APPROPRIATE USE CRITERIA FOR THE MANAGEMENT OF PEDIATRIC SUPRACONDYLAR HUMERUS FRACTURES WITH VASCULAR INJURY

Adopted by the American Academy of Orthopaedic Surgeons Board of Directors

6/12/15

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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The American Academy of Orthopaedic Surgeons exclusively funded development of these Appropriate Use Criteria. The American Academy of Orthopaedic Surgeons received no funding from outside commercial sources to support the development of these Appropriate Use Criteria.

FDA Clearance
Some drugs or medical devices referenced or described in this document may not have been cleared by the Food and Drug Administration (FDA) or may have been cleared for a specific use only. The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or device he or she wishes to use in clinical practice.

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For a user-friendly version of this AUC, please visit the AAOS OrthoGuidelines Web-Based App at:
http://www.orthoguidelines.org/auc/

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I. INTRODUCTION

OVERVIEW

The American Academy of Orthopaedic Surgeons (AAOS) has developed this Appropriate Use Criteria (AUC) to assist clinicians in determining the appropriate management of pediatric supracondylar humerus fractures with vascular injury. An "appropriate" healthcare service is one for which the expected health benefits exceed the expected negative consequences by a sufficiently wide margin.[2] 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 2011 AAOS Clinical Practice Guideline on Treatment of Pediatric Supracondylar Humerus Fractures, which can be accessed via the AAOS OrthoGuidelines web-based application: www.orthoguidelines.org

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).[2] 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, it is highly recommended that you visit the AUC application found via the "Appropriate Use Criteria" tab on the OrthoGuidelines web-based application: www.orthoguidelines.org/auc/

These criteria should not be construed as including all indications or excluding indications reasonably directed to obtaining the same results. These criteria intend to address the most common clinical scenarios facing all appropriately trained surgeons and all qualified physicians managing patients under consideration for managing pediatric supracondylar humerus fractures. 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

BEFORE THESE APPROPRIATE USE CRITERIA ARE CONSULTED, IT IS ASSUMED THAT:

1. A child who presents with a dysvascular limb is triaged in a timely and appropriate manner to a facility capable of handling these issues after an attempt to reposition or reduce the fracture into a more acceptable position to improve vascular status. A formal vascular consult or vascular study should not delay the child undergoing attempted repositioning or reduction of the fracture.
2. In the clinical setting of a SCH fracture presenting with nonpalpable radial pulse in the ED, a qualified clinician may give consideration to reposition the elbow in slight flexion and reassess whether the pulse returns.
3. Regardless of return of pulse (or lack thereof) after repositioning of elbow, the patient should be admitted to the hospital for timely reduction/fixation and observation.
4. In the scenario of a pulseless extremity, transfer of the patient to another facility should be considered if no qualified vascular or microvascular surgeon is available at that institution.
5. When patient undergoes vascular consultation, consultation should be performed by vascular surgeon, pediatric general surgeon, or a qualified surgeon with specialized microvascular or vascular training.

CONDITIONS NOT COVERED IN THIS AUC

- Lateral and medial humeral condylar fractures
- Capitellar fractures
- Any fracture where all the fracture lines are completely above the flare of metaphysis (i.e. diaphyseal humerus fractures)
- Treatment of concomitant injuries accompanying supracondylar fracture, although the influence of these injuries on treatment of the PSHF will be considered.
- Adult pattern distal humerus fractures

II. METHODS

This AUC is based on a review of the available literature regarding treatment of pediatric supracondylar humerus fractures 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)[2]. This section also includes the activities and compositions of the various panels that developed, defined, reviewed, and voted on the criteria.

Three panels participated in the development of this AUC (see list on page i). Members of the writing panel developed a list of six patient scenarios and 18 possible management options for patients with postoperative vascular injuries after surgical treatment of pediatric supracondylar humerus fractures. The review panel reviewed these scenarios and treatments independently to ensure that they were representative of patients and scenarios clinicians are likely to encounter. The voting panel provided minor edits to the patient scenarios and treatments and 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 the 18 treatments for the six 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. A teleconference was held with the voting panel members, during which they 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 for approximately two weeks following the teleconference. 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 Committee on Evidence Based Quality and Value, the AAOS Council on Research and Quality, and the AAOS Board of Directors sequentially approved the Appropriate Use Criteria for Management of Pediatric Supracondylar Humerus Fractures with Vascular Injury. AAOS will submit 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 writing panel, who are orthopaedic specialists in treating pediatric supracondylar humerus fractures, developed clinical scenarios using the following guiding principles:

