

# **APPROPRIATE USE CRITERIA FOR THE TREATMENT OF ANTERIOR CRUCIATE LIGAMENT INJURIES**

**Adopted by the American Academy of Orthopaedic Surgeons  
Board of Directors**

**October 2, 2015**

**Disclaimer**

Volunteer physicians from multiple medical specialties created and categorized these Appropriate Use Criteria. These Appropriate Use Criteria are not intended to be comprehensive or a fixed protocol, as some patients may require more or less treatment or different means of diagnosis. These Appropriate Use Criteria represent patients and situations that clinicians treating or diagnosing musculoskeletal conditions are most likely to encounter. The clinician's independent medical judgment, given the individual patient's clinical circumstances, should always determine patient care and treatment.

**Disclosure Requirement**

In accordance with American Academy of Orthopaedic Surgeons policy, all individuals whose names appear as authors or contributors to this document filed a disclosure statement as part of the submission process. All authors provided full disclosure of potential conflicts of interest prior to participation in the development of these Appropriate Use Criteria. Disclosure information for all panel members can be found in Appendix B.

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**FDA Clearance**

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# I. INTRODUCTION

## OVERVIEW

The American Academy of Orthopaedic Surgeons (AAOS) has developed this Appropriate Use Criteria (AUC) to determine appropriateness of various health care services for anterior cruciate ligament (ACL) injuries. An “appropriate” healthcare service is one for which the expected health benefits exceed the expected negative consequences by a sufficiently wide margin.<sup>2</sup>

Evidence-based information, in conjunction with the clinical expertise of physicians from multiple medical specialties, was used to develop the criteria in order to improve patient care and obtain the best outcomes while considering the subtleties and distinctions necessary in making clinical decisions. The foundation for this AUC is the 2014 Management of Anterior Cruciate Ligament Injuries Clinical Practice Guideline, which can be accessed via the following link: <http://www.aaos.org/research/guidelines/ACLGuidelineFINAL.pdf>

The purpose of this AUC is to help determine the appropriateness of clinical practice guideline recommendations for the heterogeneous patient population routinely seen in practice. The best available scientific evidence is synthesized with collective expert opinion on topics where gold standard randomized clinical trials are not available or are inadequately detailed for identifying distinct patient types. When there is evidence corroborated by consensus that expected benefits substantially outweigh potential risks, exclusive of cost, a procedure is determined to be appropriate. The AAOS uses the RAND/UCLA Appropriateness Method (RAM).<sup>2</sup> Our process includes these steps: reviewing the results of the evidence analysis, compiling a list of clinical vignettes, and having an expert panel comprised of representatives from multiple medical specialties to determine the appropriateness of each of the clinical indications for treatment as “Appropriate,” “May be Appropriate,” or “Rarely Appropriate.” To access an intuitive and more user-friendly version of the appropriate use criteria for this topic online, please visit our AUC web-based application at [www.orthoguidelines.org/auc](http://www.orthoguidelines.org/auc).

These criteria should not be construed as including all indications or excluding indications reasonably directed to obtaining the same results. The criteria intend to address the most common clinical scenarios facing all appropriately trained surgeons and all qualified physicians managing patients under consideration for treating anterior cruciate ligament injuries. The ultimate judgment regarding any specific criteria should address all circumstances presented by the patient and the needs and resources particular to the locality or institution. It is also important to state that these criteria were developed as guidelines and are not meant to supersede clinician expertise and experience or patient preference.

## INTERPRETING THE APPROPRIATENESS RATINGS

To prevent misuse of these criteria, it is extremely important that the user of this document understands how to interpret the appropriateness ratings. The appropriateness rating scale ranges from one to nine and there are three main range categories that determine how the median rating is defined (i.e. 1-3 = “Rarely Appropriate”, 4-6 = “May Be Appropriate”, and 7-9 = “Appropriate”). Before these appropriate use criteria are consulted, the user should read through and understand all contents of this document.

## **ASSUMPTIONS OF THE WRITING PANEL**

1. Patient history, physical examination, and/or imaging are consistent with diagnosis of complete ACL tear.
2. Patient has primary ACL tear, not a recurrent tear.
3. Patient does not have significant multi-ligament injuries (grade 1-2 mcl injuries are not exclusions).
4. Patient is otherwise in good health and good candidate for surgery.
5. Patient does not have a periarticular knee fracture.
6. The surgeon is trained and capable of performing all operative techniques with equal effectiveness.
7. Patient able to participate and/or cooperate in physical therapy or rehabilitation.
8. The physician has an informed discussion with the patient about the treatment options and that the optimum treatment options may change over time for the patient. Before operative intervention is recommended, the appropriateness and potential efficacy of non-operative intervention has been considered.
9. Before a patient undergoes surgery they have achieved good quad control, have minimal effusion, and good range of motion. If not, surgery will be postponed until this occurs.
10. The surgeon will perform the surgery in the most appropriate location (i.e., ASC, outpatient, inpatient) based on the health of the patient and associated injuries.
11. The facility has each type of implant/equipment available and capable support personnel.
12. Regarding graft choices: neither bone nor patellar tendon should be placed across the physes.
13. A failed optimal nonoperative measure is defined as: patient has received optimal care and has received symptoms of recurrent instability. Nonoperative measures include: bracing, activity modification, and rehabilitation/physical therapy.
14. Arthritic changes discussed in this AUC are assumed to be from osteoarthritis or post traumatic arthritis and exclude inflammatory arthropathies.
15. Arthritic changes in patients with open physes were removed due to clinical rarity

## **CONDITIONS NOT COVERED BY THIS AUC**

- Tibial eminence fracture
- Additional ligament injuries beyond an incomplete MCL injury
- Re-tears of prior reconstructions
- Partial ACL injuries

## **PATIENT POPULATION & SCOPE OF GUIDELINE**

This document is intended for use for both skeletally immature and skeletally mature patients who have been diagnosed with an ACL injury of the knee.

## **BURDEN OF DISEASE**

Persons who suffer ACL injuries are at increased risk for developing arthritis later in life.<sup>3</sup>  
Females are two to eight times more likely to suffer an ACL injury compared to males.<sup>3</sup>



## **ETIOLOGY**

ACL rupture is typically the result of a traumatic, sports-related injury. This injury may be contact or non-contact.

## **INCIDENCE AND PREVALENCE**

The annual rate of patients who present with anterior cruciate ligament injuries has been estimated at 252,000.<sup>3</sup>

## **POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS**

Most treatments are associated with some known risks, especially invasive and operative treatments. Contraindications vary widely based on the treatment administered. A particular concern when treating ACL injuries is routine surgical complications such as infection, DVT, anesthesia complications, etc. Other complications associated with ACL surgery include: postoperative loss of motion or arthrofibrosis, ongoing instability episodes, neurovascular injury, etc. Additional factors may affect the physician's choice of treatment including but not limited to associated injuries the patient may present with as well as the individual's co-morbidities, skeletal maturity, and/or specific patient characteristics including obesity, activities, work demands, etc.. Clinician input based on experience increases the probability of identifying patients who will benefit from specific treatment options. The individual patient and the patient's family dynamic will also influence treatment decisions therefore, discussion of available treatments and procedures applicable to the individual patient rely on mutual communication between the patient and the patient's guardian (when appropriate for minor patients) and physician, weighing the potential risks and benefits for that patient. Once the patient and patient's guardian has been informed of available therapies and has discussed these options with the patient and guardian (if appropriate), an informed decision can be made.

