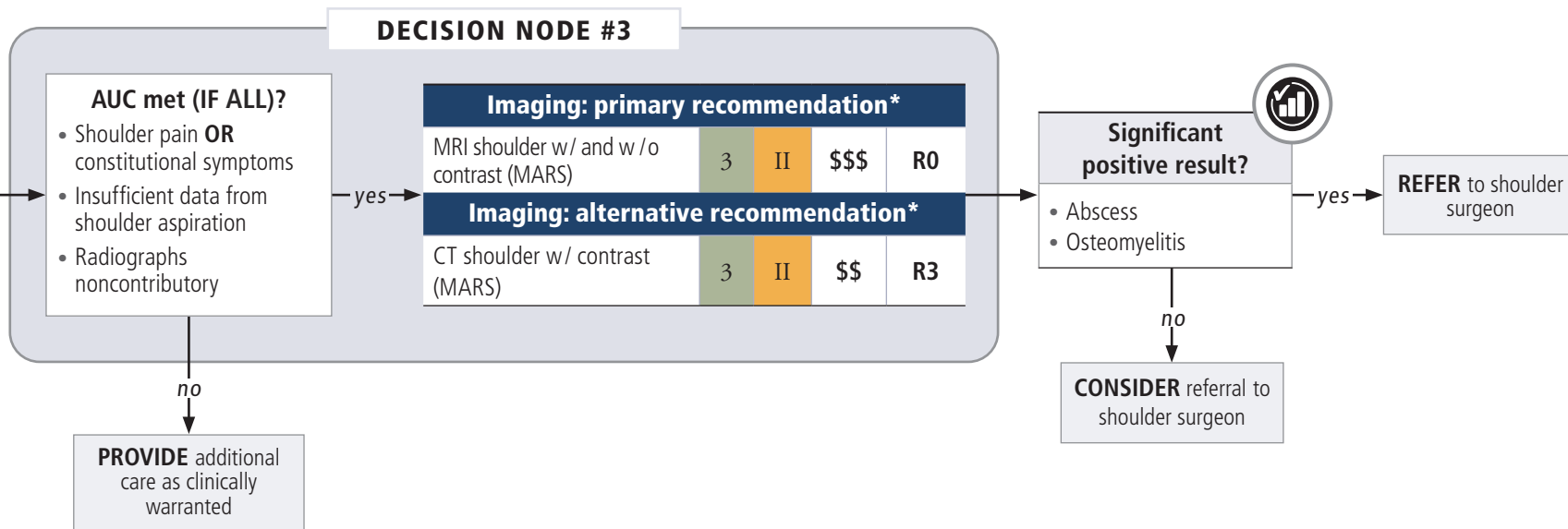
**\$\$\$\$** (10–15 RVUs) **\$\$\$\$\$** (15+ RVUs)

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.

See abbreviations on [page 2](#).



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



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

**DECISION NODE #3 KEY EVIDENCE**

Cyteval C, Bourdon A. Imaging orthopedic implant infections. *Diagn Interv Imaging*. 2012;93(6):547-557.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® Imaging after shoulder arthroplasty. *J Am Coll Radiol*. 2016;13(11):1324-1336.

Jiang MH, He C, Feng JM, et al. Magnetic resonance imaging parameter optimizations for diagnosis of periprosthetic infection and tumor recurrence in artificial joint replacement patients. *Sci Rep*. 2016;6:36995.

Verberne SJ, Raijmakers PG, Temmerman OP. The Accuracy of imaging techniques in the assessment of periprosthetic hip infection. *J Bone Joint Surg Am*. 2016;98(19):1638-1645.

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

**LEGEND**



Clinical Scenario



Urgent or Emergency Situation



2 OCEBM Level of Evidence



II Fryback & Thornbury Level of Evidence



Intermountain Measure

**R0** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

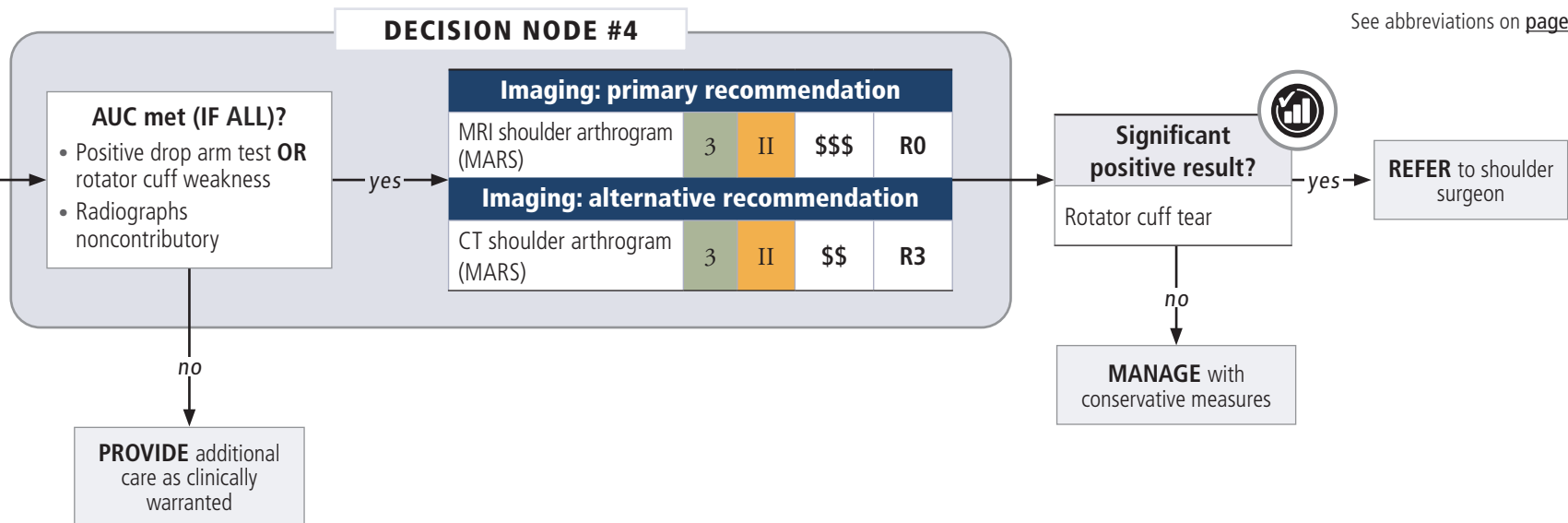
**R4** (10–30mSv) See page 2–3 for explanation.

**\$\$\$\$** (10–15 RVUs) **\$\$\$\$\$** (15+ RVUs)





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



**DECISION NODE #4 KEY EVIDENCE**

Beltran J, Gray LA, Bools JC, Zuelzer W, Weis LD, Unverferth LJ. Rotator cuff lesions of the shoulder: evaluation by direct sagittal CT arthrography. *Radiology*. 1986;160(1):161-165.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® imaging after shoulder arthroplasty. *J Am Coll Radiol*. 2016;13(11):1324-1336.

Nwawka OK, Konin GP, Sneag DB, Gulotta LV, Potter HG. Magnetic resonance imaging of shoulder arthroplasty: review article. *HSS J*. 2014;10(3):213-224.

Wagner SC, Schweitzer ME, Morrison WB, Fenlin JM Jr, Bartolozzi AR. Shoulder instability: accuracy of MR imaging performed after surgery in depicting recurrent injury--initial findings. *Radiology*. 2002;222(1):196-203.

(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** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$** (5–10 RVUs)

**R4** (10–30mSv)

**\$\$\$** (10–15 RVUs)

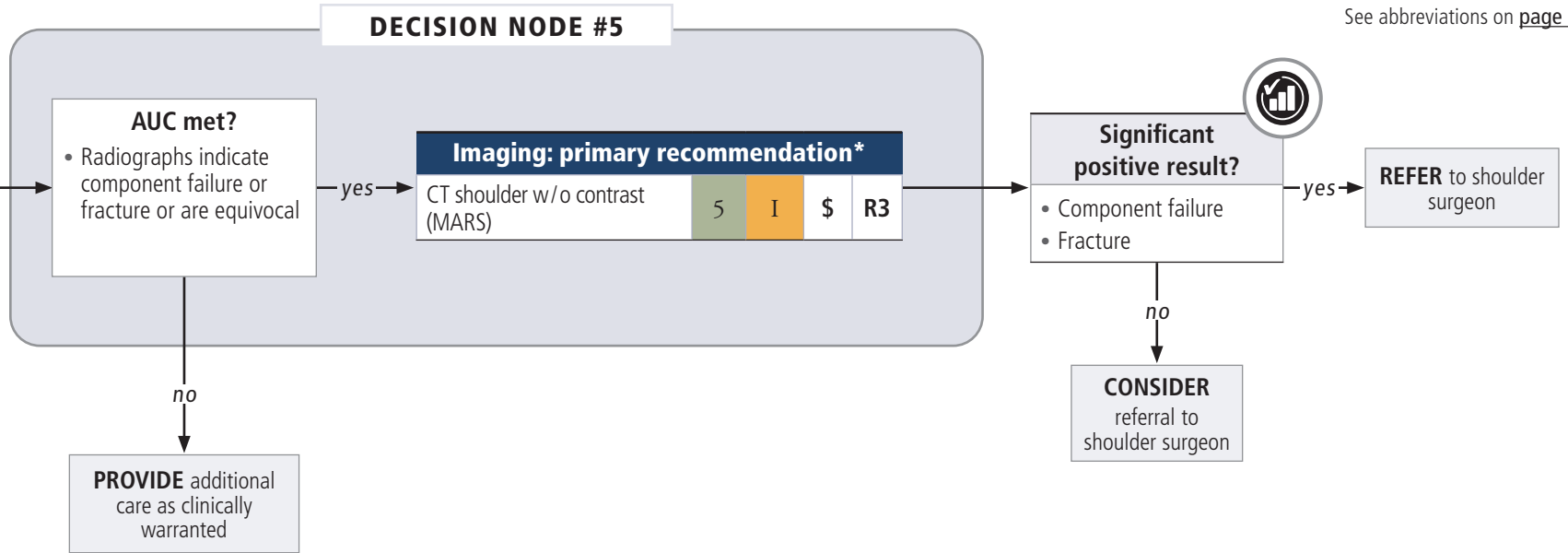
See page 2–3 for explanation.

**\$\$\$\$** (15+ RVUs)





**Acute SP + suspected component failure (POST TSA)**



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

**DECISION NODE #5 KEY EVIDENCE**

Eichinger JK, Galvin JW. Management of complications after total shoulder arthroplasty. *Curr Rev Musculoskelet Med.* 2015;8(1):83-91.

Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® imaging after shoulder arthroplasty. *J Am Coll Radiol.* 2016;13(11):1324-1336.