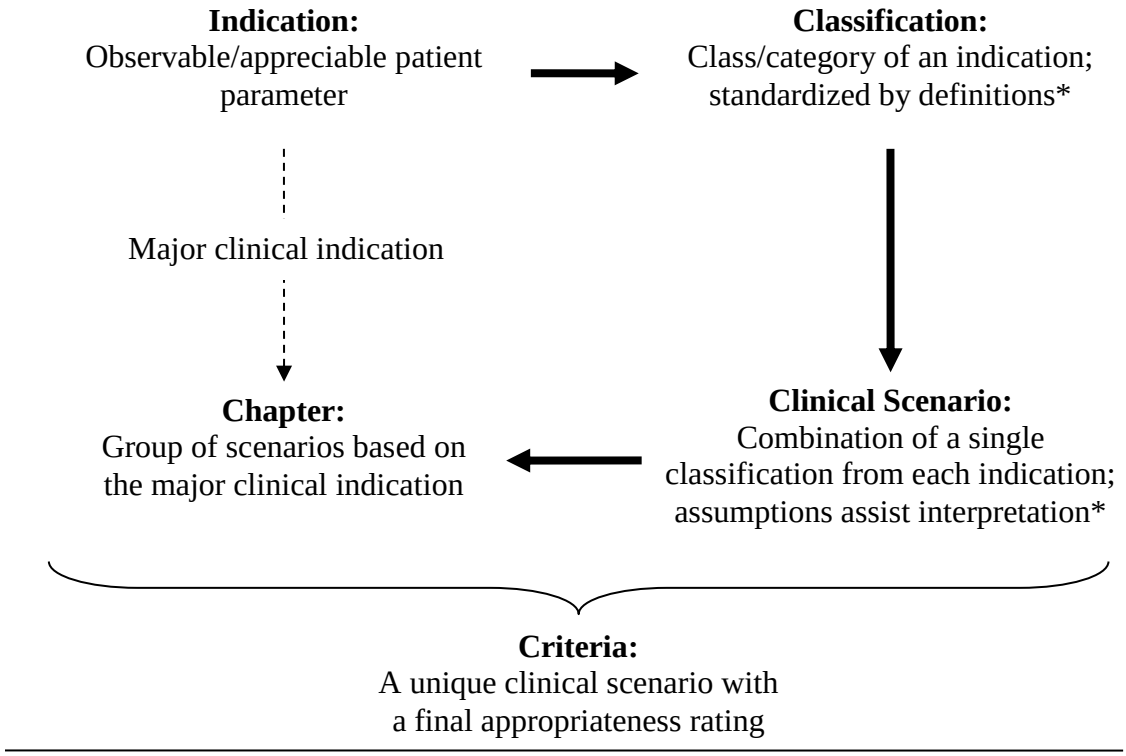
- Patient scenarios must include a broad spectrum of patients that may be eligible for treatment of pediatric supracondylar humerus fractures *[comprehensive]*
- Patient indications must classify patients into a unique scenario *[mutually exclusive]*
- Patient indications must consistently classify similar 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 vascular injuries after surgical treatment of pediatric supracondylar humerus fractures 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 Pediatric Supracondylar Humerus Fractures 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: degree of perfusion and the presence of concomitant median, radial, ulnar, and/or nerve palsy (Table 4).

CREATING DEFINITIONS AND ASSUMPTIONS

The AUC writing panel constructed concise and explicit definitions for the indications and classifications. This standardization helped ensure the way that the writing panel defined degree of perfusion and the presence of concomitant median, radial, ulnar, and/or nerve palsy 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.[1]

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) Redefined the vascular status sub-indications to read:

    a) Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds) *without* palpable distal pulse

    b) Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) *without* palpable distal pulse

c) Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) *with* palpable distal pulse

LITERATURE REVIEW

The limited literature base for this AUC is the AAOS Clinical Practice Guideline on the Treatment of Pediatric Supracondylar Humerus Fractures which can be accessed via the AAOS OrthoGuidelines web-based application: www.orthoguidelines.org.

REVIEWING SCENARIOS

After the writing panel developed the scenarios, the AUC for Management of Pediatric Supracondylar Humerus Fractures review panel reviewed the proposed chapters in order to ensure that they were representative of patients and scenarios clinicians are likely to encounter. The review panel was comprised of both orthopaedic surgeons who routinely perform treatments for pediatric supracondylar humerus fractures and other specialties that may refer patients with pediatric supracondylar humerus fractures to a specialist. No member of this panel participated in the writing panel's initial development of the scenarios or participated in the voting panel's appropriateness rating of the scenarios.

Review panel members considered the lists of scenarios, definitions, assumptions, and the literature review associated with each scenario. Each independent reviewer suggested potential modifications to the content or structure of the lists and literature review. The writing panel provided the final determination of modifications to the indications, scenarios, assumptions, and literature review that would be included in the materials sent to the voting panel.

DETERMINING APPROPRIATENESS

VOTING PANEL

A multidisciplinary panel of clinicians was assembled to determine the appropriateness of treatments for pediatric supracondylar humerus fractures. This group consisted of approximately 50% specialists and 50% non-specialists. Two non-voting moderators, who are orthopaedic surgeons, facilitated 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 pediatric supracondylar humerus fractures.