## **II. METHODS**

This AUC for Treatment of Anterior Cruciate Ligament Injuries is based on a review of the available literature and a list of clinical scenarios (i.e. criteria) constructed and voted on by experts in orthopaedic surgery and other relevant medical fields. This section describes the methods adapted from the RAND/UCLA Appropriateness Method (RAM)<sup>2</sup>. This section also includes the activities and compositions of the various panels that developed, defined, reviewed, and voted on the criteria.

Two panels participated in the development of the AAOS AUC for Treatment of Anterior Cruciate Ligament Injuries (see list on [page i](#)). Members of the writing panel developed a list of over 350 patient scenarios, for which 10 treatments were evaluated for appropriateness. The voting panel participated in two rounds of voting. During the first round of voting, the voting panel was given approximately one month to independently rate the appropriateness of each the provided treatments for each of the relevant patient scenarios as 'Appropriate', 'May Be Appropriate', or 'Rarely Appropriate' via an electronic ballot. After the first round of appropriateness ratings were submitted, AAOS staff calculated the median ratings for each patient scenario and specific treatment. An in-person voting panel meeting was held in Rosemont, IL on April 25<sup>th</sup> of 2015. During this meeting, voting panel members addressed the scenarios/treatments which resulted in disagreement (definition of disagreement can be found in

Table 3). The voting panel members were asked to rerate their first round ratings during and after the voting panel meeting, only if they were persuaded to do so by the discussion and available evidence. Voting occurred during the in-person meeting and continued for approximately one week following the meeting. The voting panel determined appropriateness by rating scenarios (i.e. criteria) as ‘Appropriate’, ‘May Be Appropriate’, or ‘Rarely Appropriate’. There was no attempt to obtain consensus about appropriateness.

AAOS Appropriate Use Criteria Section, the AAOS Council on Research and Quality, and the AAOS Board of Directors sequentially approved the Appropriate Use Criteria for Management of Anterior cruciate ligament injuries. AAOS submits this AUC to the National Guidelines Clearinghouse and, in accordance with the National Guidelines Clearinghouse criteria, will update or retire this AUC within five years of the publication date.

## **DEVELOPING CRITERIA**

Members of the AUC for Treatment of Anterior Cruciate Ligament Injuries writing panel, who are orthopaedic specialists in treating knee-related injuries/diseases, developed clinical scenarios using the following guiding principles:

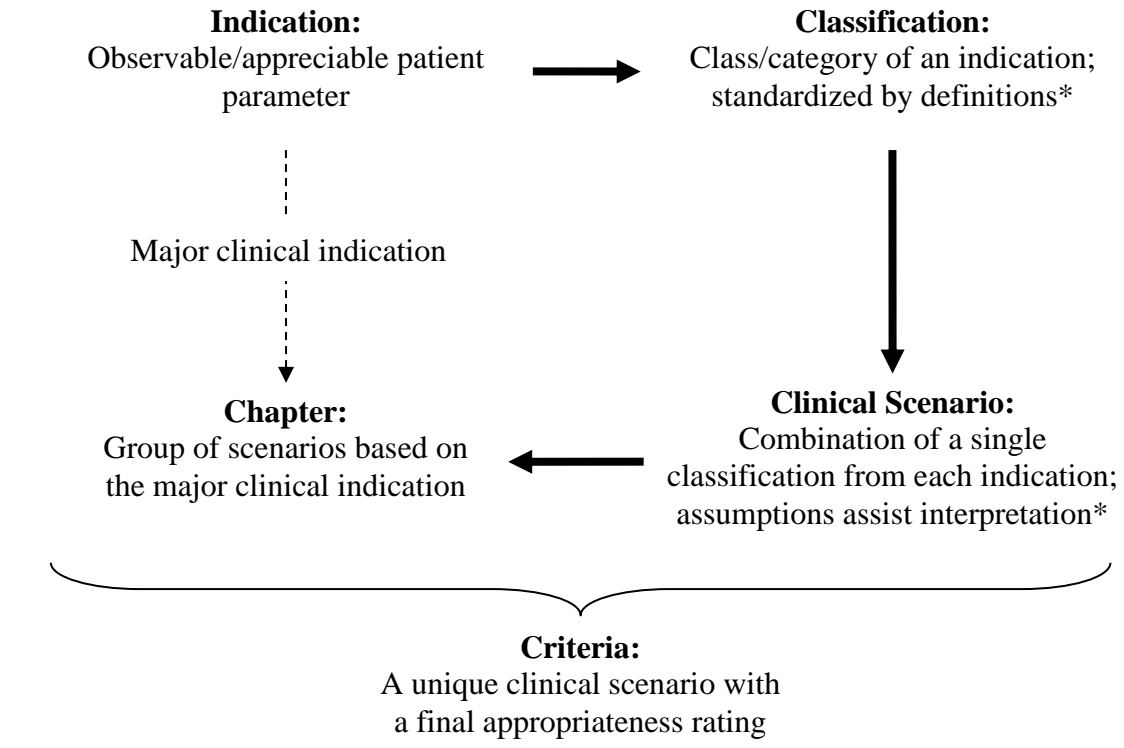
- Patient scenarios must include a broad spectrum of patients that may be eligible for treatment of anterior cruciate ligament injuries [*comprehensive*]
- Patient indications must classify patients into a unique scenario [*mutually exclusive*]
- Patient indications must consistently classify similar patients into the same scenario [*reliable, valid indicators*]

The writing panel developed the scenarios by categorizing patients in terms of indications evident during the clinical decision making process (Figure 1). These scenarios relied upon definitions and general assumptions, mutually agreed upon by the writing panel during the development of the scenarios. These definitions and assumptions were necessary to provide consistency in the interpretation of the clinical scenarios among experts voting on the scenarios and readers using the final criteria.

## **FORMULATING INDICATIONS AND SCENARIOS**

The AUC writing panel began the development of the scenarios by identifying clinical indications typical of patients commonly presenting with anterior cruciate ligament injuries in clinical practice. Indications are most often parameters observable by the clinician, including symptoms or results of diagnostic tests. Additionally, “human factor” (e.g. activity level) or demographic variables can be considered.

**Figure 1. Developing Criteria**



Indications identified in clinical trials (derived from patient selection criteria) included in AAOS Clinical Practice Guidelines served as a starting point for the writing panel and ensured that these Appropriate Use Criteria referred to the evidence base for the treatment of anterior cruciate ligament injuries CPG. The writing panel considered this initial list and other indications based on their clinical expertise and selected the most clinically relevant indications ([Table 4](#)). The writing panel then defined distinct classes for each indication in order to stratify/categorize the indication ([Table 4](#)).

The writing panel organized these indications into a matrix of clinical scenarios that addressed all combinations of the classifications. The writing panel was given the opportunity to remove any scenarios that rarely occur in clinical practice, but agreed that all scenarios were clinically relevant. The major clinical decision making indications chosen by the writing panel divided the matrix of clinical scenarios into chapters, as follows: age/maturity level, activity level, presence of advanced arthritis, presence of reparable meniscus tear, and prior failure of nonoperative measures ([Table 4](#)).

## CREATING DEFINITIONS AND ASSUMPTIONS

The AUC for Treatment of Anterior Cruciate Ligament Injuries writing panel constructed concise and explicit definitions for the indications and classifications. This standardization helped ensure the way that the writing panel defined the patient indications was consistent

among those reading the clinical scenario matrix or the final criteria. Definitions drew explicit boundaries when possible and were based on standard medical practice or existing literature.

Additionally, the writing panel formulated a list of general assumptions in order to provide more consistent interpretations of a scenario (see [Assumptions of the Writing Panel](#)). These assumptions differed from definitions in that they identified circumstances that exist outside of the control of the clinical decision making process.