(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** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

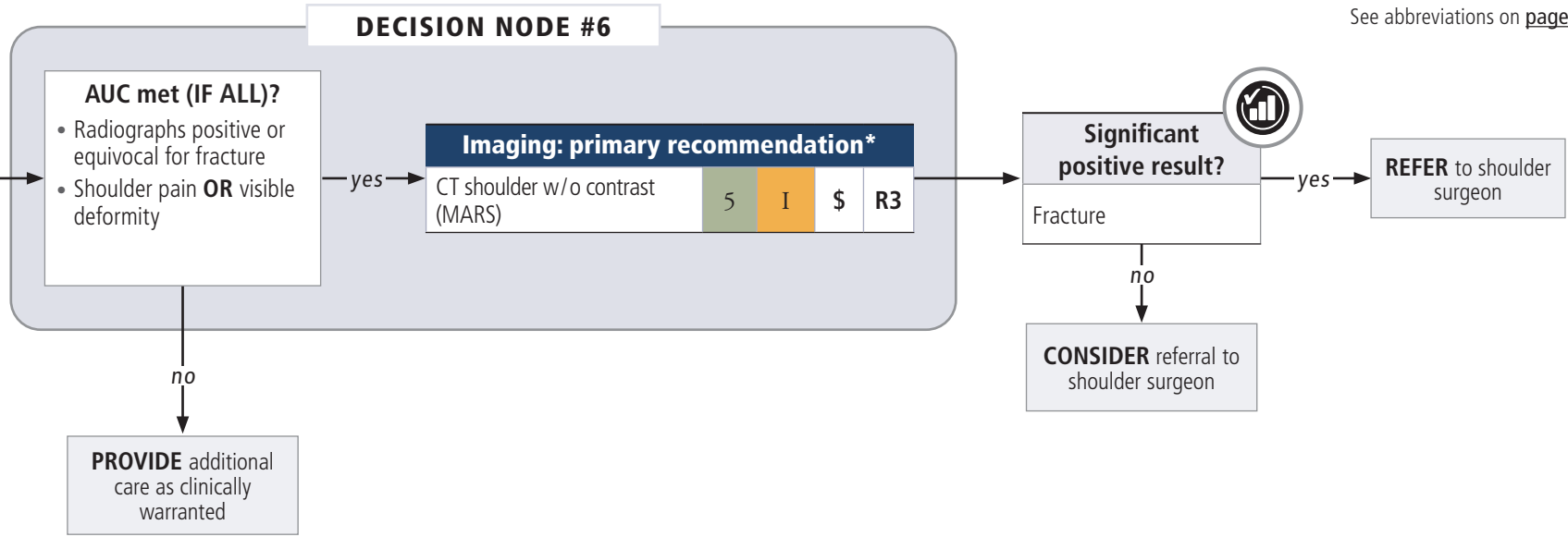
**R4** (10–30mSv) See page 2–3 for explanation.

**\$\$\$\$** (10–15 RVUs) **\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



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



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

**DECISION NODE #6 KEY EVIDENCE**

Eichinger JK, Galvin JW. Management of complications after total shoulder arthroplasty. *Curr Rev Musculoskelet Med.* 2015;8(1):83-91.

Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® imaging after shoulder arthroplasty. *J Am Coll Radiol.* 2016;13(11):1324-1336.

(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** (0mSv)  
\$ (0–5 RVUs)

**R3** (1–10 mSv)  
\$\$ (5–10 RVUs)

**R4** (10–30mSv) See page 2–3 for explanation.  
\$\$\$ (10–15 RVUs)    \$\$\$\$ (15+ RVUs)

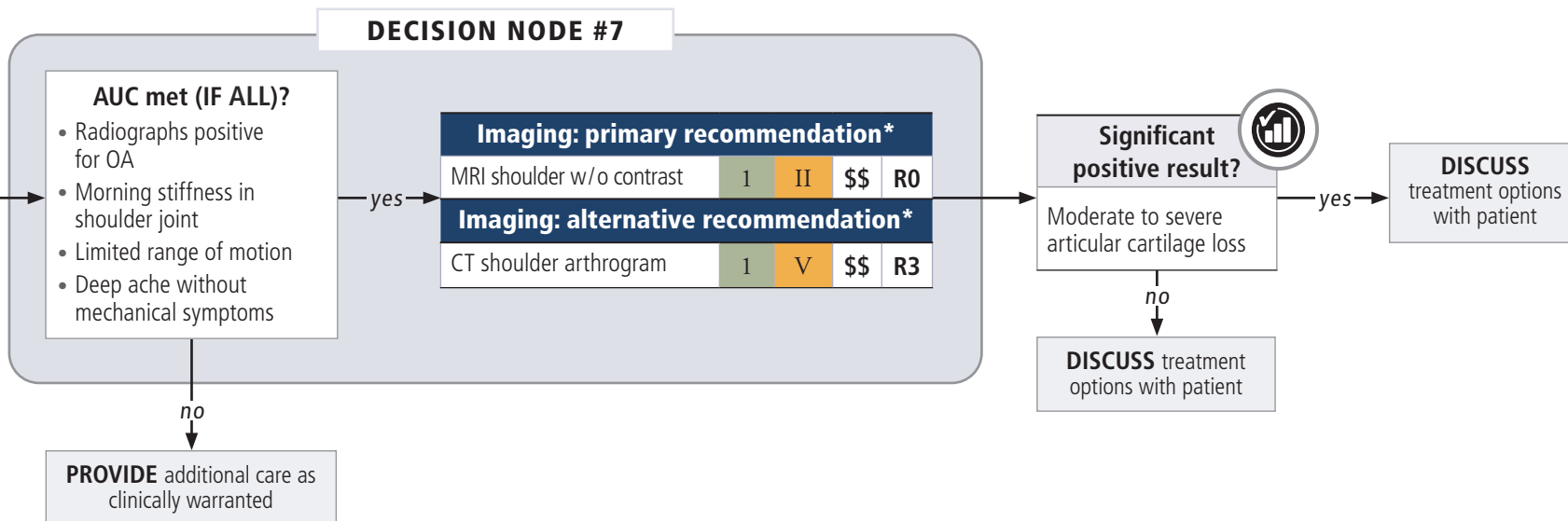
▶ **SHOULDER PAIN (SP) CARE PATHWAY ALGORITHMS:  
NOT POST TOTAL SHOULDER ARTHROPLASTY (TSA)**

See abbreviations on [page 2](#).

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](#).



**Chronic SP + moderate to severe osteoarthritis**



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

**DECISION NODE #7 KEY EVIDENCE**

<p>Glickstein MF, Burk DL Jr, Schiebler ML, et al. Avascular necrosis versus other diseases of the hip: sensitivity of MR imaging. <i>Radiology</i>. 1988;169(1):213-215.</p> <p>Guggenberger R, Ulbrich EJ, Dietrich TJ, et al. C-arm flat-panel CT arthrography of the shoulder: radiation dose considerations and preliminary data on diagnostic performance. <i>Eur Radiol</i>. 2017;27(2):454-463.</p> <p>Murphey MD, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria® osteonecrosis of the hip. <i>J Am Coll Radiol</i>. 2016;13(2):147-155.</p>	<p>Omoumi P, Rubini A, Dubuc JE, Vande Berg BC, Lecouvet FE. Diagnostic performance of CT-arthrography and 1.5T MR-arthrography for the assessment of glenohumeral joint cartilage: a comparative study with arthroscopic correlation. <i>Eur Radiol</i>. 2015;25(4):961-969.</p> <p>Quatman CE, Hettrich CM, Schmitt LC, Spindler KP. The clinical utility and diagnostic performance of magnetic resonance imaging for identification of early and advanced knee osteoarthritis: a systematic review. <i>Am J Sports Med</i>. 2011;39(7):1557-1568.</p>
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(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** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

**R4** (10–30 mSv)

**\$\$\$\$** (10–15 RVUs)

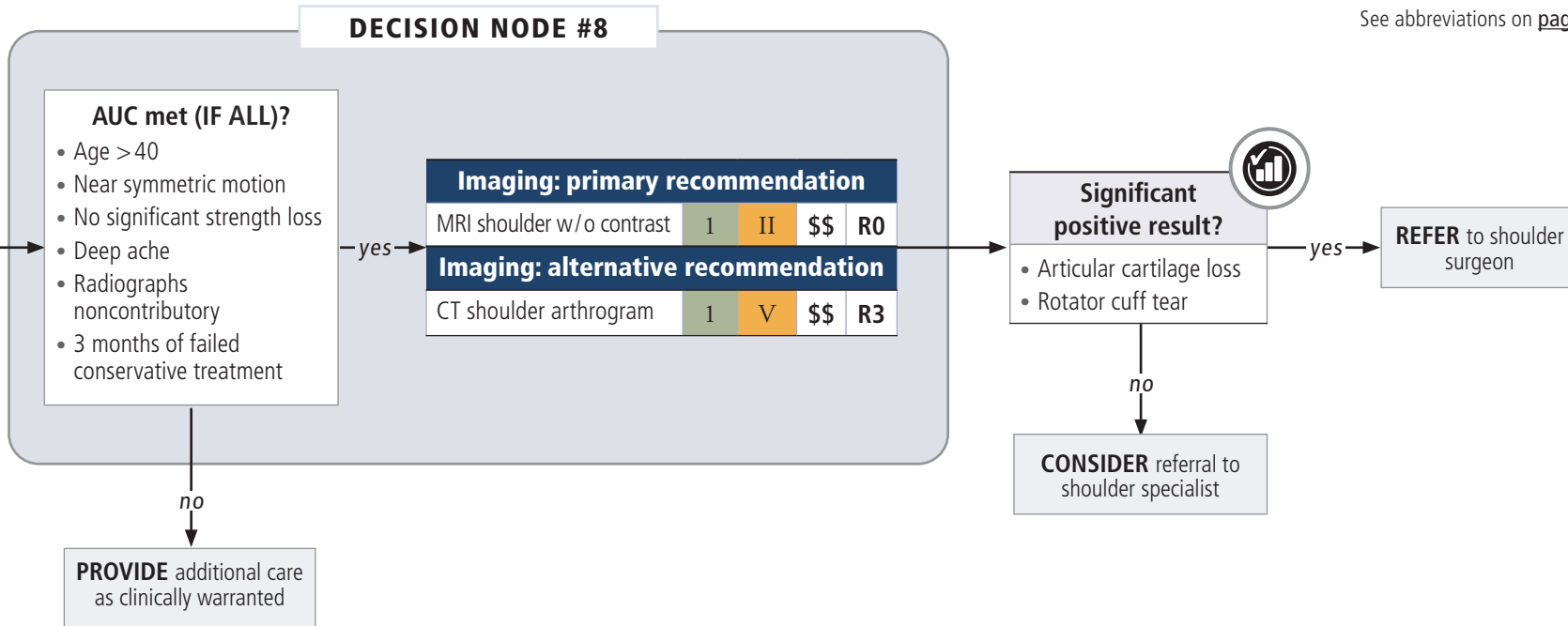
See page 2–3 for explanation.

**\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Chronic SP + mild osteoarthritis**



**DECISION NODE #8 KEY EVIDENCE**

Glickstein MF, Burk DL Jr, Schiebler ML, et al. Avascular necrosis versus other diseases of the hip: sensitivity of MR imaging. *Radiology*. 1988;169(1):213-215.

Guggenberger R, Ulbrich EJ, Dietrich TJ, et al. C-arm flat-panel CT arthrography of the shoulder: radiation dose considerations and preliminary data on diagnostic performance. *Eur Radiol*. 2017;27(2):454-463.

Murphey MD, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria® osteonecrosis of the hip. *J Am Coll Radiol*. 2016;13(2):147-155.

Omoumi P, Rubini A, Dubuc JE, Vande Berg BC, Lecouvet FE. Diagnostic performance of CT-arthrography and 1.5T MR-arthrography for the assessment of glenohumeral joint cartilage: a comparative study with arthroscopic correlation. *Eur Radiol*. 2015;25(4):961-969.

Quatman CE, Hettrich CM, Schmitt LC, Spindler KP. The clinical utility and diagnostic performance of magnetic resonance imaging for identification of early and advanced knee osteoarthritis: a systematic review. *Am J Sports Med*. 2011;39(7):1557-1568.

(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)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

**R4** (10–30 mSv)

**\$\$\$\$** (10–15 RVUs)

See page 2–3 for explanation.