RATING APPROPRIATENESS

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

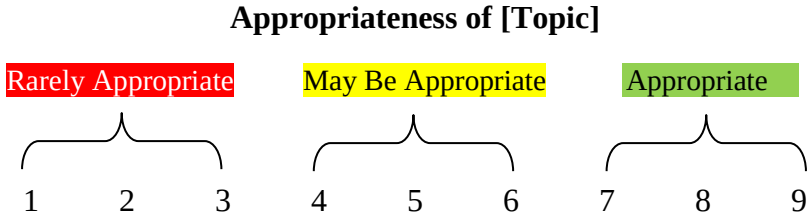
"An appropriate treatment for pediatric supracondylar humerus fractures is one for which the treatment **is** generally acceptable, **is** a reasonable approach for the indication, and **is** likely to improve the patient's health outcomes or survival."

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

Rating	Explanation
7-9	**Appropriate**: Appropriate for the indication provided, meaning treatment **is** generally acceptable and **is** a reasonable approach for the indication and **is** likely to improve the patient's health outcomes or survival.
4-6	**May Be Appropriate**: Uncertain for the indication provided, meaning treatment **may** be acceptable and **may** 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	**Rarely Appropriate**: **Rarely** an appropriate option for management of patients in this population due to the lack of a clear benefit/risk advantage; **rarely** 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 after the teleconference voting panel discussion on February 5, 2015. Before the teleconference discussion 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. These 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. Additionally, voting panel members were allowed to submit any amended ratings (i.e. second round ratings) for two weeks after the in-person meeting. 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 [2], for a panel of 14-16 voting members (see Table 2 below). For this panel size, disagreement is defined as when ≥ 5 members' appropriateness ratings fell within the appropriate (7-9) and rarely appropriate (1-3) ranges for any scenario (i.e. ≥ 5 members' ratings fell between 1-3 and ≥ 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 ≤ 4 panelists rated outside of the 3-point range containing the median.

Table 2 Defining Agreement and Disagreement for Appropriateness Ratings

Panel Size	Disagreement Number of panelists rating in each extreme (1-3 and 7-9)	Agreement Number of panelists rating outside the 3-point region containing the median (1-3, 4-6, 7-9)
8, 9, 10	≥ 3	≤ 2
11, 12, 13	≥ 4	≤ 3
14, 15, 16	≥ 5	≤ 4

Adapted from RAM [1]

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

Table 3 Interpreting Final Ratings of Criteria

Level of Appropriateness	Description
Appropriate	• Median panel rating between 7-9 and no disagreement
May Be Appropriate	• Median panel rating between 4-6 or • Median panel rating 1-9 with disagreement
Rarely Appropriate	• Median panel rating between 1-3 and no disagreement

REVISION PLANS

These criteria represent a cross-sectional view of current use of treatments for pediatric supracondylar humerus fractures 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

The results of this AUC can be accessed via a user-friendly app by visiting the OrthoGuidelines web-based application: http://www.orthoguidelines.org/ auc/

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, 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 SCENARIOS AND TREATMENTS

PATIENT SCENARIOS

Table 4. Patient Scenarios

1. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse

2. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse

3. Patients with a suspected vascular injury after closed reduction and pinning, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)

4. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse

5. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse

6. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)