Assumptions also addressed the use of existing published literature regarding the effectiveness of treatment and/or the procedural skill level of physicians. Additionally, assumptions highlighted intrinsic methods described in this document such as the role of cost considerations in rating appropriateness or the validity of the definition of appropriateness. The main goal of assumptions was to focus scenarios so that they apply to the average patient presenting to an average physician at an average facility.<sup>1</sup>

The definitions and assumptions should provide all readers with a common starting point in interpreting the clinical scenarios. This list of definitions and assumptions accompanied the matrix of clinical scenarios in all stages of the development of this AUC and appears in the Assumptions of the Writing Panel section of this document.

## **VOTING PANEL MODIFICATIONS TO WRITING PANEL MATERIALS**

At the start of the in-person voting panel meeting, the voting panel was reminded that they have the ability to amend the original writing panel materials if the amendments resulted in more clinically relevant and practical criteria. In order to amend the original materials, the voting panel members were instructed that a member must make a motion to amend and another member must “second” that motion, after which a vote is conducted. If a majority of voting panel members voted “yes” to amend the original materials, the amendments were accepted.

The voting panel opted to make the following amendments/additions to the original AUC materials:

- 1) Remove “arthritic changes” option for open physes patients.
- 2) Added assumptions 12-15.
- 3) Added a “severe arthritic changes” option to the “closing physes < 25 years of age” patients.
- 4) Modified the original “physeal sparing” treatment option to include the following treatment options:
  - Physeal sparing autograft
  - Transphyseal autograft
  - Physeal sparing allograft
  - Transphyseal allograft
- 5) Combined the original “closing physes < 25 years of age” patients with the “closed physes patients” to construct one “closed/closing physes < 25 years of age” patient choice.
- 6) For the nonoperative treatment options, added “...without reconstruction”.

- 7) Further defined nonoperative measures patient indication by adding the following:  
“Nonoperative measures” include”: bracing, activity modification, and rehabilitation/physical therapy. “Failed optimal nonoperative measures” is defined as: “patient has received optimal care and has received symptoms of recurrent instability”

## **LITERATURE REVIEW**

Concurrent with the writing panel developing the criteria, the AAOS Evidence-Based Medicine Unit undertook a literature review based on the results of the AAOS Clinical Practice Guideline on Treatment of Anterior cruciate ligament injuries and all literature published after the release of the clinical practice guideline related to the treatment of anterior cruciate ligament injuries. This literature review informed the decisions relevant to the indications identified by the writing panel when they were available and necessary. The literature review also considered lower quality evidence when the best available evidence (i.e. randomized control trials) did not contain information relevant to the clinical scenarios.

AAOS published the Clinical Practice Guideline on the Treatment of Anterior Cruciate Ligament injuries on September 5<sup>th</sup>, 2014.

## **DETERMINING APPROPRIATENESS VOTING PANEL**

A multidisciplinary panel of clinicians was assembled to determine the appropriateness of treatments for anterior cruciate ligament injuries. Two non-voting moderators, who are orthopaedic surgeons but are not specialists in the treatment of anterior cruciate ligament injuries, moderated the voting panel. The moderators were familiar with the methods and procedures of AAOS Appropriate Use Criteria and led the panel (as non-voters) in discussions. Additionally, no member of the voting panel was involved in the development (writing panel) or independent review (review panel) of the scenarios.

The voting panel used a modified Delphi procedure to determine appropriateness ratings. The voting panel participated in two rounds of voting while considering evidence-based information provided in the literature review. While cost is often a relevant consideration, panelists focused their appropriateness ratings on the effectiveness of treatment for anterior cruciate ligament injuries.

## **RATING APPROPRIATENESS**

When rating the appropriateness of a scenario, the voting panel considered the following definition:

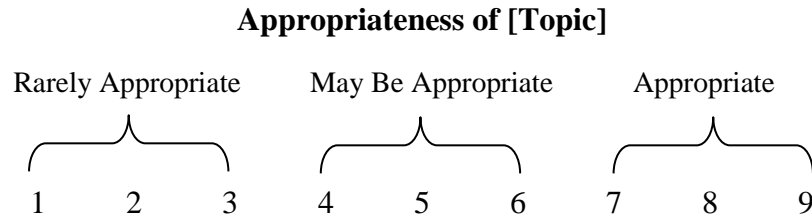
“An appropriate treatment for anterior cruciate ligament injuries is one for which the treatment **is** generally acceptable, **is** a reasonable approach for the indication, and **is** likely to improve the patient’s health outcomes or survival.”

They then rated each scenario using their best clinical judgment, taking into consideration the available evidence, for an average patient presenting to an average physician at an average facility as follows:

**Table 1 Interpreting the 9-Point Appropriateness Scale**

<b>Rating</b>	<b>Explanation</b>
7-9	<b>Appropriate:</b> Appropriate for the indication provided, meaning treatment <b>is</b> generally acceptable and <b>is</b> a reasonable approach for the indication and <b>is</b> likely to improve the patient's health outcomes or survival.
4-6	<b>May Be Appropriate:</b> Uncertain for the indication provided, meaning treatment <b>may</b> be acceptable and <b>may</b> be a reasonable approach for the indication, but with uncertainty implying that more research and/or patient information is needed to further classify the indication.
1-3	<b>Rarely Appropriate:</b> <b>Rarely</b> an appropriate option for management of patients in this population due to the lack of a clear benefit/risk advantage; <b>rarely</b> an effective option for individual care plans; exceptions should have documentation of the clinical reasons for proceeding with this care option (i.e. procedure is not generally acceptable and is not generally reasonable for the indication).

Each panelist uses the scale below to record their response for each scenario:



## ROUND ONE VOTING

The first round of voting occurred after completion of the independent review of the scenarios by the review panel and approval of the final indications, scenarios, and assumptions by the writing panel. The voting panel rated the scenarios electronically using a personalized ballot created by AAOS staff using the AAOS AUC Electronic Ballot Tool. There was no interaction between panel members while completing the first round of voting. Panelists considered the following materials:

- The instructions for rating appropriateness
- The completed literature review, that is appropriately referenced when evidence is available for a scenario
- The list of indications, definitions, and assumptions, to ensure consistency in the interpretation of the clinical scenarios

## **ROUND TWO VOTING**

The second round of voting occurred during the in-person voting panel meeting on April 25, 2015. Before the in-person meeting started, each panelist received a personalized document that included their first round ratings along with summarized results of the first-round ratings that resulted in disagreement. These results indicated the frequency of ratings for a scenario for all panelists. The document contained no identifying information for other panelists' ratings. The moderator also used a document that summarized the results of the panelists' first round voting. These personalized documents served as the basis for discussions of scenarios which resulted in disagreement.

During the discussion, the voting panel members were allowed to record a new rating for any scenarios if they were persuaded to do so by the discussion or the evidence. After the final ratings were submitted, AAOS staff used the AAOS AUC Electronic Ballot Tool to export the median values and level of agreement for all voting items. There was no attempt to obtain consensus among the panel members.