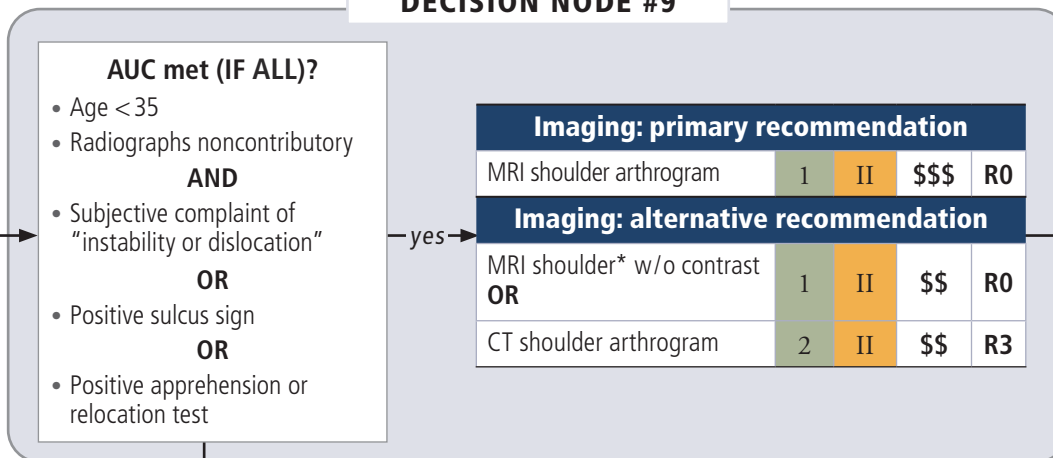
**\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).

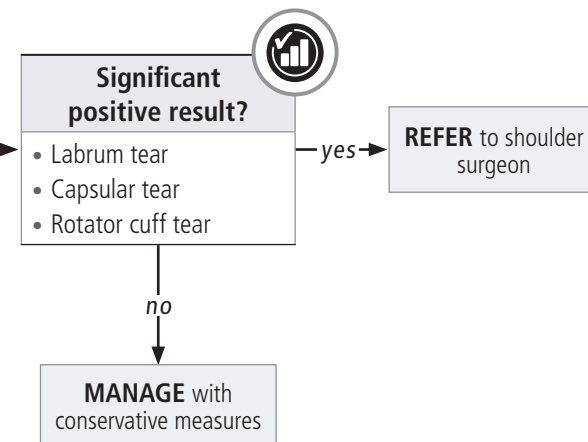


**Chronic SP +  
labrum tear**

**DECISION NODE #9**



Imaging: primary recommendation					
MRI shoulder arthrogram	1	II	\$\$\$	R0	
Imaging: alternative recommendation					
MRI shoulder* w/o contrast	1	II	\$\$	R0	
OR					
CT shoulder arthrogram	2	II	\$\$	R3	



**PROVIDE** additional care as clinically warranted

**DECISION NODE #9 KEY EVIDENCE**

Chandnani VP, Yeager TD, DeBerardino T, et al. Glenoid labral tears: prospective evaluation with MRI imaging, MR arthrography, and CT arthrography. *AJR Am J Roentgenol.* 1993;161(6):1229-1235.

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Farin PU, Kaukanen E, Jaroma H, Väättäin U, Miettinen H, Soimakallio S. Site and size of rotator-cuff tear. Findings at ultrasound, double-contrast arthrography, and computed tomography arthrography with surgical correlation. *Invest Radiol.* 1996;31(7):387-394.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

Reiman MP, Thorborg K, Goode AP, Cook CE, Weir A, Hölmich P. Diagnostic accuracy of imaging modalities and injection techniques for the diagnosis of femoroacetabular impingement/labral tear: a systematic review with meta-analysis. *Am J Sports Med.* 2017;45(11):2665-2677.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

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

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

**LEGEND**



Clinical Scenario



Urgent or Emergency Situation



OCEBM Level of Evidence



Fryback & Thornbury Level of Evidence



Intermountain Measure

**R0** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

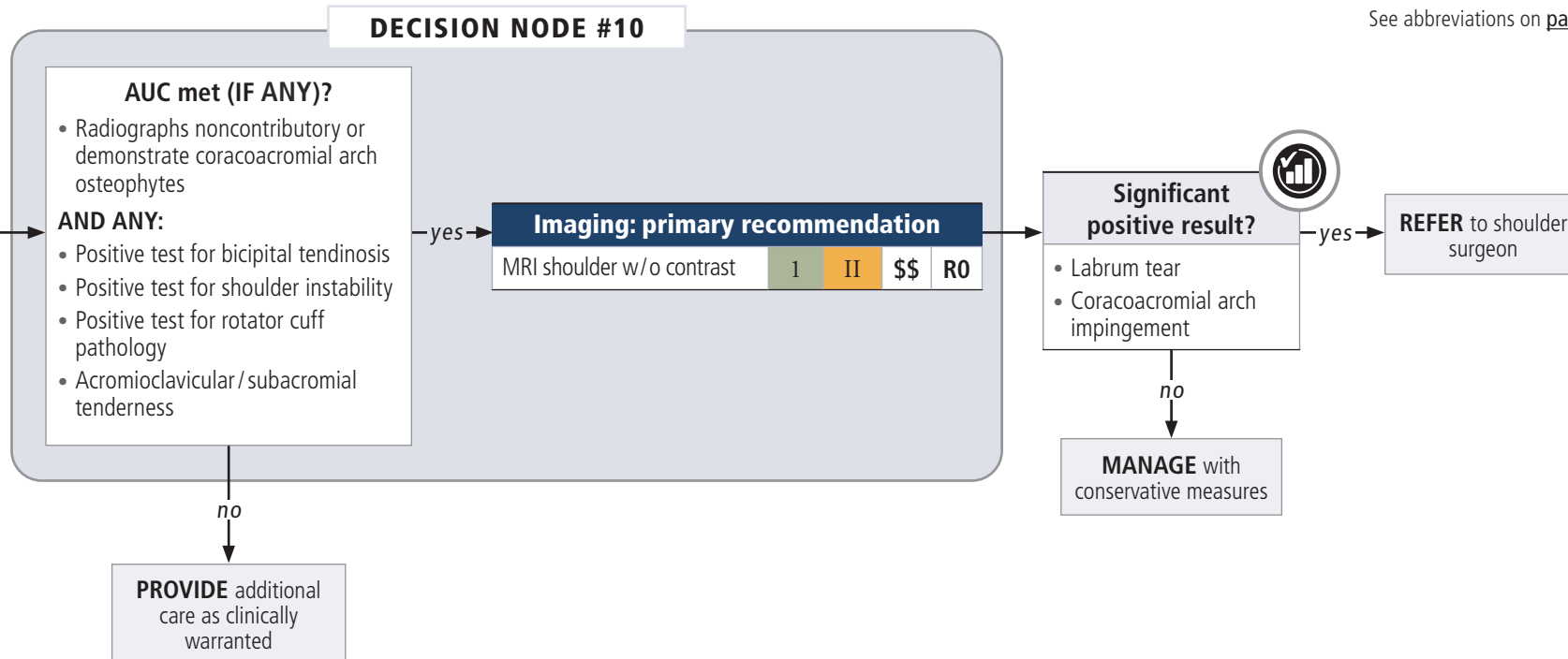
**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$\$** (10–15 RVUs) **\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Chronic SP + suspected rotator cuff tear / impingement**



**DECISION NODE #10 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

(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)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

**R4** (10–30 mSv)

**\$\$\$\$** (10–15 RVUs)

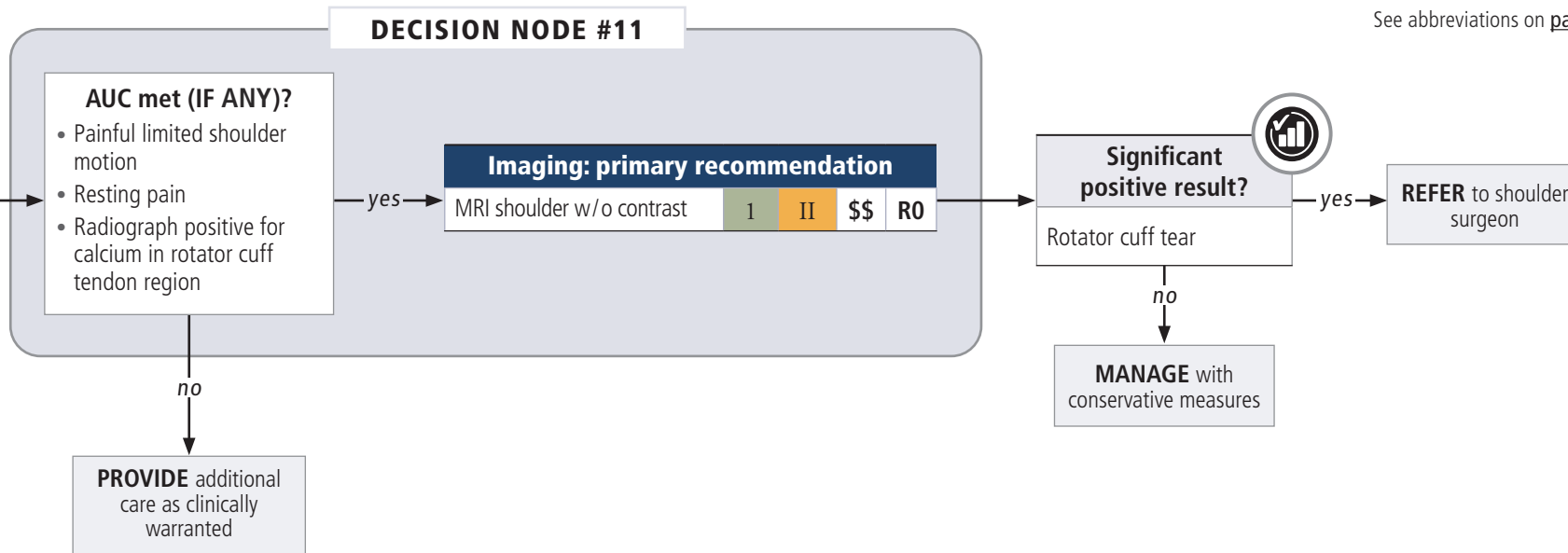
See page 2–3 for explanation.

**\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Chronic SP + calcific tendinitis**



**DECISION NODE #11 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

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

**LEGEND**



Clinical Scenario



Urgent or Emergency Situation



2 OCEBM Level of Evidence



II Fryback & Thornbury Level of Evidence



Intermountain Measure

**RO** (0 mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$** (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.