TREATMENTS

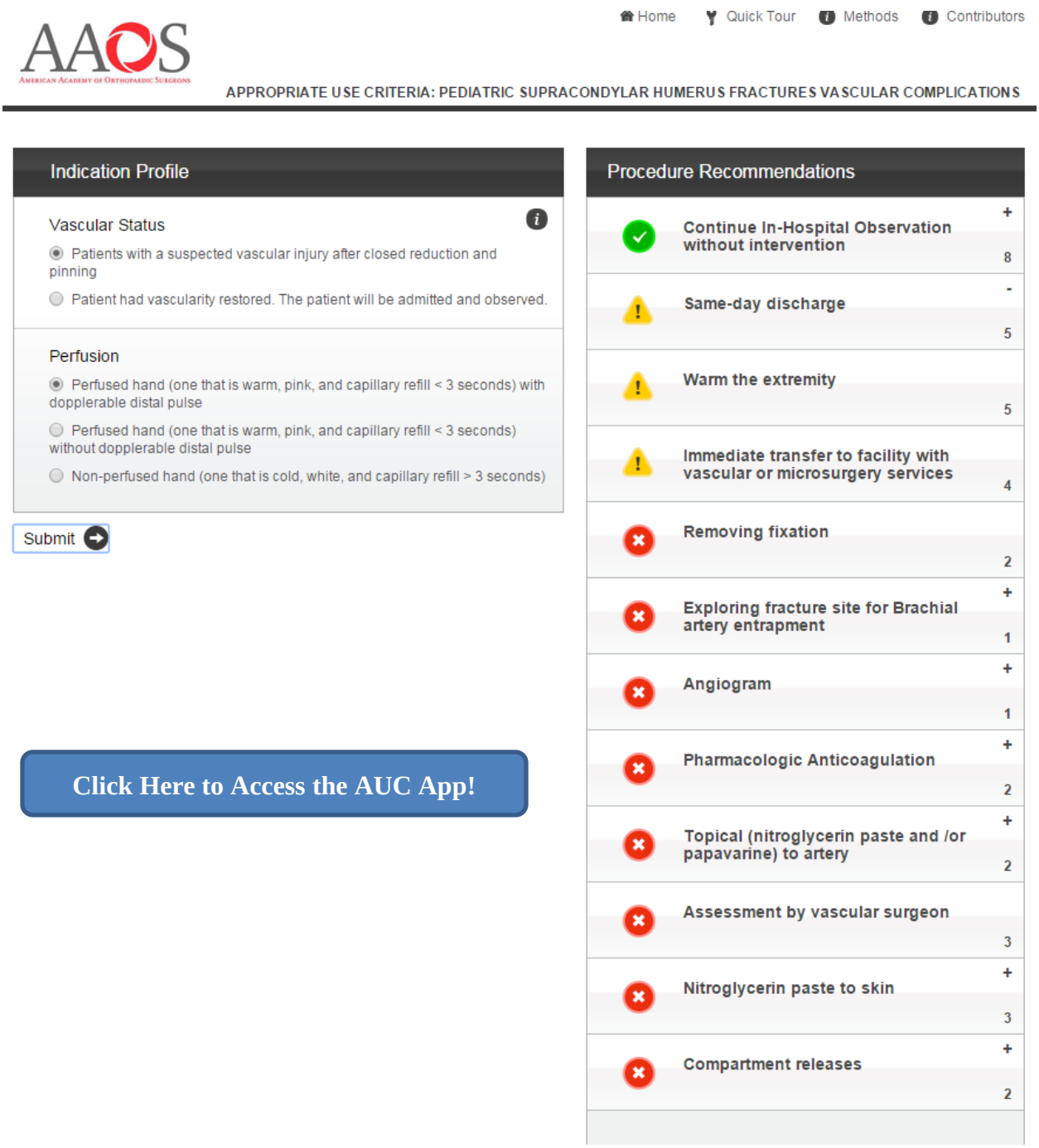
Table 5. Management Options/Treatments Addressed Within This AUC

1. **Same-day discharge** (only an option prior to vascular restoration)
2. **Continue in-hospital observation without intervention** (only an option prior to vascular restoration)
3. **Warm the extremity**
4. **Removing fixation** (only an option prior to vascular restoration)
5. **Exploring fracture site for Brachial artery entrapment** (only an option prior to vascular restoration)
6. **Angiogram**
7. **Pharmacologic Anticoagulation**
8. **Topical (nitroglycerin paste and /or Papavarine) to artery** (only an option prior to vascular restoration)
9. **Assessment by vascular surgeon**
10. **Nitroglycerin paste to skin**
11. **Immediate transfer to facility with vascular or microsurgery services**
12. **Compartment releases** (only an option prior to vascular restoration)
13. **Same-day discharge with observation less than 24 hours** (only an option after vascularity is restored)
14. **Continue In-Hospital Observation for more than 24 hours without intervention** (only an option after vascularity is restored)
15. **Measure compartment pressures** (only an option after vascularity is restored)
16. **Return to OR to perform compartment releases** (only an option after vascularity is restored)
17. **Return to OR for exploration of brachial artery for possible arterial reconstruction or arteriotomy** (only an option after vascularity is restored)
18. **Return to OR for topical (nitroglycerin paste and/or Papavarine) to artery** (only an option after vascularity is restored)

IV. RESULTS OF APPROPRIATENESS RATINGS

For a user-friendly version of these appropriate use criteria and the supporting literature review findings, please access our AUC web-based application at: **www.orthoguidelines.org/auc/**

Web-Based AUC Application Screenshot



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 18 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 72 total voting items, 19 (26%) voting items were rated as "Appropriate", 22 (31%) voting items were rated as "May Be Appropriate", and 31 (43%) voting items were rated as "Rarely Appropriate" (Figure 1). Additionally, the voting panel members were in agreement on 27 (38%) voting items and were in disagreement on 2 (3%) voting items (Figure 2).