## **FINAL RATINGS**

Using the median value of the second round ratings, AAOS staff determined the final levels of appropriateness. Disagreement among raters can affect the final rating. Agreement and disagreement were determined using the BIOMED definitions of Agreement and Disagreement, as reported in the RAND/UCLA Appropriate Method User's Manual <sup>2</sup>, for a panel of 8-10 voting members (see Table 2 below). For this panel size, disagreement is defined as when  $\geq 3$  members' appropriateness ratings fell within the appropriate (7-9) and rarely appropriate (1-3) ranges for any scenario (i.e.  $\geq 3$  members' ratings fell between 1-3 and  $\geq 5$  members' ratings fell between 7-9 on any given scenario and its treatment). If there is still disagreement in the voting panel ratings after the second round of voting, that voting item is labeled as "5" regardless of median score. Agreement is defined as  $\leq 2$  panelists rated outside of the 3-point range containing the median.

**Table 2 Defining Agreement and Disagreement for Appropriateness Ratings**

Panel Size	<u>Disagreement</u>	<u>Agreement</u>
	Number of panelists rating in each extreme (1-3 and 7-9)	Number of panelists rating outside the 3-point region containing the median (1-3, 4-6, 7-9)
<b>8,9,10</b>	$\geq 3$	$\leq 2$
11,12,13	$\geq 4$	$\leq 3$
14,15,16	$\geq 5$	$\leq 4$

*Adapted from RAM<sup>1</sup>*

The classifications in the table below determined final levels of appropriateness.

**Table 3 Interpreting Final Ratings of Criteria**

Level of Appropriateness	Description
Appropriate	<ul style="list-style-type: none"> <li>Median panel rating between 7-9 and no disagreement</li> </ul>
May Be Appropriate	<ul style="list-style-type: none"> <li>Median panel rating between 4-6 or</li> <li>Median panel rating 1-9 with disagreement</li> </ul>
Rarely Appropriate	<ul style="list-style-type: none"> <li>Median panel rating between 1-3 and no disagreement</li> </ul>

## REVISION PLANS

These criteria represent a cross-sectional view of current use of treatments for anterior cruciate ligament injuries and may become outdated as new evidence becomes available or clinical decision making indicators are improved. In accordance with the standards of the National Guideline Clearinghouse, AAOS will update or withdraw these criteria in five years. AAOS will issue updates in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology.



## **DISSEMINATING APPROPRIATE USE CRITERIA**

Publication of the Appropriate Use Criteria (AUC) document is on the AAOS website at [<http://www.aaos.org/auc>]. This document provides interested readers with full documentation about the development of Appropriate Use Criteria and further details of the criteria ratings.

AUCs are first announced by an Academy press release and then published on the AAOS website. AUC summaries are published in the *AAOS Now* and the Journal of the American Academy of Orthopaedic Surgeons (JAAOS). In addition, the Academy's Annual Meeting showcases the AUCs on Academy Row and at Scientific Exhibits.

The dissemination efforts of AUC include web-based mobile applications, webinars, and online modules for the Orthopaedic Knowledge Online website, radio media tours, and media briefings. In addition AUCs are also promoted in relevant Continuing Medical Education (CME) courses and distributed at the AAOS Resource Center.

Other dissemination efforts outside of the AAOS include submitting AUCs to the National Guideline Clearinghouse and to other medical specialty societies' meetings.

### III. PATIENT INDICATIONS AND TREATMENTS

#### INDICATIONS

**Table 4 Patient Indications and Classifications**

Indication	Classification(s)
<b>Age/Maturity</b>	a) Open Physes b) Closed/Closing Physes <25 years of age c) >25 years of age
<b>Activity Level</b>	a) Participates in cutting/pivoting sport (e.g. “leaping, pivoting, lunging sports, such as, but not limited to: football, soccer, basketball, etc.”) b) Does not participate in cutting/pivoting sport
<b>Presence of Advanced Arthritis</b>	a) Advanced Arthritic Changes (Note: Advanced arthritis only applies to patients over the age of 25) b) Mild to Moderate Arthritic Changes c) No Arthritic Changes
<b>Presence of Reparable Meniscal Tear</b>	a) No b) Yes
<b>Non-Operative Measures</b>	a) Patient did not fail optimal non-operative measures b) Patient failed optimal non-operative measures (e.g. patient has received optimal care and has symptoms of recurrent instability)

## **TREATMENTS**

### **Treatments Addressed Within This AUC**

- 1) Self-directed exercise program
- 2) Supervised Rehabilitation program
- 3) Activity Modification
- 4) ACL Functional Knee Brace

### **The following treatments only apply to scenarios without open physes:**

- 5) ACL Reconstruction –Autograft
- 6) ACL Reconstruction –Allograft.











### **The following treatments only apply to scenarios with open physes:**

- 7) Physeal sparing autograft
- 8) Physeal sparing allograft
- 9) Transphyseal sparing autograft
- 10) Transphyseal sparing allograft

## IV. RESULTS OF APPROPRIATENESS RATINGS

For a user-friendly version of these appropriate use criteria, please access our AUC web-based application at [www.orthoguidelines.org/auc](http://www.orthoguidelines.org/auc).

### Web-Based AUC Application Screenshot

Indication Profile	Procedure Recommendations
<b>Age/Maturity</b>  <ul style="list-style-type: none"> <li><input checked="" type="radio"/> Open Physes</li> <li><input type="radio"/> Closed/Closing Physes &lt;25 years of age</li> <li><input type="radio"/> &gt;25 years of age</li> </ul>	<div>  <b>Supervised Rehabilitation program without reconstruction</b> <span>7</span> </div>
	<div>  <b>Physseal sparing autograft</b> <span>+</span> 7                 </div>
	<div>  <b>Self-directed exercise program without reconstruction</b> <span>4</span> </div>
	<div>  <b>Activity Modification without reconstruction</b> <span>6</span> </div>
	<div>  <b>ACL Functional Knee Brace without reconstruction</b> <span>+</span> 5                 </div>
	<div>  <b>Transphyseal sparing autograft</b> <span>-</span> 5                 </div>
	<div>  <b>Physseal sparing allograft</b> <span>3</span> </div>
	<div>  <b>Transphyseal sparing allograft</b> <span>+</span> 2                 </div>
<div>                     Submit  </div>	

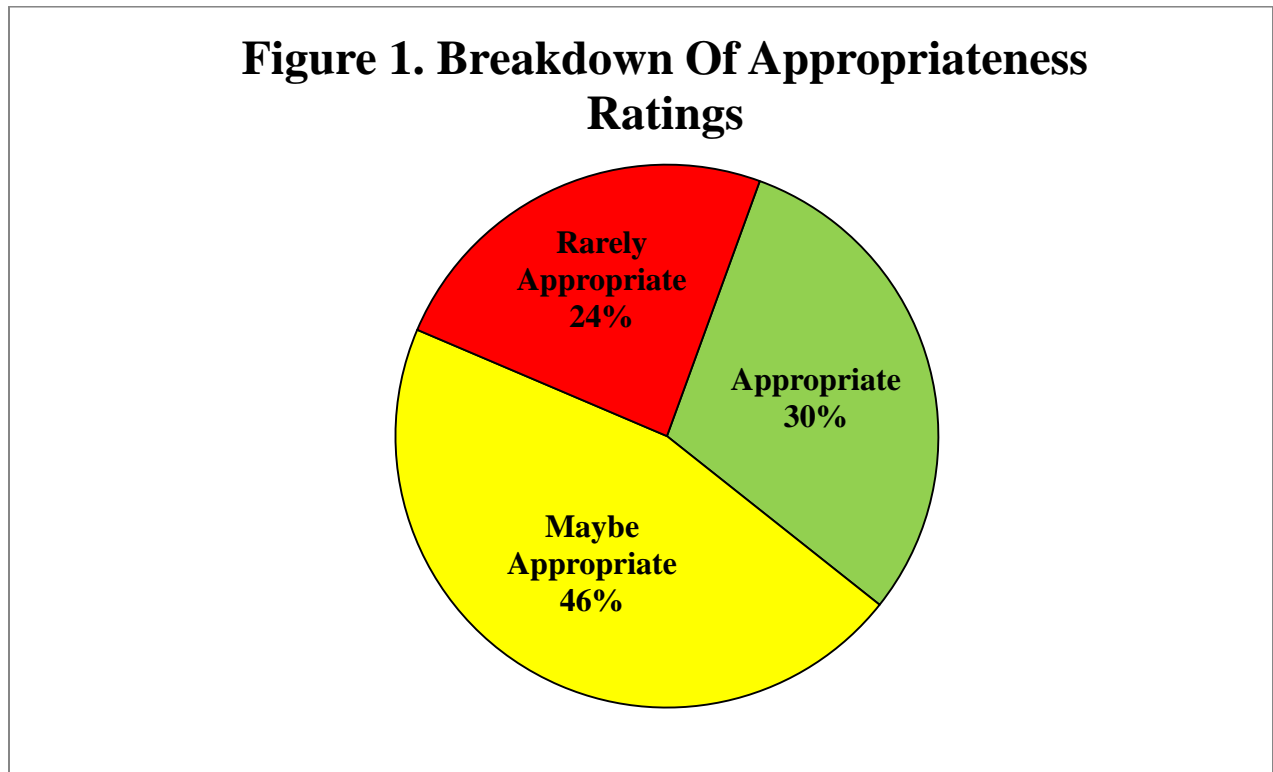
[Click Here to Access the AUC App!](#)