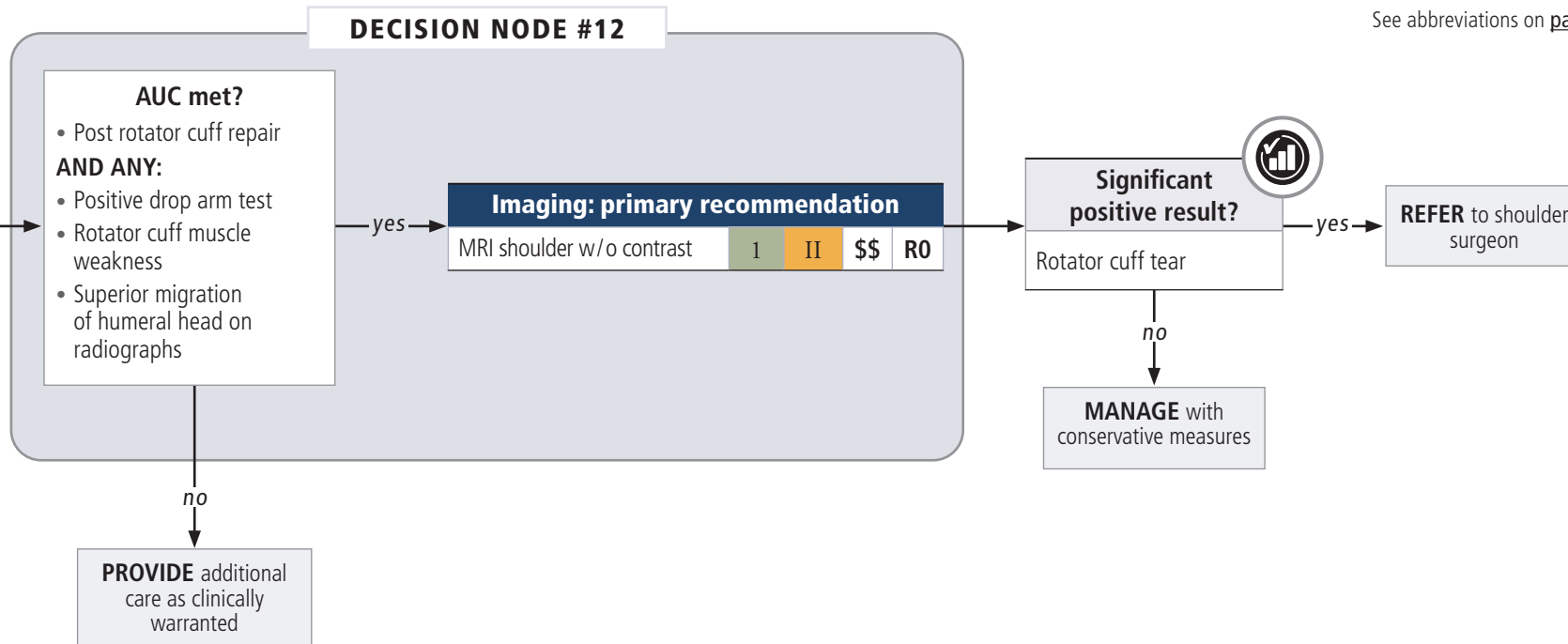
**\$\$\$** (10–15 RVUs)    **\$\$\$\$** (15+ RVUs)



See abbreviations on [page 2](#).



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



**DECISION NODE #12 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

(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)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

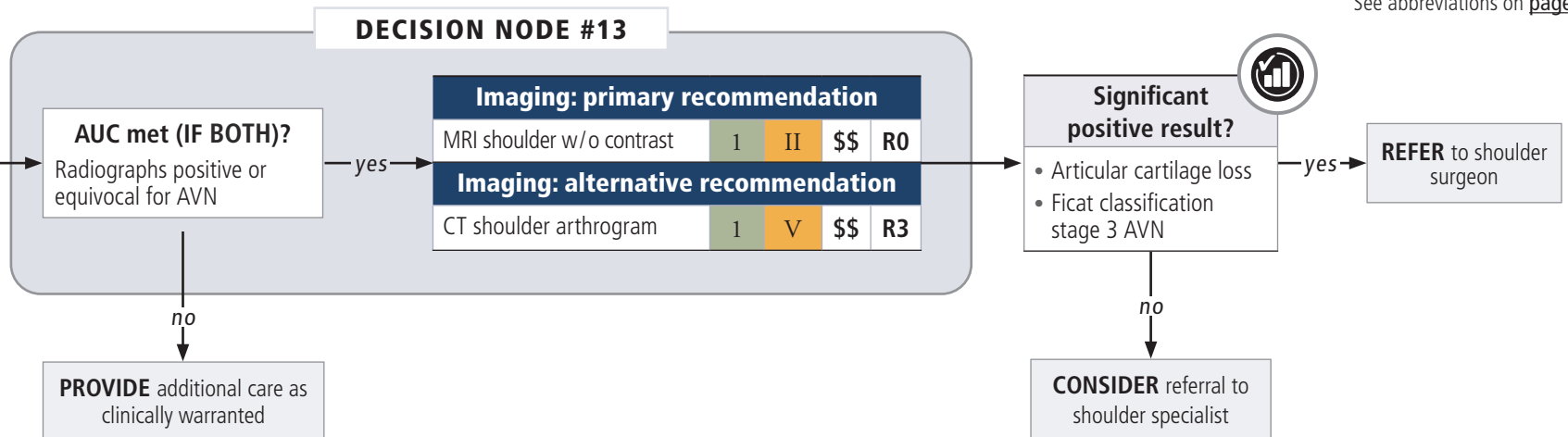
**\$\$** (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$** (10–15 RVUs)    **\$\$\$\$** (15+ RVUs)



**Chronic SP + avascular necrosis (AVN) or osteochondral lesion**



**DECISION NODE #13 KEY EVIDENCE**

Glickstein MF, Burk DL, Schiebler ML Jr, et al. Avascular necrosis versus other diseases of the hip: Sensitivity of MR imaging. *Radiology*. 1988;169(1):213-215.

Guggenberger R, Ulbrich EJ, Dietrich TJ, et al. C-arm flat-panel CT arthrography of the shoulder: radiation dose considerations and preliminary data on diagnostic performance. *Eur Radiol*. 2017;27(2):454-463.

Murphey MD, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria® osteonecrosis of the hip. *J Am Coll Radiol*. 2016;13(2):147-155.

Omoumi P, Rubini A, Dubuc JE, Vande Berg BC, Lecouvet FE. Diagnostic performance of CT-arthrography and 1.5T MR-arthrography for the assessment of glenohumeral joint cartilage: comparative study with arthroscopic correlation. *Eur Radiol*. 2015;25(4):961-969.

Quatman CE, Hettrich CM, Schmitt LC, Spindler KP. The clinical utility and diagnostic performance of magnetic resonance imaging for identification of early and advanced knee osteoarthritis: a systematic review. *Am J Sports Med*. 2011;39(7):1557-1568.

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

**LEGEND**



Clinical Scenario



Urgent or Emergency Situation



2 OCEBM Level of Evidence



II Fryback & Thornbury Level of Evidence



Intermountain Measure

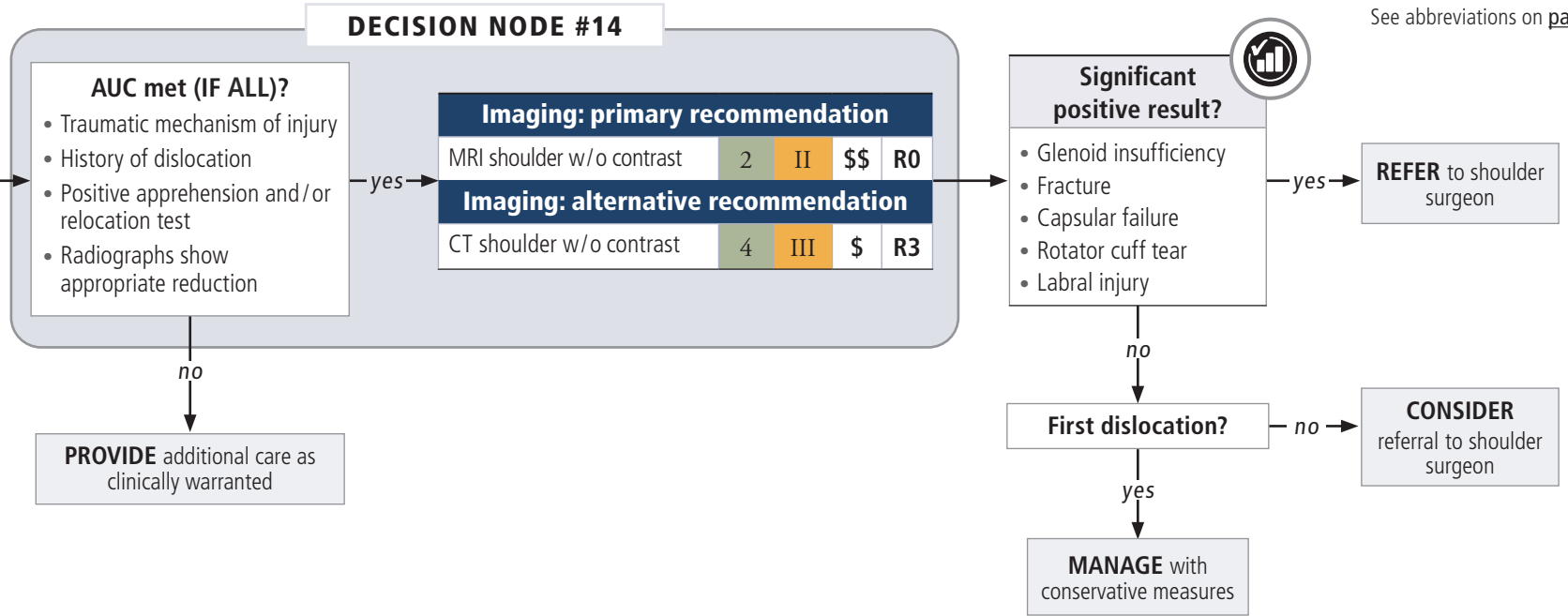
**R0** (0 mSv)  
\$ (0–5 RVUs)

**R3** (1–10 mSv)  
\$\$ (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.  
\$\$\$ (10–15 RVUs)    \$\$\$\$ (15+ RVUs)



**Chronic SP +  
glenohumeral  
dislocation**



See abbreviations on [page 2](#).

**DECISION NODE #14 KEY EVIDENCE**

Auffarth A, Mayer M, Kofler B, et al. The interobserver reliability in diagnosing osseous lesions after first-time anterior shoulder dislocation comparing plain radiographs with computed tomography scans. *J Shoulder Elb Surg.* 2013;22(11):1507-1513.

Kiuru MJ, Pihlajamaki HK, Hietanen HJ, Ahovuo JA. MR imaging, bone scintigraphy, and radiography in bone stress injuries of the pelvis and the lower extremity. *Acta Radiol.* 2002;43(2):207-212.

Cabarrus MC, Ambekar A, Lu Y, Link TM. MRI and CT of insufficiency fractures of the pelvis and the proximal femur. *AJR Am J Roentgenol.* 2008;191(4):995-1001.

Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

(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)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$\$** (5–10 RVUs)

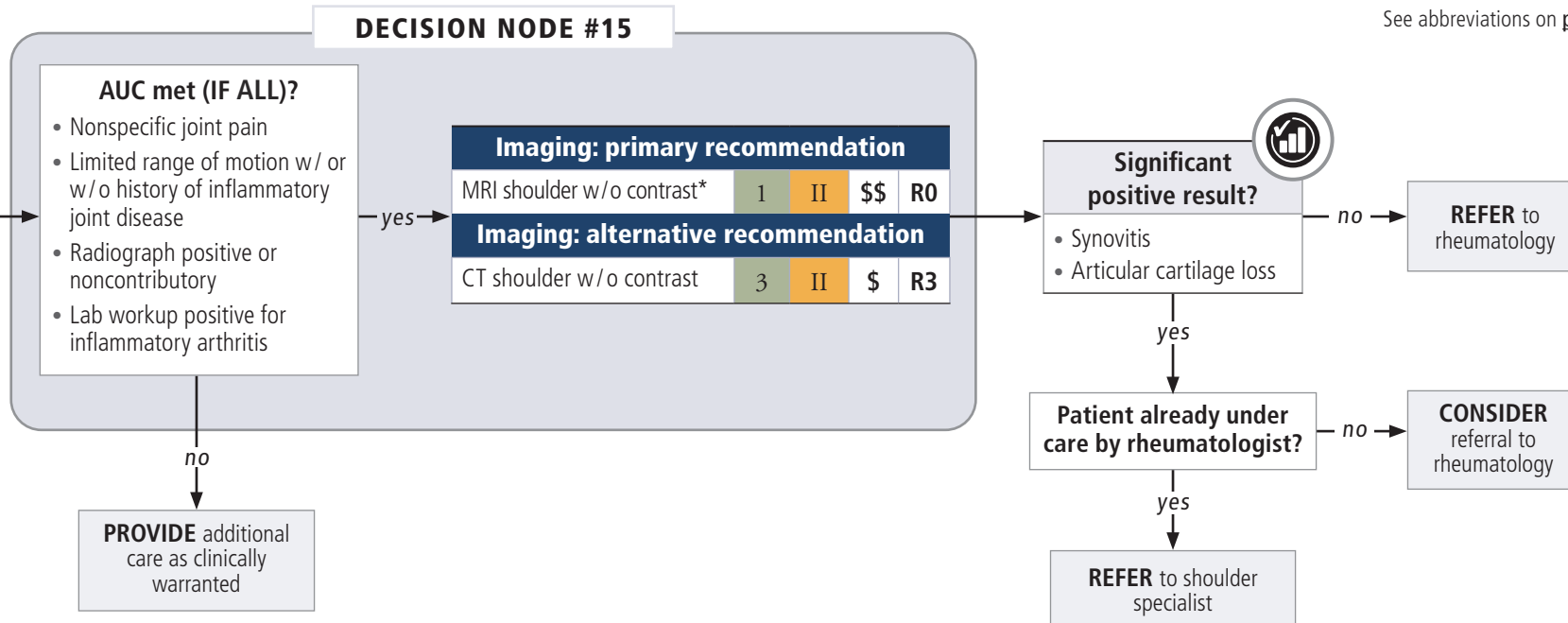
**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$\$** (10–15 RVUs) **\$\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Chronic SP + inflammatory/nonspecific arthropathy**