Figure 1. Breakdown of Appropriateness Ratings

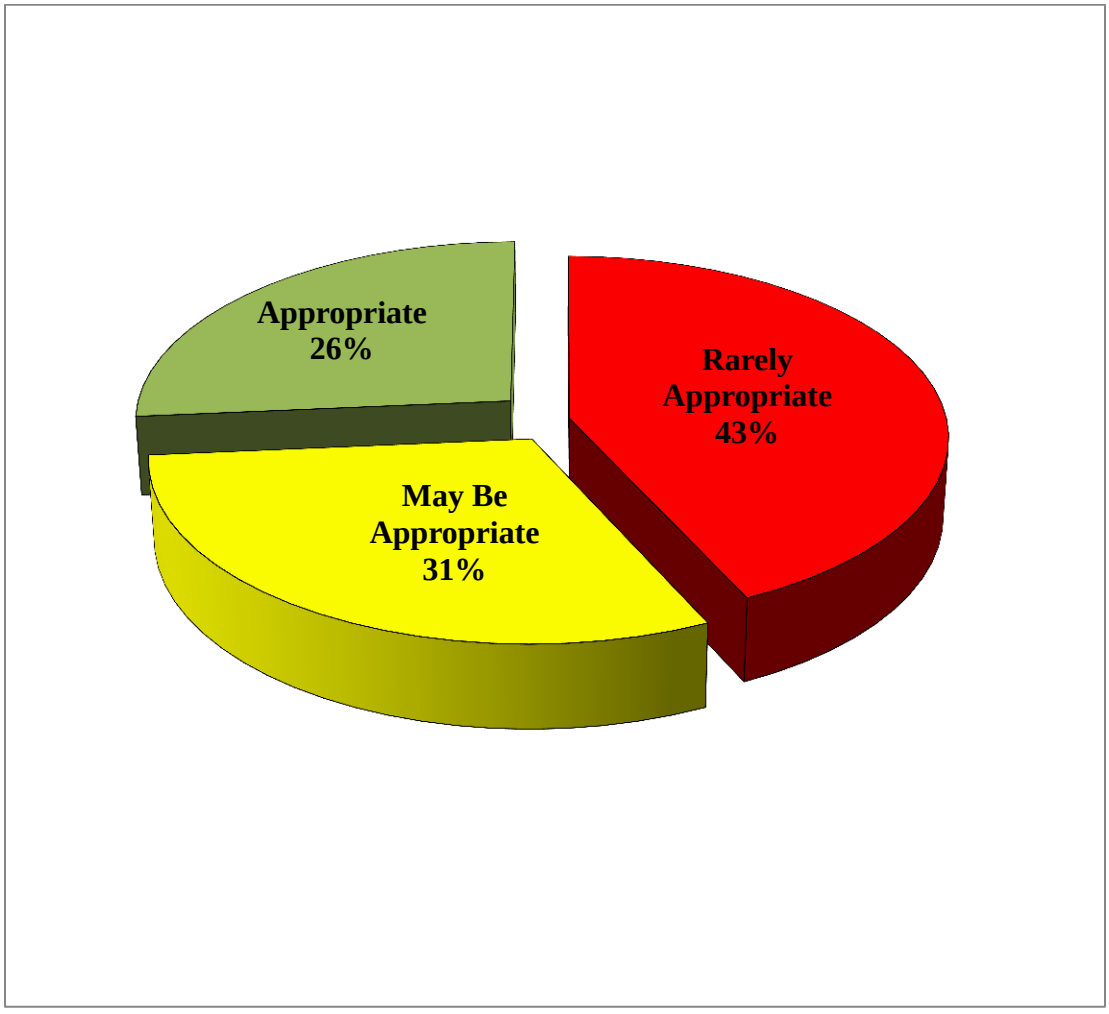


Figure 2. Breakdown of