## Results

The following Appropriate Use Criteria tables contain the final appropriateness ratings assigned by the ten members of the voting panel. Patient characteristics are found under the column titled “Scenario”. The Appropriate Use Criteria for each patient scenario can be found within each of the 10 treatment rows. These criteria are formatted by appropriateness labels (i.e. “R”=Rarely Appropriate, “M”=May Be Appropriate, and “A”=Appropriate), median rating, and + or - indicating agreement or disagreement amongst the voting panel, respectively.

Out of 352 total voting items (i.e. 56 patient scenarios x 6 or 8 treatments), 106 (30%) voting items were rated as “Appropriate”, 161 (46%) voting items were rated as “May Be Appropriate”, and 85 (24%) voting items were rated as “Rarely Appropriate” (Figure 1). Additionally, the voting panel members were in agreement on 89 (25%) voting items and were in disagreement on 12 (3%) voting items (Figure 2). For a within treatment breakdown of appropriateness ratings, please refer to Figure 3.

**Figure 1. Breakdown of Appropriateness Ratings**



**Figure 2. Breakdown of Agreement amongst Voting Panel**

**Figure 2. Breakdown of Agreement Ratings**

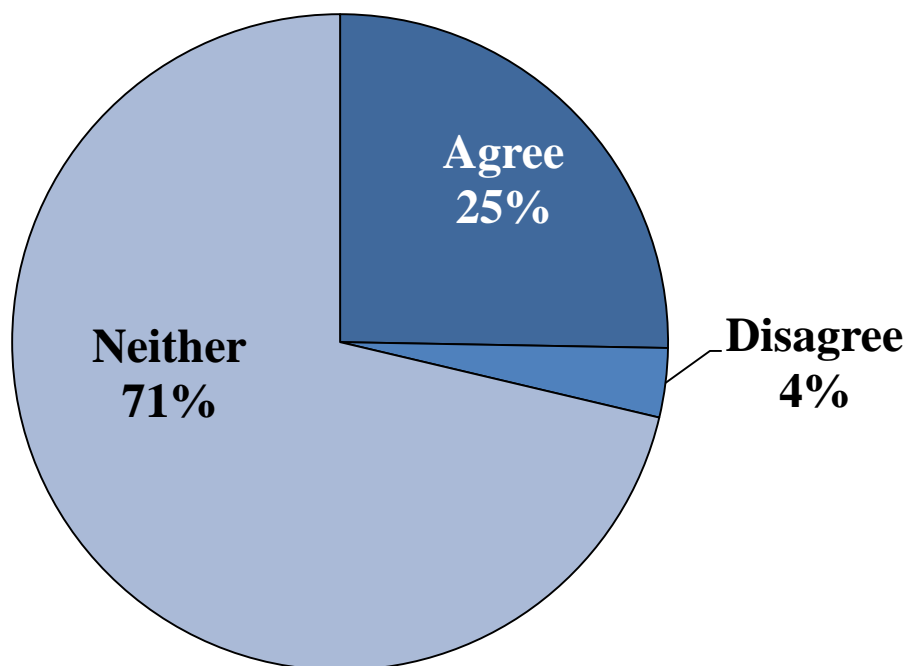


Figure 3. Distribution of Appropriateness Ratings on 9-Point Rating Scale

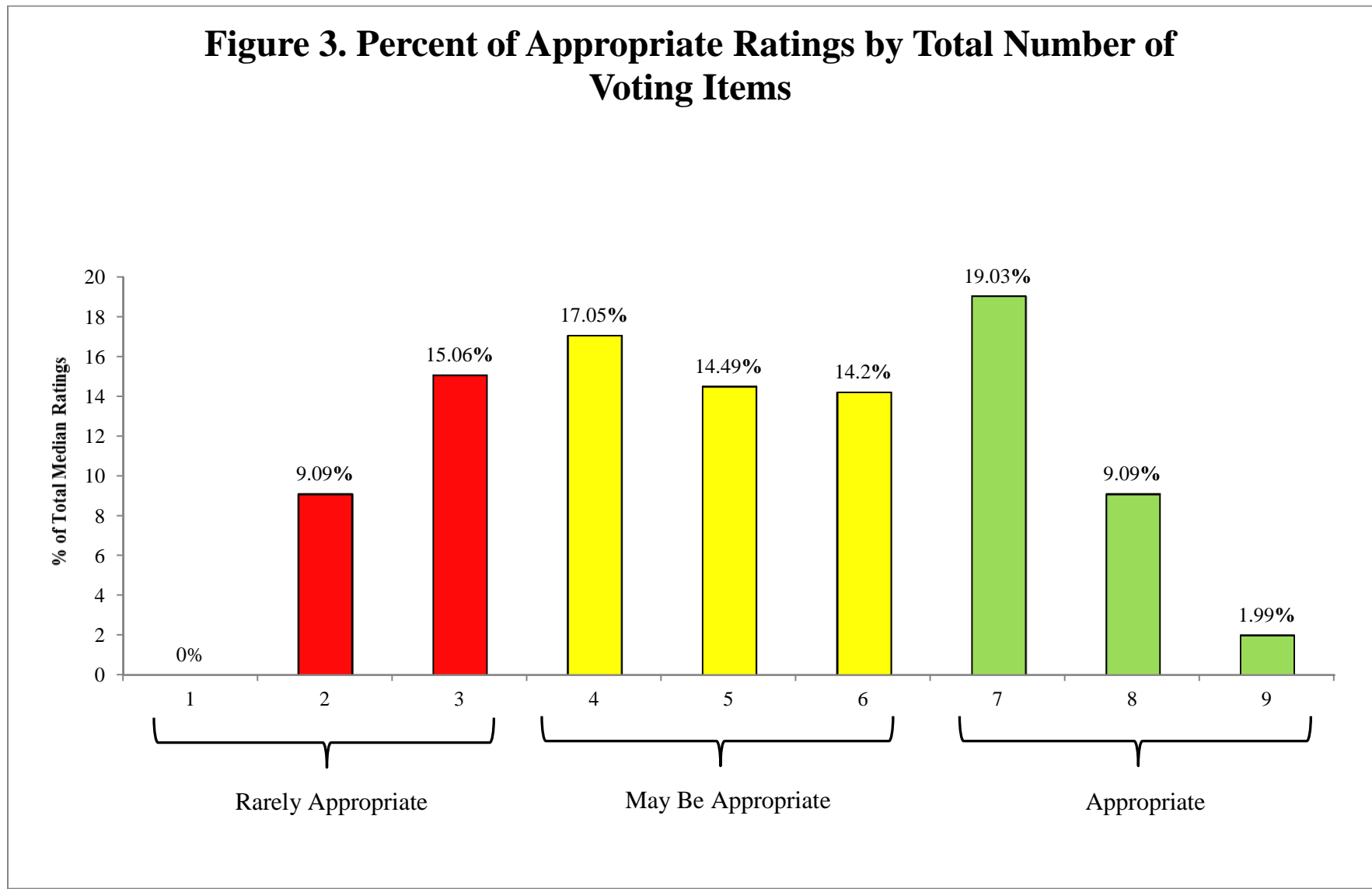
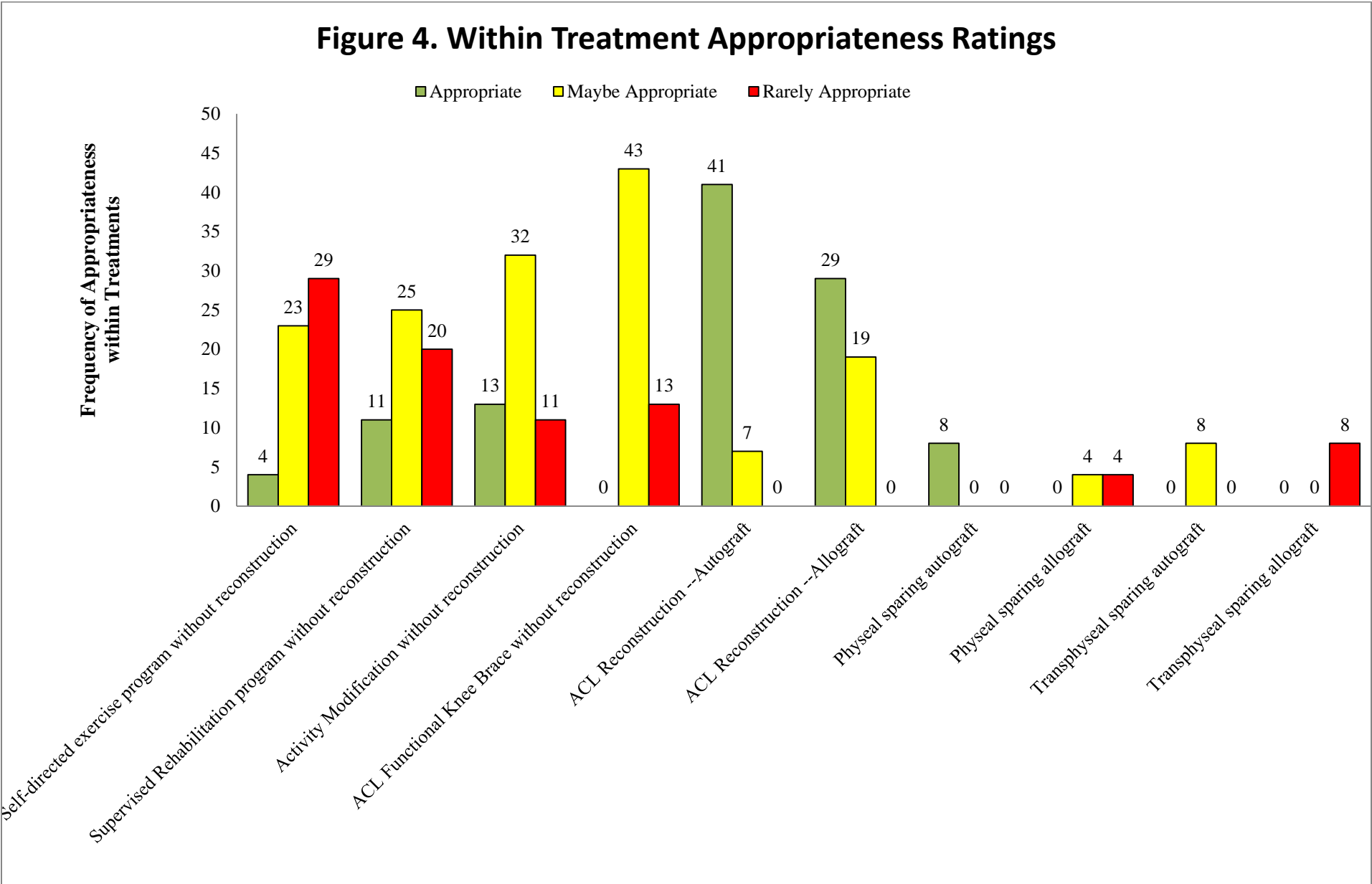


Figure 4. Within Treatment Appropriateness Ratings





## APPROPRIATE USE CRITERIA FOR TREATMENT OF ANTERIOR CRUCIATE LIGAMENT INJURIES

### Interpreting the AUC tables:

- R = Rarely Appropriate, M = May Be Appropriate, A = Appropriate
- Numbers under “Median” column indicate the median rating of voting panel
- A plus symbol (+) indicates agreement between voting panel members and a minus symbol (-) indicates disagreement between voting panel members