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

**DECISION NODE #15 KEY EVIDENCE**

Alasaarela E, Suramo I, Tervonen O, Lähde S, Takalo R, Hakala M. Evaluation of humeral head erosions in rheumatoid arthritis: a comparison of ultrasonography, magnetic resonance imaging, computed tomography and plain radiography. *Br J Rheumatol*. 1998;37(11):1152-1156.

Aleo E, Migone S, Prono V, Barbieri F, Garlaschi G, Cimmino MA. Imaging techniques in psoriatic arthritis: update 2012-2014 on current status and future prospects. *J Rheumatol Suppl*. 2015;93:53-56.

Baillet A, Gaujoux-Viala C, Mouterde G, et al. Comparison of the efficacy of sonography, magnetic resonance imaging and conventional radiography for the detection of bone erosions in rheumatoid arthritis patients: a systematic review and meta-analysis. *Rheumatology (Oxford)*. 2011;50(6):1137-1147.

Jacobson JA, Roberts CC, Bencardino JT, et al. ACR Appropriateness Criteria® Chronic extremity joint pain-suspected inflammatory Arthritis. *J Am Coll Radiol*. 2017;14(5S):S81-S89.

Mandl P, Navarro-Compán V, Terslev L, et al; European League Against Rheumatism (EULAR). EULAR recommendations for the use of imaging in the diagnosis and management of spondyloarthritis in clinical practice. *Ann Rheum Dis*. 2015;74(7):1327-1339.

(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 (0mSv)

R3 (1–10 mSv)

R4 (10–30 mSv) See page 2–3 for explanation.

\$ (0–5 RVUs)

\$\$ (5–10 RVUs)

\$\$\$ (10–15 RVUs)

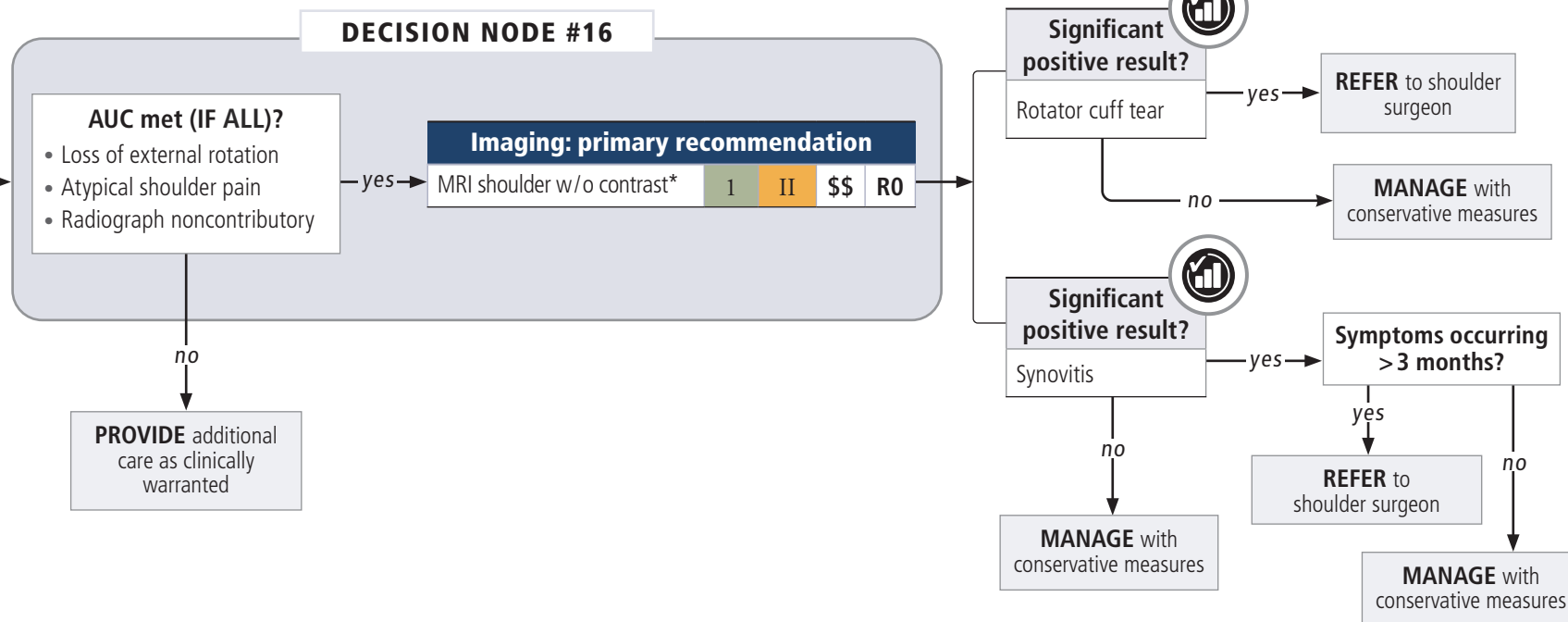
\$\$\$\$ (15+ RVUs)

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.

See abbreviations on [page 2](#).



**Acute SP + adhesive capsulitis**



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

**DECISION NODE #16 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

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

**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)

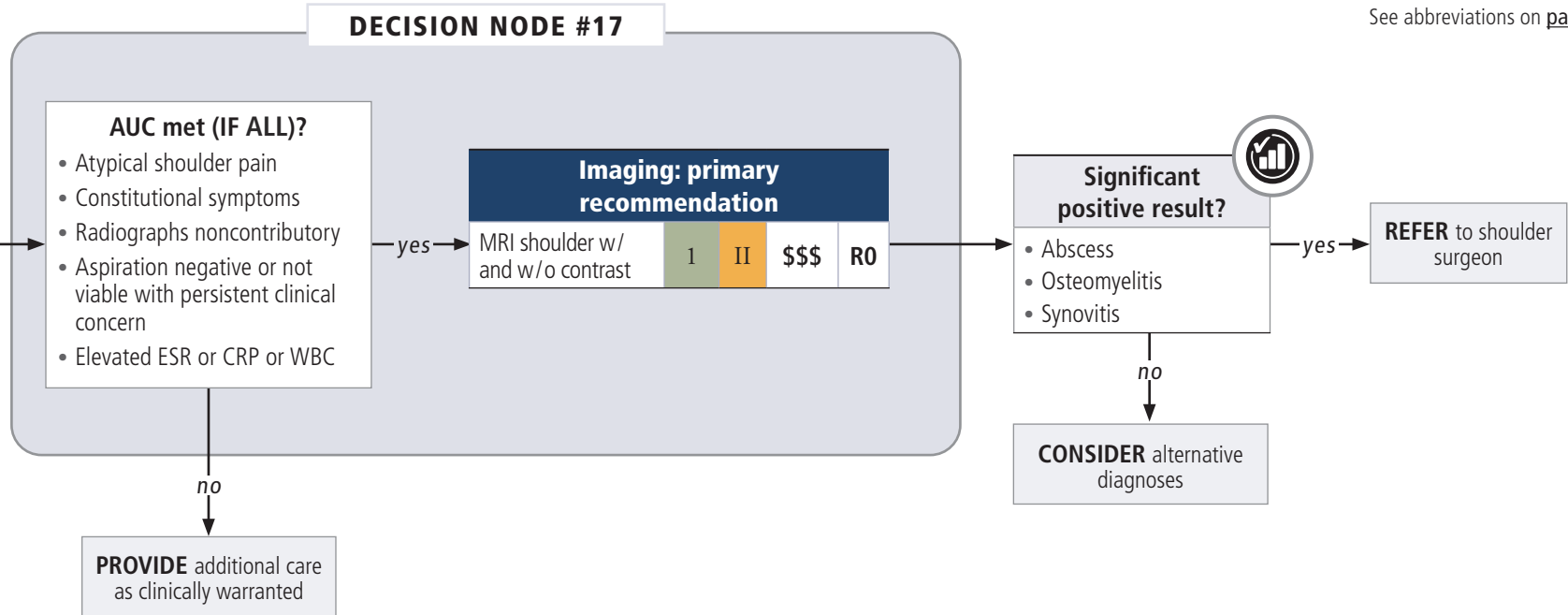
\$\$\$ (10–15 RVUs)

\$\$\$\$ (15+ RVUs)

See abbreviations on [page 2](#).



**Acute SP +  
septic  
arthritis**



**DECISION NODE #17 KEY EVIDENCE**

Termaat MF, Raijmakers PG, Scholten HJ, Bakker FC, Patka P, Haarman HJ. The accuracy of diagnostic imaging for the assessment of chronic osteomyelitis: a systematic review and meta-analysis. *J Bone Joint Surg Am.* 2005;87(11):2464-2471.

Beaman FD, von Herrmann PF, Kransdorf MJ, et al. ACR Appropriateness Criteria® Suspected osteomyelitis, septic arthritis, or soft tissue infection (excluding spine and diabetic foot). *J Am Coll Radiol.* 2017;14(5S):S326-S337.