Agreement amongst Voting Panel

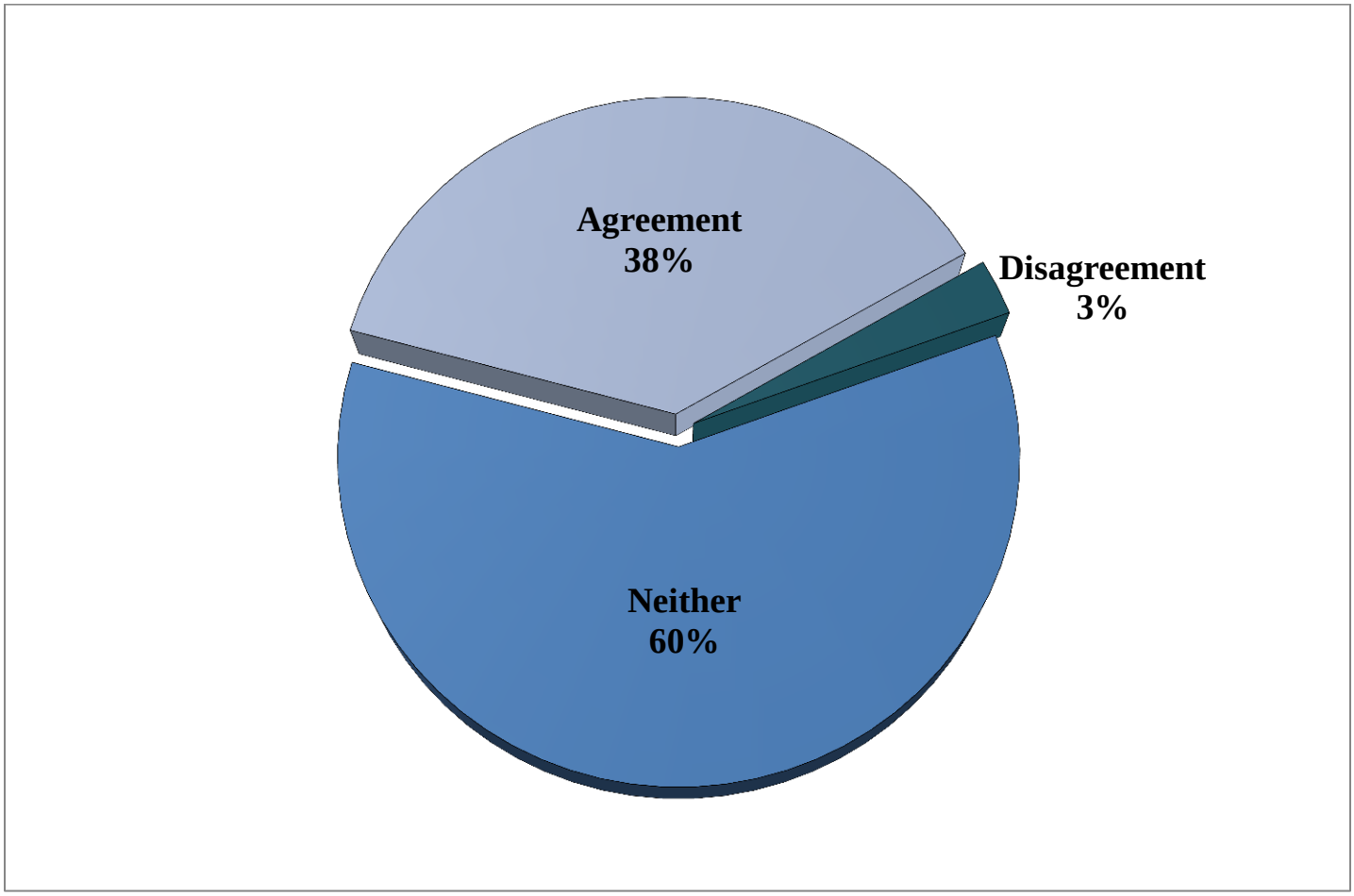
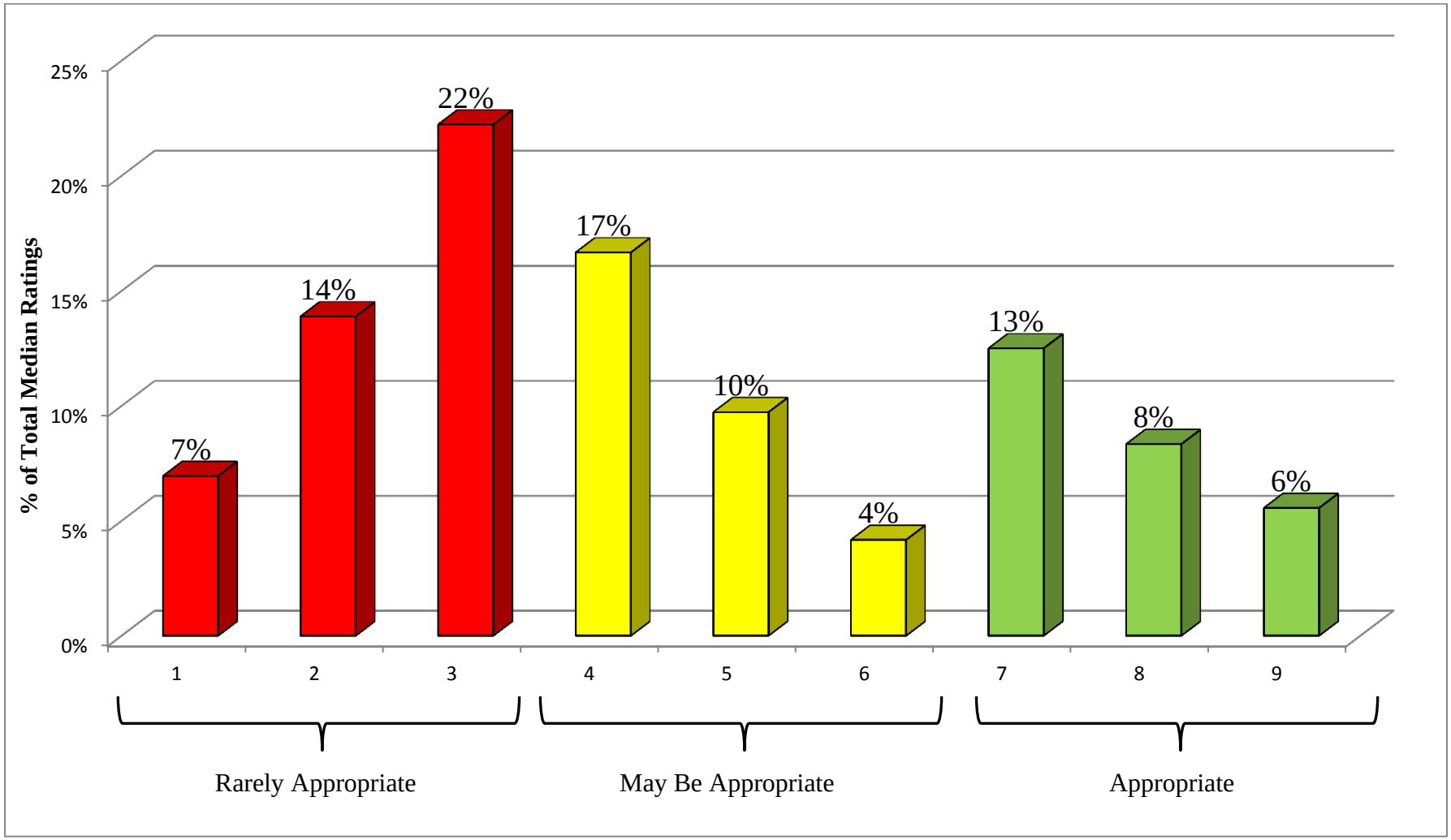