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
1	Open Physes, Participates in cutting/pivoting sport, No Arthritic Changes, No Reparable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	4	
		Supervised Rehabilitation program without reconstruction	A	7	
		Activity Modification without reconstruction	M	6	
		ACL Functional Knee Brace without reconstruction	M	5	+
		Physeal sparing autograft	A	7	+
		Physeal sparing allograft	R	3	
		Transphyseal sparing autograft	M	5	-
		Transphyseal sparing allograft	R	2	+
2	Open Physes, Participates in cutting/pivoting sport, No Arthritic Changes, No Reparable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	
		Activity Modification without reconstruction	R	3	
		ACL Functional Knee Brace without	R	3	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		reconstruction			
		Physeal sparing autograft	A	8	+
		Physeal sparing allograft	R	3	
		Transphyseal sparing autograft	M	6	-
		Transphyseal sparing allograft	R	2	+
3	Open Physes, Participates in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	R	3	+
		Supervised Rehabilitation program without reconstruction	R	3	
		Activity Modification without reconstruction	R	3	
		ACL Functional Knee Brace without reconstruction	R	3	
		Physeal sparing autograft	A	8	+
		Physeal sparing allograft	R	3	
		Transphyseal sparing autograft	M	6	-
		Transphyseal sparing allograft	R	2	+
4	Open Physes, Participates in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	2	+
		Activity Modification without reconstruction	R	2	+
		ACL Functional Knee Brace without reconstruction	R	2	+
		Physeal sparing autograft	A	8	+
		Physeal sparing allograft	R	3	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		Transphyseal sparing autograft	M	6	-
		Transphyseal sparing allograft	R	2	+
5	Open Physes, Does not participate in cutting/pivoting sport, No Arthritic Changes, No Reparable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	5	
		Supervised Rehabilitation program without reconstruction	A	7	
		Activity Modification without reconstruction	A	7	
		ACL Functional Knee Brace without reconstruction	M	5	
		Physeal sparing autograft	A	7	+
		Physeal sparing allograft	M	4	
		Transphyseal sparing autograft	M	4	
		Transphyseal sparing allograft	R	2	+
6	Open Physes, Does not participate in cutting/pivoting sport, No Arthritic Changes, No Reparable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	M	4	
		Activity Modification without reconstruction	M	4	
		ACL Functional Knee Brace without reconstruction	R	3	
		Physeal sparing autograft	A	8	+
		Physeal sparing allograft	M	4	
		Transphyseal sparing autograft	M	5	-
		Transphyseal sparing allograft	R	2	
7	Open Physes, Does not participate in cutting/pivoting sport, No	Self-directed exercise	M	5	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
	Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	program without reconstruction			
		Supervised Rehabilitation program without reconstruction	M	6	-
		Activity Modification without reconstruction	M	6	-
		ACL Functional Knee Brace without reconstruction	M	5	
		Physeal sparing autograft	A	7	+
		Physeal sparing allograft	M	4	
		Transphyseal sparing autograft	M	6	
		Transphyseal sparing allograft	R	2	+
8	Open Physes, Does not participate in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	+
		Activity Modification without reconstruction	R	3	+
		ACL Functional Knee Brace without reconstruction	R	3	
		Physeal sparing autograft	A	8	+
		Physeal sparing allograft	M	4	
		Transphyseal sparing autograft	M	5	-
		Transphyseal sparing allograft	R	2	
9	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, Mild to Moderate Arthritic Changes, No Reparable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	6	
		Supervised Rehabilitation program without reconstruction	A	7	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		Activity Modification without reconstruction	M	6	
		ACL Functional Knee Brace without reconstruction	M	5	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	M	5	
10	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, Mild to Moderate Arthritic Changes, No Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	
		Activity Modification without reconstruction	M	4	
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	9	+
		ACL Reconstruction -- Allograft	A	7	
11	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, Mild to Moderate Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	4	
		Supervised Rehabilitation program without reconstruction	M	6	
		Activity Modification without reconstruction	M	5	
		ACL Functional Knee Brace without reconstruction	M	5	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction --	A	7	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		Allograft			
12	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, Mild to Moderate Arthritic Changes, Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	2	+
		Activity Modification without reconstruction	R	3	
		ACL Functional Knee Brace without reconstruction	R	3	
		ACL Reconstruction -- Autograft	A	9	+
		ACL Reconstruction -- Allograft	A	7	
13	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, No Arthritic Changes, No Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	5	
		Supervised Rehabilitation program without reconstruction	M	5	
		Activity Modification without reconstruction	M	5	
		ACL Functional Knee Brace without reconstruction	M	5	+
		ACL Reconstruction -- Autograft	A	8	
		ACL Reconstruction -- Allograft	M	6	
14	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, No Arthritic Changes, No Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	+
		Activity Modification	R	3	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		without reconstruction			
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	A	7	
15	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	4	
		Supervised Rehabilitation program without reconstruction	M	5	
		Activity Modification without reconstruction	M	5	
		ACL Functional Knee Brace without reconstruction	R	3	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	A	7	
16	Closed/Closing Physes <25 years of age, Participates in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	2	+
		Activity Modification without reconstruction	R	3	
		ACL Functional Knee Brace without reconstruction	R	3	
		ACL Reconstruction -- Autograft	A	9	+
		ACL Reconstruction -- Allograft	A	7	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
17	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, Mild to Moderate Arthritic Changes, No Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	6	
		Supervised Rehabilitation program without reconstruction	M	6	
		Activity Modification without reconstruction	A	7	
		ACL Functional Knee Brace without reconstruction	M	5	
		ACL Reconstruction -- Autograft	A	7	
		ACL Reconstruction -- Allograft	M	6	
18	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, Mild to Moderate Arthritic Changes, No Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	
		Activity Modification without reconstruction	M	4	
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	A	7	
19	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, Mild to Moderate Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	4	
		Supervised Rehabilitation program without reconstruction	M	5	-
		Activity Modification without reconstruction	M	5	



Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	7	+
		ACL Reconstruction -- Allograft	A	7	
20	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, Mild to Moderate Arthritic Changes, Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	2	+
		Supervised Rehabilitation program without reconstruction	R	3	+
		Activity Modification without reconstruction	R	3	+
		ACL Functional Knee Brace without reconstruction	R	3	+
		ACL Reconstruction -- Autograft	A	9	+
		ACL Reconstruction -- Allograft	A	7	
21	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, No Arthritic Changes, No Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	A	7	
		Supervised Rehabilitation program without reconstruction	A	7	
		Activity Modification without reconstruction	A	7	
		ACL Functional Knee Brace without reconstruction	M	5	
		ACL Reconstruction -- Autograft	A	7	
		ACL Reconstruction -- Allograft	M	5	

Scenario Number	Scenario Details	Treatment	Appropriateness	Median Rating	Agreement
22	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, No Arthritic Changes, No Repairable Meniscal Tear, Patient failed optimal non-operative measures	Self-directed exercise program without reconstruction	R	3	+
		Supervised Rehabilitation program without reconstruction	R	3	
		Activity Modification without reconstruction	M	4	
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	A	7	
23	Closed/Closing Physes <25 years of age, Does not participate in cutting/pivoting sport, No Arthritic Changes, Repairable Meniscal Tear, Patient did not fail optimal non-operative measures	Self-directed exercise program without reconstruction	M	5	
		Supervised Rehabilitation program without reconstruction	M	6	
		Activity Modification without reconstruction	M	6	
		ACL Functional Knee Brace without reconstruction	M	4	
		ACL Reconstruction -- Autograft	A	8	+
		ACL Reconstruction -- Allograft	M	6	

## APPENDICES

## **APPENDIX A. DOCUMENTATION OF APPROVAL**

### **AAOS BODIES THAT APPROVED THIS APPROPRIATE USE CRITERIA**

#### **AUC Section: Approved on <DATE>**

The AAOS Appropriate Use Criteria Section of the Committee on Evidence Based Quality and Value consists of six AAOS members. The overall purpose of this Section is to plan, organize, direct, and evaluate initiatives related to Appropriate Use Criteria.

#### **Council on Research and Quality: Approved on <DATE>**

To enhance the mission of the AAOS, the Council on Research and Quality promotes the most ethically and scientifically sound basic, clinical, and translational research possible to ensure the future care for patients with musculoskeletal disorders. The Council also serves as the primary resource to educate its members, the public, and public policy makers regarding evidenced-based medical practice, orthopaedic devices and biologics regulatory pathways and standards development, patient safety, occupational health, technology assessment, and other related areas of importance.

#### **Board of Directors: Approved on <DATE>**

The 16 member AAOS Board of Directors manages the affairs of the AAOS, sets policy, and determines and continually reassesses the Strategic Plan.