(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)  
\$ (0–5 RVUs)

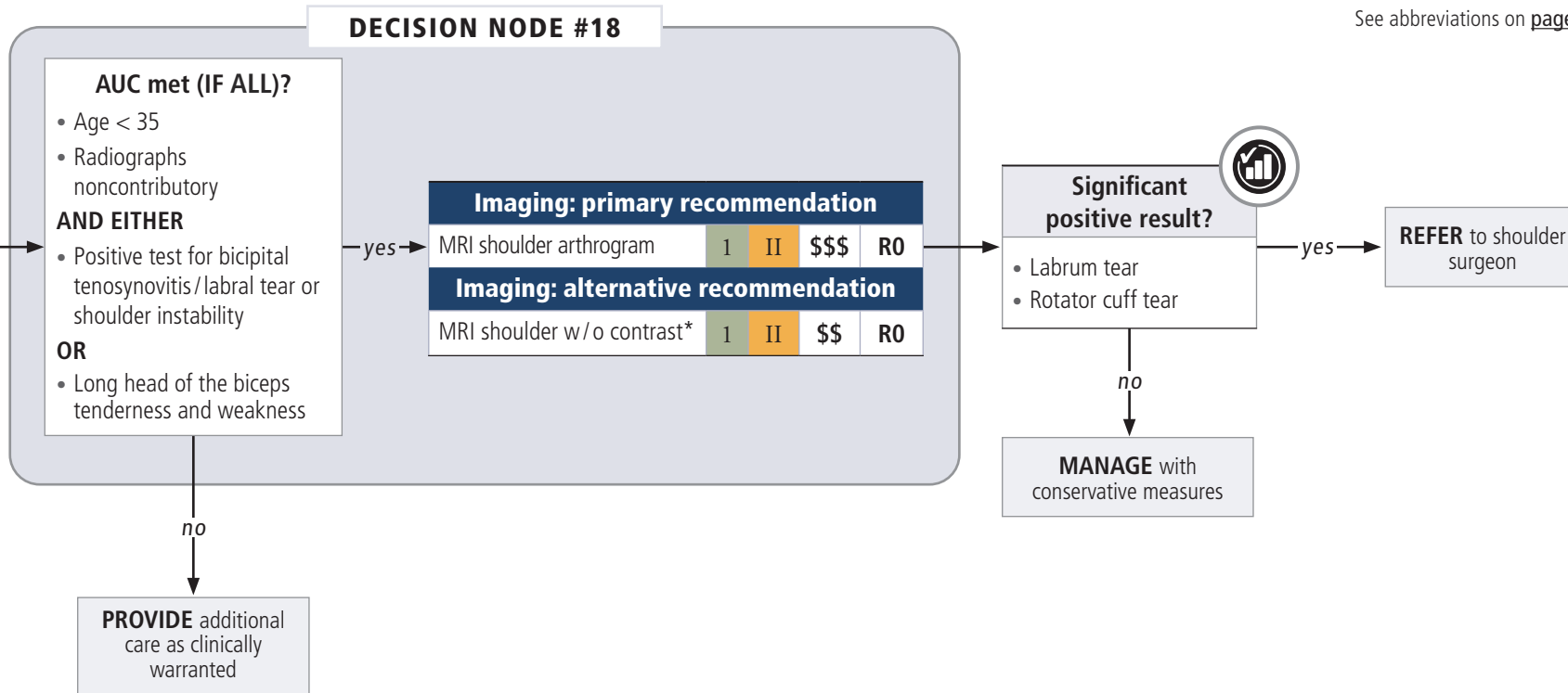
**R3** (1–10 mSv)  
\$\$ (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.  
\$\$\$ (10–15 RVUs)    \$\$\$\$ (15+ RVUs)

See abbreviations on [page 2](#).



**Acute SP +  
labral tear  
(SLAP tear)**



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

**DECISION NODE #18 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

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

**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)

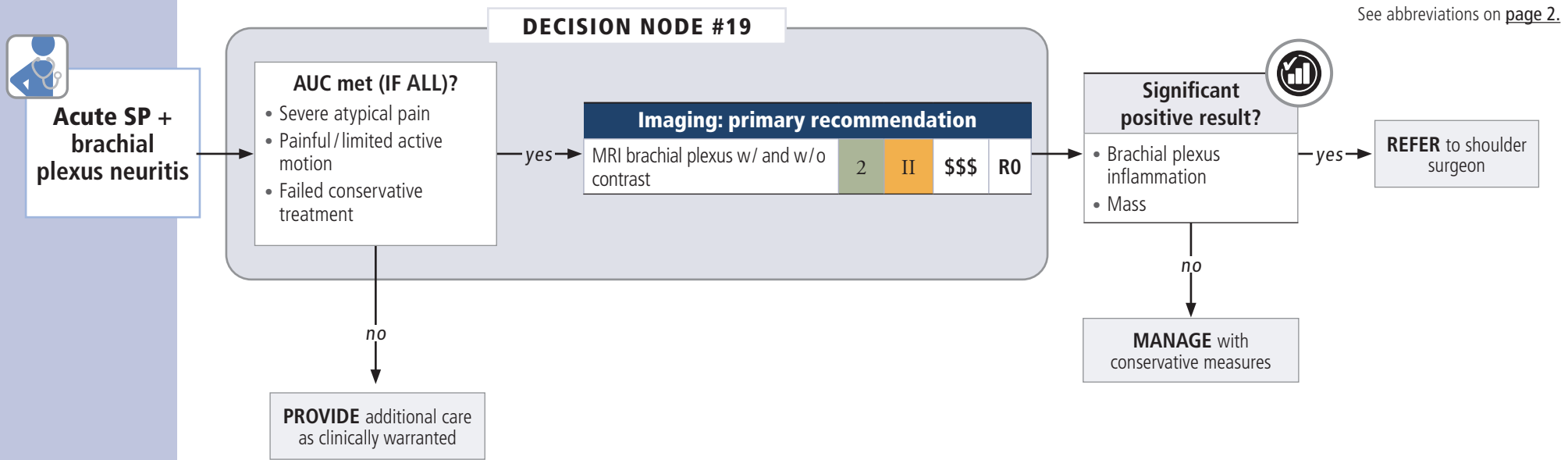
**R3** (1–10 mSv)

**\$\$** (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$** (10–15 RVUs) **\$\$\$\$** (15+ RVUs)





**DECISION NODE #19 KEY EVIDENCE**

Chhabra A, Thawait GK, Soldatos T, et al. High-Resolution 3T MR neurography of the brachial plexus and its branches, with emphasis on 3D imaging. *AJNR Am J Neuroradiol.* 2013;34(3):456-497.

Tagliafico A, Succio G, Serafini G, Martinoli C. Diagnostic accuracy of MRI in adults with suspect brachial plexus lesions: a multicentre retrospective study with surgical findings and clinical follow-up as reference standard. *Eur J Radiol.* 2012;81(10):2666-2672.

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

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)

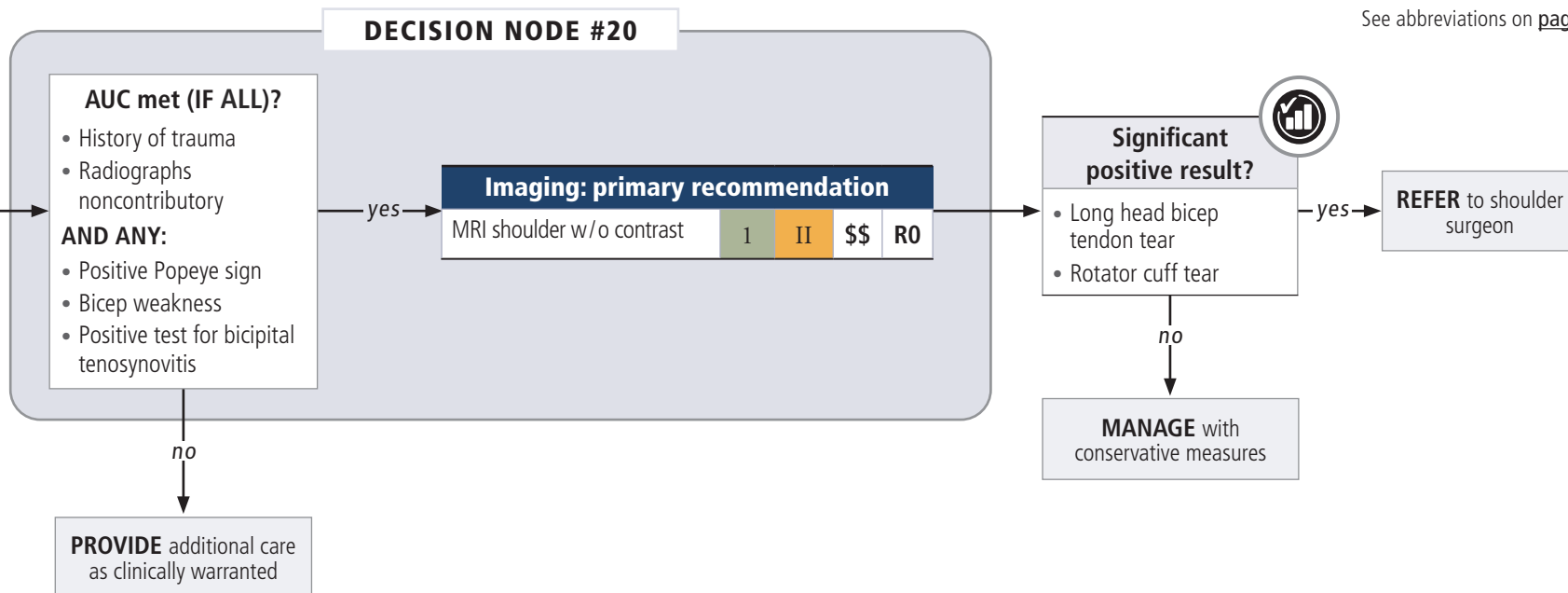
R3 (1–10 mSv)  
\$\$ (5–10 RVUs)

R4 (10–30 mSv) See page 2–3 for explanation.  
\$\$\$ (10–15 RVUs) \$\$\$\$ (15+ RVUs)

See abbreviations on [page 2](#).



**Acute SP + bicep rupture / tendinopathy**



**DECISION NODE #20 KEY EVIDENCE**

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess.* 2003;7(29):iii, 1-166.

Smith TO, Drew BT, Toms AP. A meta-analysis of the diagnostic test accuracy of MRA and MRI for the detection of glenoid labral injury. *Arch Orthop Trauma Surg.* 2012;132(7):905-919.

Lenza M, Buchbinder R, Takwoingi Y, Johnston R V, Hanchard NC, Faloppa F. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. *Cochrane database Syst Rev.* 2013;(9):CD009020. doi: 10.1002/14651858.CD009020.

(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)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

**\$\$** (5–10 RVUs)

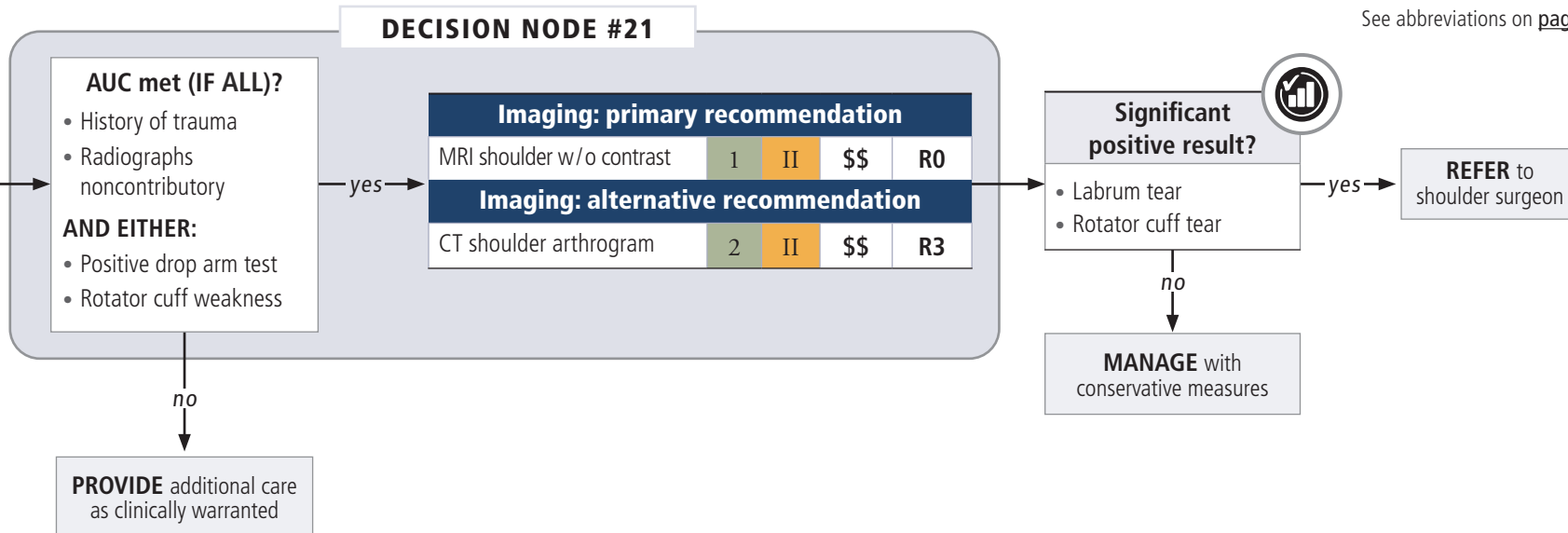
**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$** (10–15 RVUs)    **\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Acute SP + rotator cuff tear**



**DECISION NODE #21 KEY EVIDENCE**

Chandnani VP, Yeager TD, DeBerardino T, et al. Glenoid labral tears: prospective evaluation with MRI imaging, MR arthrography, and CT arthrography. *AJRN Am J Roentgenol*. 1993;161(6):1229-1235.

Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. *Health Technol Assess*. 2003;7(29):iii, 1-166.

Farin PU, Kaukanen E, Jaroma H, Väätäinen U, Miettinen H, Soimakallio S. Site and size of rotator-cuff tear. Findings at ultrasound, double-contrast arthrography, and computed tomography arthrography with surgical correlation. *Invest Radiol*. 1996;31(7):387-394.

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(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** (0mSv)

**\$** (0–5 RVUs)

**R3** (1–10 mSv)

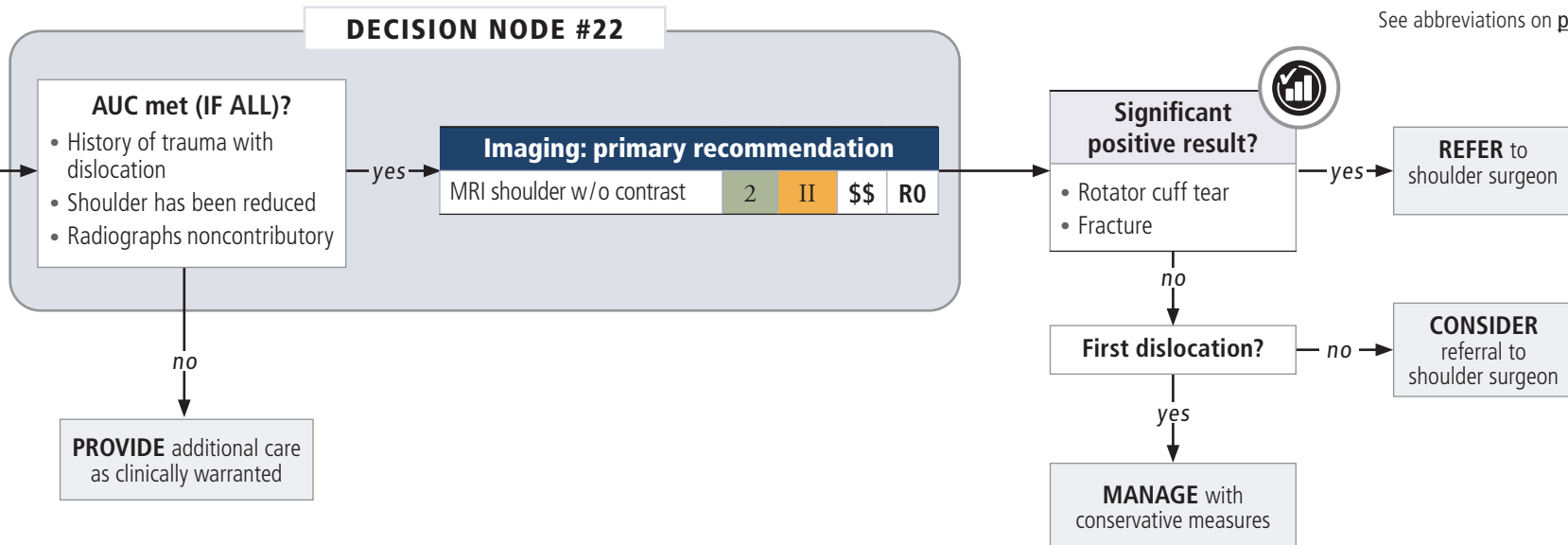
**\$\$** (5–10 RVUs)

**R4** (10–30mSv) See page 2–3 for explanation.

**\$\$\$** (10–15 RVUs) **\$\$\$\$** (15+ RVUs)



**Acute SP +  
dislocation  
(post  
relocation)**



See abbreviations on [page 2](#).

**DECISION NODE #22 KEY EVIDENCE**

Kirkley A, Litchfield R, Thain L, Spouge A. Agreement between magnetic resonance imaging and arthroscopic evaluation of the shoulder joint in primary anterior dislocation of the shoulder. *Clin J Sport Med.* 2003;13(3):148-151.

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Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

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

**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)

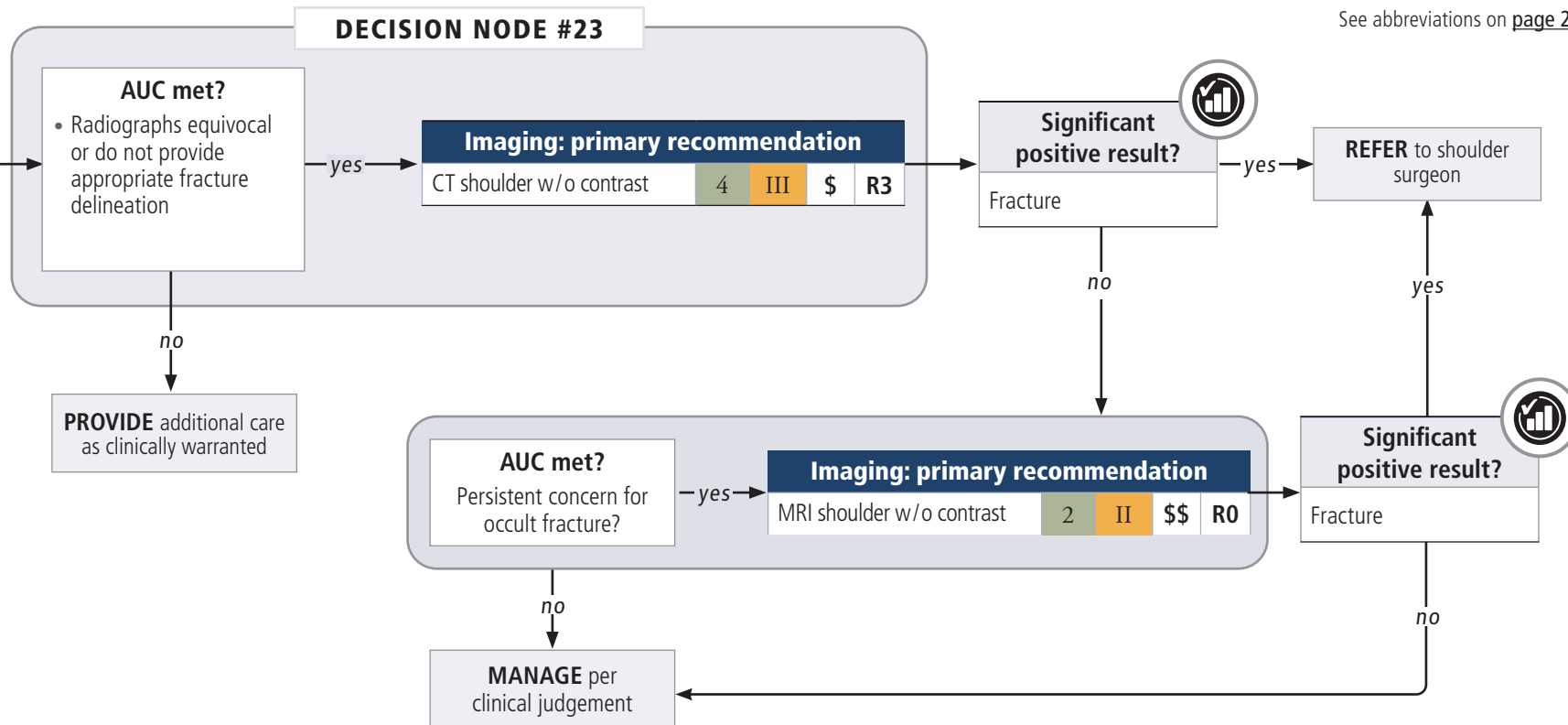
**\$\$** (5–10 RVUs)

**R4** (10–30 mSv) See page 2–3 for explanation.

**\$\$\$** (10–15 RVUs)    **\$\$\$\$** (15+ RVUs)



**Acute SP + suspected fracture of humerus, clavicle, or scapula**



**DECISION NODE #23 KEY EVIDENCE**

Auffarth A, Mayer M, Kofler B, et al. The interobserver reliability in diagnosing osseous lesions after first-time anterior shoulder dislocation comparing plain radiographs with computed tomography scans. *J Shoulder Elb Surg.* 2013;22(11):1507-1513.

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Kiuru MJ, Pihlajamaki HK, Hietanen HJ, Ahovuo JA. MR imaging, bone scintigraphy, and radiography in bone stress injuries of the pelvis and the lower extremity. *Acta Radiol.* 2002;43(2):207-212.

Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol.* 2011;8(9):602-609.

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

**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)

**\$\$\$** (10–15 RVUs)

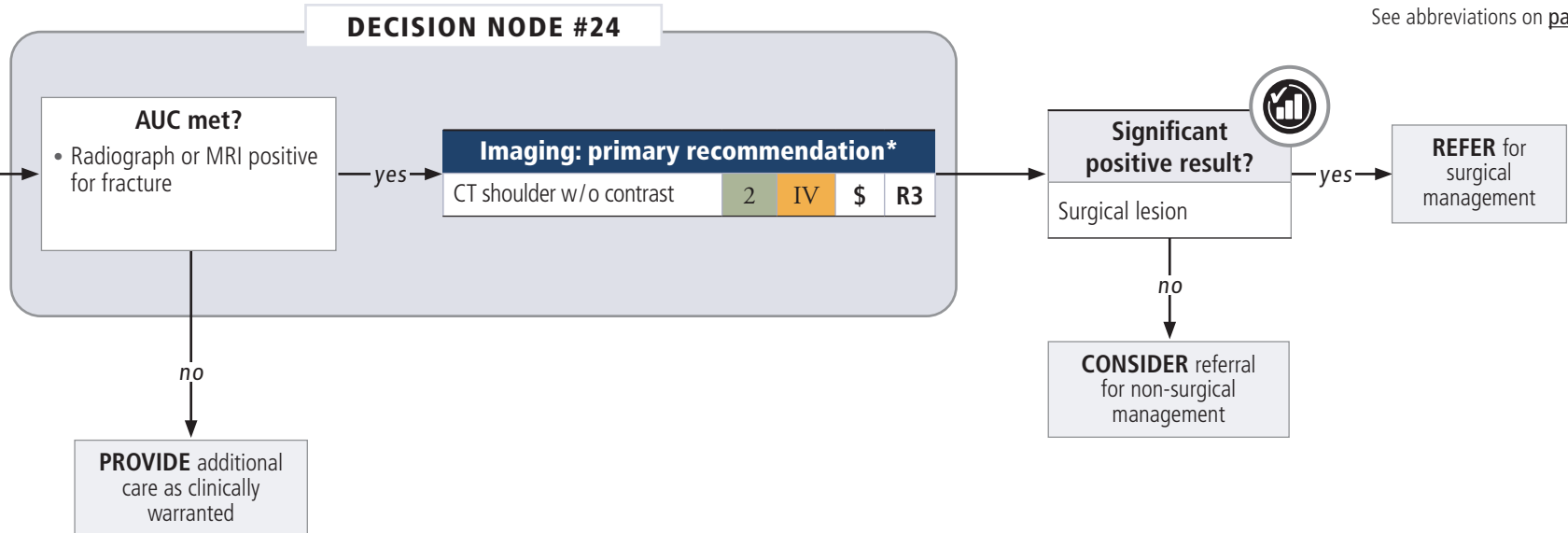
See page 2–3 for explanation.