Figure 3. Distribution of Appropriateness Ratings on 9-Point Rating Scale



Appropriate Use Criteria for Management of Pediatric Supracondylar Humerus Fractures with Vascular Injury

Interpreting the AUC tables:

- R = Rarely Appropriate, M = May Be Appropriate, A = Appropriate
- Numbers beside appropriateness 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

#	Treatment Options	1. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse	2. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse	3. Patients with a suspected vascular injury after closed reduction and pinning, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)	4. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse	5. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse	6. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)
1	**Same-day discharge**	M;5 (-)	R;2	R;1			
2	**Continue In-Hospital Observation without intervention**	A;8 (+)	A;8 (+)	R;1 (+)			
3	**Warm the extremity**	M;5	A;7	R;3	M;5 (-)	M;4	R;1 (+)
4	**Removing fixation**	R;2	M;4	A;7			
5	**Exploring fracture site for Brachial artery entrapment**	R;1 (+)	M;4	M;4			
6	**Angiogram**	R;1 (+)	M;4	A;8 (+)	A;7	A;8 (+)	R;2 (+)
7	**Pharmacologic Anticoagulation**	R;2 (+)	R;3 (+)	M;4	M;5	A;7	R;3
8	**Topical (nitroglycerin paste and /or papavarine) to artery**	R;2 (+)	R;3	M;5			
9	**Assessment by vascular surgeon**	R;3	A;7	A;9 (+)	A;7	A;8 (+)	A;9 (+)
10	**Nitroglycerin paste to**	R;3 (+)	R;3	M;4	R;3 (+)	R;3	M;5

#	Treatment Options	1. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse	2. Patients with a suspected vascular injury after closed reduction and pinning, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse	3. Patients with a suspected vascular injury after closed reduction and pinning, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)	4. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) with dopplerable distal pulse	5. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Perfused hand (one that is warm, pink, and capillary refill < 3 seconds) without dopplerable distal pulse	6. Patient had vascularity restored. The patient will be admitted and observed, During observation time, Non-perfused hand (one that is cold, white, and capillary refill > 3 seconds)
	skin						
11	**Immediate transfer to facility with vascular or microsurgery services**	M;4	A;7	A;9 (+)	R;3	R;3	M;4
12	**Compartment releases**	R;2 (+)	R;2 (+)	M;6			
13	**Same-day discharge with observation less than 24 hours**				R;2 (+)	R;3	R;3
14	**Continue In-Hospital Observation for more than 24 hours without intervention**				M;4	A;7	A;9 (+)
15	**Measure compartment pressures**				M;4	M;5	A;7
16	**Return to OR to perform compartment releases**				R;3	M;4	M;6
17	**Return to OR for exploration of brachial artery for possible arterial reconstruction or arteriotomy**				R;2 (+)	R;3	A;8 (+)
18	**Return to OR for topical (nitroglycerin paste and/or papavarine) to artery**				R;2 (+)	R;3 (+)	M;6

APPENDICES

APPENDIX A. DOCUMENTATION OF APPROVAL

AAOS BODIES THAT APPROVED THIS APPROPRIATE USE CRITERIA

Committee on Evidence Based Quality and Value: Approved on <DATE>
The AAOS Committee on Evidence Based Quality and Value consists of six AAOS members. The overall purpose of this committee is to plan, organize, direct, and evaluate AAOS quality initiatives.