## APPENDIX B. DISCLOSURE INFORMATION

### Anterior Cruciate Ligament Injuries Writing Panel

**1. Robert Marx, MD, MSc, FRCSC**

*American Orthopaedic Society of Sports Medicine*

**Robert G Marx, MD:** 7 (Springer; Demos Health); 8 (HSS Journal;; Knee Surgery, Sports Traumatology, Arthroscopy; Journal of Bone and Joint Surgery - American); 9 (International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine); Submitted on: 04/28/2014

**2. Rick Wright, MD**

*American Orthopaedic Society of Sports Medicine*

**Rick W Wright, MD:** 5 (National Institutes of Health (NIAMS & NICHD)); 7 (Wolters Kluwer Health - Lippincott Williams & Wilkins); Submitted on: 05/20/2014

**3. Jeffrey P. Feden, MD, FACEP**

*American College of Emergency Physicians*

**Jeffrey Feden, MD:** (n); Submitted on: 05/22/2014

**4. Brian Pietrosimone PhD, ATC**

*National Academy of Sports Medicine*

**Brian G Pietrosimone, PhD, ATC:** 8 (Journal of Athletic Training; Journal of Sport Rehabilitation); Submitted on: 05/29/2014

**5. Anthony Beutler, MD**

*American Medical Society for Sports Medicine*

**Anthony Beutler, MD:** 7 (Saunders/Mosby-Elsevier); 9 (American Board of Family Medicine; American Medical Society for Sports Medicine (AMSSM)); Submitted on: 06/02/2014

**6. Daniel C. Herman, MD, PhD, CAQSM**

*American Academy of Physical Medicine and Rehabilitation*

**Daniel C Herman, MD, PhD:** 8 (American Journal of Physical Medicine and Rehabilitation; Research in Sports Medicine; Sports Biomechanics); 9 (American Medical Society for Sports Medicine); Submitted on: 06/03/2014

**7. Christopher C. Kaeding MD**

*International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine*

**Christopher C Kaeding, MD:** 3B (Biomet); 9 (AAOS; American Orthopaedic Association; American Orthopaedic Society for Sports Medicine); Submitted on: 04/10/2014

**8. Robert A. Magnussen MD, MPH**

*International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine*

**Robert A Magnussen, MD:** 8 (Orthopaedic Journal of Sports Medicine); 9 (American Orthopaedic Society for Sports Medicine); Submitted on: 02/28/2014

**9. David Anthony Parker MBBS, BMedSci, FRACS**

*International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine*

**David Parker, MD:** 2 (Arthrex, Inc; Smith & Nephew); 8 (SMARTT Journal); 9 (Asia Pacific Knee Arthroscopy and Sports Medicine Society; International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine); Submitted on: 05/24/2014

**10. Elvire Servien MD, PhD, Prof**

*International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine*

**Elvire Servien, MD:** 5 (Synthes); 6 (Tornier); 9 (International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine); Submitted on: 05/27/2014

**11. Peter H. Seidenberg, MD, FAAFP, FACSM**

*American College of Sports Medicine*

**12. Michael Khazzam, MD**

*American Academy of Orthopaedic Surgeons*

**Michael S Khazzam, MD:** 2 (Arthrex, Inc); Submitted on: 04/06/2014

**13. William G. DeLong Jr., MD**

*American College of Surgeons*

**William G DeLong, Jr MD:** 3B (Aesculap/B.Braun,IlluminOss,; Novacart); 9 (AAOS; American College of Surgeons; Orthopaedic Trauma Association); Submitted on: 03/05/2014

**Anterior Cruciate Ligament Injuries Voting Panel**

**1. Moira Davenport, MD**

*American College of Emergency Physicians*

American College of Emergency Physicians: Board or committee member; iSTAT: Research support; Society for Academic Emergency Medicine: Board or committee member. Submitted on: 12/10/2014

**2. Anna L. Waterbrook, MD, FACEP**

*American College of Emergency Physicians*

(This individual reported nothing to disclose); Submitted on: 11/19/2014

**3. Cynthia R. LaBella, MD**

*American Medical Society for Sports Medicine*

American Academy of Pediatrics: Board or committee member; Publishing royalties, financial or material support. Submitted on: 10/27/2014

**4. Neeru Jayanthi, MD**

*American Medical Society for Sports Medicine*

American Medical Society for Sports Medicine: Board or committee member; Journal of Medicine and Science in Tennis: Editorial or governing board; Society for Tennis and Medicine Science: Board or committee member; Up To Date: Publishing royalties, financial or material support. Submitted on: 12/12/2014

**5. T David Hayes, MD**

*The Knee Society*

(This individual reported nothing to disclose); Submitted on: 11/19/2014

**6. Steven B. Singleton, MD**

*Arthroscopy Association of North America*

(This individual reported nothing to disclose); Submitted on: 12/02/2014

**7. Bradley J. Nelson, MD**

*American Orthopaedic Society for Sports Medicine*

AAOS: Board or committee member; American Orthopaedic Society for Sports Medicine: Board or committee member; DePuy, A Johnson & Johnson Company: Research support; Histogenics: Research support; Omeros: Research support; Zimmer: Research support. Submitted on: 04/05/2015

**8. Douglas W. Lundy, MD**

*American College of Surgeons*

AAOS: Board or committee member; American Board of Orthopaedic Surgery, Inc.: Board or committee member; American College of Surgeons: Board or committee member; American Orthopaedic Association: Board or committee member; Clinical Orthopaedics and Related Research: Editorial or governing board; Journal of Orthopaedic Trauma: Editorial or governing board; Journal of the Southern Medical Association: Editorial or governing board; Orthopaedic Trauma Association: Board or committee member; Orthopedics: Editorial or governing board; Synthes: Paid consultant. Submitted on: 05/08/2015

**9. Kevin R. Vincent, MD, PhD**

*American Academy of Physical Medicine and Rehabilitation*

(This individual reported nothing to disclose); Submitted on: 08/13/2013

**10. Sandra J. Shultz, PhD**

*National Athletic Trainers' Association*

Human Kinetics: Publishing royalties, financial or material support; Journal of Athletic Training: Editorial or governing board; Journal of Sports Health: Editorial or governing board; Medicine and Science in Sport and Exercise: Editorial or governing board. Submitted on: 01/07/2015

## **Moderators:**

### **James O Sanders, MD**

AAOS: Board or committee member; Abbott: Stock or stock Options; Abbvie: Stock or stock Options;  
GE Healthcare: Stock or stock Options;  
Hospira: Stock or stock Options; Pediatric Orthopaedic Society of North America: Board or committee member;  
Scoliosis Research Society: Board or committee member. Submitted on: 04/25/2015

### **Gregory A. Brown, MD, PhD**

AAOS: Board or committee member; ASTM: Board or committee member;  
International Standards Organization: Board or committee member; KareMetrix LLC: Stock or stock Options;  
Orthopaedic Solutions LLC: Stock or stock Options; Smith & Nephew: Paid presenter or speaker; Research support.  
Submitted on: 04/07/2015

(n) = Respondent answered 'No' to all items indicating no conflicts.

1= Royalties from a company or supplier; 2= Speakers bureau/paid presentations for a company or supplier; 3A= Paid employee for a company or supplier; 3B= Paid consultant for a company or supplier; 3C= Unpaid consultant for a company or supplier; 4= Stock or stock options in a company or supplier; 5= Research support from a company or supplier as a PI; 6= Other financial or material support from a company or supplier; 7= Royalties, financial or material support from publishers; 8= Medical/Orthopaedic publications editorial/governing board; 9= Board member/committee appointments for a society.



## APPENDIX C. REFERENCES

- (1) American Academy of Orthopaedic Surgeons. The Burden of Musculoskeletal Diseases in the United States. American Academy of Orthopaedic Surgeons; 2008.
- (2) Fitch K, Bernstein SJ, Aguilar MD et al. *The RAND/UCLA Appropriateness Method User's Manual*. Santa Monica, CA: RAND Corporation; 2001.
- (3) Ahldén, M., Samuelsson, K., Sernert, N., Forssblad, M., Karlsson, J., Kartus, J. The Swedish National Anterior Cruciate Ligament Register: a report on baseline variables and outcomes of surgery for almost 18,000 patients. *Am J Sports Med*. 2012 October; 40(10): 2230–2235. Published online 2012 September 7.  
doi: 10.1177/0363546512457348