**\$\$\$\$** (15+ RVUs)

See abbreviations on [page 2](#).



**Acute SP + known fracture (pre-op planning)**



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

**DECISION NODE #24 KEY EVIDENCE**

Auffarth A, Mayer M, Kofler B, et al. The interobserver reliability in diagnosing osseous lesions after first-time anterior shoulder dislocation comparing plain radiographs with computed tomography scans. *J Shoulder Elb Surg.* 2013;22(11):1507-1513.

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

**LEGEND**

Clinical Scenario	Urgent or Emergency Situation	2 OCEBM Level of Evidence	II Fryback & Thornbury Level of Evidence	Intermountain Measure	<b>R0</b> (0 mSv) \$ (0–5 RVUs)	<b>R3</b> (1–10 mSv) \$\$\$ (5–10 RVUs)	<b>R4</b> (10–30 mSv) See page 2–3 for explanation. \$\$\$\$ (10–15 RVUs)    \$\$\$\$\$ (15+ RVUs)
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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 1. MRI shoulder *without contrast* appropriate use indications (PRIMARY recommendation)**

**NOT POST TSA (IF ALL)**

**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

**Chronic SP + suspected rotator cuff tear / impingement**

- Radiographs noncontributory or demonstrate coracoacromial arch osteophytes

**AND ANY OF THESE:**

- Positive test for bicipital tendinosis
- Positive test for shoulder instability
- Positive test for rotator cuff pathology
- Acromioclavicular / subacromial tenderness

**Chronic SP + calcific tendinitis**

- Painful limited shoulder motion
- Resting pain
- Radiograph positive for calcium in rotator cuff tendon region

**Chronic SP + glenohumeral dislocation**

- Traumatic mechanism of injury
- History of dislocation
- Positive apprehension and /or relocation test
- Radiographs show appropriate reduction

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

- Post rotator cuff repair
- AND ANY OF THESE:**
- Positive drop arm test
- Rotator cuff muscle weakness
- Superior migration of humeral head on radiographs

**Chronic SP + avascular necrosis or osteochondral lesion**

- Radiographs positive or equivocal for AVN

**Chronic SP + inflammatory / nonspecific arthropathy**

- 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

**Acute SP + adhesive capsulitis**

- Loss of external rotation
- Atypical shoulder pain
- Radiographs noncontributory

**Acute SP + bicep rupture / tendinopathy**

- History of trauma
- Radiographs noncontributory
- AND ANY OF THESE:**
- Positive Popeye sign
- Bicep weakness
- Positive test for bicipital tenosynovitis

**Acute SP + rotator cuff tear**

- History of trauma
- Radiographs noncontributory
- AND EITHER OF THESE:**
- Positive drop arm test
- Rotator cuff weakness

**Acute SP + dislocation post-relocation**

- History of trauma
- Shoulder has been reduced
- Radiographs noncontributory

**Acute SP + fracture of humerus, clavicle, or scapula**

- History of trauma
- Radiographs equivocal or do not provide appropriate fracture delineation
- Negative CT
- Persistent concern for occult fracture



▶ POINT-OF-ORDER CHECKLISTS, CONTINUED

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

NOT POST TSA (IF ALL)
<input type="checkbox"/> <b>Chronic SP + labrum tear</b> <input type="checkbox"/> Age < 35 <input type="checkbox"/> Radiographs noncontributory <b>AND</b> <input type="checkbox"/> Subjective complaint of "instability or dislocation" <b>OR EITHER OF THESE:</b> <input type="checkbox"/> Positive sulcus sign <input type="checkbox"/> Positive apprehension or relocation test
<input type="checkbox"/> <b>Acute SP + labral tear (SLAP tear)</b> <input type="checkbox"/> Age < 35 <input type="checkbox"/> Radiographs noncontributory <b>AND EITHER OF THESE:</b> <input type="checkbox"/> Positive test for bicipital tenosynovitis/labral tear or shoulder instability <input type="checkbox"/> Long head of the biceps tenderness and weakness

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

POST TSA (IF ALL)	NOT POST TSA (IF ALL)
<input type="checkbox"/> <b>Chronic SP + suspected infection</b> <input type="checkbox"/> Shoulder pain OR constitutional symptoms <input type="checkbox"/> Insufficient data from shoulder aspiration <input type="checkbox"/> Radiographs noncontributory <input type="checkbox"/> <b>Acute SP + suspected infection</b> <input type="checkbox"/> Shoulder pain OR constitutional symptoms <input type="checkbox"/> Insufficient data from shoulder aspiration <input type="checkbox"/> Radiographs noncontributory	<input type="checkbox"/> <b>Acute SP + septic arthritis</b> <input type="checkbox"/> Atypical shoulder pain <input type="checkbox"/> Constitutional symptoms <input type="checkbox"/> Radiographs noncontributory <input type="checkbox"/> Aspiration negative or not viable with persistent clinical concern <input type="checkbox"/> Elevated ESR or CRP or WBC

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

POST TSA (IF ALL)	NOT POST TSA (IF ALL)
<input type="checkbox"/> <b>Acute SP + rotator cuff tear</b> <input type="checkbox"/> Positive drop arm test OR rotator cuff weakness <input type="checkbox"/> Radiographs noncontributory	<input type="checkbox"/> <b>Chronic SP + labrum tear</b> <input type="checkbox"/> Age < 35 <input type="checkbox"/> Radiographs noncontributory <b>AND</b> <input type="checkbox"/> Subjective complaint of "instability or dislocation" <b>OR EITHER OF THESE</b> <input type="checkbox"/> Positive sulcus sign <input type="checkbox"/> Positive apprehension or relocation test <input type="checkbox"/> <b>Acute SP + labral tear (SLAP tear)</b> <input type="checkbox"/> Age < 35 <input type="checkbox"/> Radiographs noncontributory <b>AND EITHER OF THESE:</b> <input type="checkbox"/> Positive test for bicipital tenosynovitis/labral tear or shoulder instability <input type="checkbox"/> Long head of the biceps tenderness and weakness

▶ POINT-OF-ORDER CHECKLISTS, CONTINUED

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

POST TSA (IF ALL)	NOT POST TSA
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + suspected component loosening</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Persistent pain in shoulder / proximal humerus</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + suspected component failure</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs indicate component failure or fracture or are equivocal</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + fracture</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs positive or equivocal for fracture</li> <li><input type="checkbox"/> Shoulder pain or visible deformity</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Acute SP + suspected fracture of humerus, clavicle, or scapula</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs equivocal or do not provide appropriate fracture delineation</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + known fracture (pre-op planning)</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs or MRI positive for fracture</li> </ul> </li> </ul>

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

NOT POST TSA (IF ALL)
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + glenohumeral dislocation</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Traumatic mechanism of injury</li> <li><input type="checkbox"/> History of dislocation</li> <li><input type="checkbox"/> Positive apprehension and/or relocation test</li> <li><input type="checkbox"/> Radiographs show appropriate reduction</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + inflammatory/nonspecific arthropathy</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Nonspecific joint pain</li> <li><input type="checkbox"/> Limited range of motion, w/ or w/ out history of inflammatory joint disease</li> <li><input type="checkbox"/> Radiograph positive or noncontributory</li> <li><input type="checkbox"/> Lab workup positive for inflammatory arthritis</li> </ul> </li> </ul>

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

POST TSA (IF ALL)
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + suspected infection</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Shoulder pain OR constitutional symptoms</li> <li><input type="checkbox"/> Insufficient data from shoulder aspiration</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + suspected infection</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Shoulder pain OR constitutional symptoms</li> <li><input type="checkbox"/> Insufficient data from shoulder aspiration</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> </ul>

▶ POINT-OF-ORDER CHECKLISTS, CONTINUED

**TABLE 8. CT shoulder arthrogram appropriate use indications (ALTERNATIVE recommendation)**

POST TSA (IF ALL)	NOT POST TSA (IF ALL)	
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Acute SP + rotator cuff tear</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive drop arm test OR rotator cuff weakness</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + labrum tear</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Age &lt; 35</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> <li><b>AND</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Subjective complaint of "instability or dislocation"</li> </ul> </li> <li><b>OR EITHER OF THESE:</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive sulcus sign</li> <li><input type="checkbox"/> Positive apprehension or relocation test</li> </ul> </li> <li><input type="checkbox"/> <b>Acute SP + rotator cuff tear</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> History of trauma</li> <li><input type="checkbox"/> Radiographs noncontributory</li> </ul> </li> <li><b>AND EITHER OF THESE:</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Positive drop arm test</li> <li><input type="checkbox"/> Rotator cuff weakness</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + avascular necrosis or osteochondral lesion</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs positive or equivocal for AVN</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + moderate to severe osteoarthritis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Radiographs positive for OA</li> <li><input type="checkbox"/> Morning stiffness in shoulder joint</li> <li><input type="checkbox"/> Limited range of motion</li> <li><input type="checkbox"/> Deep ache without mechanical symptoms</li> </ul> </li> <li><input type="checkbox"/> <b>Chronic SP + mild osteoarthritis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Age &gt; 40</li> <li><input type="checkbox"/> Near symmetric motion</li> <li><input type="checkbox"/> No significant strength loss</li> <li><input type="checkbox"/> Deep ache</li> <li><input type="checkbox"/> Radiographs noncontributory</li> <li><input type="checkbox"/> 3 months of failed conservative treatment</li> </ul> </li> </ul>

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

POST TSA (IF ALL)
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Chronic SP + suspected component loosening</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Persistent pain in shoulder/proximal humerus</li> <li><input type="checkbox"/> Radiographs noncontributory</li> <li><input type="checkbox"/> Negative CT</li> <li><input type="checkbox"/> Persistent concern for component loosening</li> </ul> </li> </ul>

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

AUC met (IF ALL)? (applicable to both post and not-post TSA)
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>Acute SP + brachial plexus neuritis</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Severe atypical pain</li> <li><input type="checkbox"/> Painful/limited active motion</li> <li><input type="checkbox"/> Failed conservative treatment</li> </ul> </li> </ul>



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1. Cyteval C, Bourdon A. Imaging orthopedic implant infections. *Diagn Interv Imaging*. 2012;93(6):547-557.
2. Cyteval C, Hamm V, Sarrabère MP, Lopez FM, Maury P, Taourel P. Painful infection at the site of hip prosthesis: CT imaging. *Radiology*. 2002;224(2):477-483.
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6. Ho CP, Ommen ND, Bhatia S, et al. Predictive value of 3-T magnetic resonance imaging in diagnosing grade 3 and 4 chondral lesions in the hip. *Arthroscopy*. 2016; 32(9):1808-1813.
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**NODE #2**

1. Eichinger JK, Galvin JW. Management of complications after total shoulder arthroplasty. *Curr Rev Musculoskelet Med*. 2015;8(1):83-91.
2. Gyftopoulos S, Rosenberg ZS, Roberts CC, et al. ACR Appropriateness Criteria® imaging after shoulder arthroplasty. *J Am Coll Radiol*. 2016;13(11):1324-1336.
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**NODE #3**

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2. Cyteval C, Hamm V, Sarrabère MP, Lopez FM, Maury P, Taourel P. Painful infection at the site of hip prosthesis: CT imaging. *Radiology*. 2002;224(2):477-483.
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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.