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

Writing Panel

Fizan Abdullah, MD, PhD: (n); Submitted on: 07/03/2013

Matthew Halsey, MD: 9 (Scoliosis Research Society); Submitted on: 04/02/2014

Christine Ho, MD: (n); Submitted on: 04/02/2014

David Leu, MD: 2 (Baxter); 3B (Baxter); 9 (Baltimore City Medical Society); Submitted on: 08/06/2014

COL(R) Kathleen A McHale, MD, MSEd, FACS: 9 (AAOS); Submitted on: 04/01/2014

Kevin McHorse, PT, SCS, Cert. MDT: 9 (Sports Section of APTA); Submitted on: 08/07/2014

James F Mooney III, MD: 5 (Synthes); 8 (JSOA; Pediatric Radiology); 9 (Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 04/02/2014

Kishore Mulpuri, MD: 5 (DePuy, A Johnson & Johnson Company); 9 (Canadian Orthopaedic Association; International Hip Dysplasia Institute; Pediatric Orthopaedic Society of North America); Submitted on: 05/29/2014

David Nelson, MD: (n); Submitted on: 08/06/2014

Matthew Oetgen, MD: 3B (Medtronic); 9 (AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 04/01/2014

Larry L Pack, MD: 9 (Board of Directors of the Michigan Orthopaedic Society); Submitted on: 08/06/2014

Laurel H Saliman, MD: (n); Submitted on: 07/03/2013

John M. Stephenson, MD: 9 (American Society for Surgery of the Hand); Submitted on: 04/01/2014

Yi-Meng (Beng) Yen, MD, PhD, FAAP: 3A (Agios Pharmaceuticals); 3B (Smith & Nephew; Orthopediatrics; Arthrex, Inc); 4 (Agios Pharmaceuticals); Submitted on: 05/02/2014

Review Panel

Donald S Bae, MD: 4 (DTRX; Johnson & Johnson; VVUS); 7 (Lippincott Williams & Wilkins); 9 (ASSH; POSNA); Submitted on: 04/09/2014

Holly J Benjamin, MD: 9 (American Academy of Pediatrics; American College of Sports Medicine; American Medical Society for Sports Medicine; ICAAP); Submitted on: 01/30/2014

Dale Blasier, MD: 2 (Synthes); 9 (AAOS; North American Spine Society; Scoliosis Research Society); Submitted on: 04/10/2014

Patrick Bosch, MD: 5 (Haemonetics); 9 (Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 08/07/2014

Gregory John Della Rocca, MD, PhD, FACS: 2 (Synthes); 3B (LifeNet Health; Intellectual Ventures; Synthes; Bioventus); 4 (Amedica; The Orthopaedic Implant Company; MergeNet); 5 (Wound Care Technologies; Eli Lilly; Sonoma Orthopaedics); 8 (Geriatric Orthopaedic Surgery and Rehabilitation; Journal of Bone and Joint Surgery - American; Journal of Orthopaedic Trauma; Journal of the American Academy of Orthopaedic Surgeons); 9 (AAOS; Orthopaedic Trauma Association; American College of Surgeons); Submitted on: 04/01/2014

EricEdmonds, MD: 2 (Arthrex, Inc; Orthopediatrics); 5 (Inion); 9 (AAOS; American Orthopaedic Society for Sports Medicine; Pediatric Orthopaedic Society of North America); Submitted on: 04/16/2014

Hilton Gottschalk, MD: 3A (Biogen Idec); 4 (Biogen Idec); 8 (Biogen Idec); Submitted on: 04/01/2014

DanielGreen, MD, MS: 1 (Pega Medical); 2 (Arthrex, Inc); 7 (Current Opinion in Pediatrics); 8 (Current Opinion in Pediatrics; Current Opinion in Pediatrics); 9 (AAOS; AAOS; New York County Medical Society; new york state society of orthopedic surgeons; Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 04/28/2014

Sumit Gupta, MD, FRCSC: (n); Submitted on: 04/01/2014

James Hanley, III, MD: (n); Submitted on: 01/28/2014

Daniel Hely, MD: (n); Submitted on: 01/12/2014

Stephanie Holmes, MD: (n); Submitted on: 04/01/2014

Pooya Hosseinzadeh, MD: (n); Submitted on: 04/02/2014

Charles J Hyman, MD: (n); Submitted on: 02/24/2014

Mark T Kraus, MD: (n); Submitted on: 01/17/2014

Walter Krengel III, MD: 4 (Amgen Co; Bristol-Myers Squibb; Edwards Life Sciences; GNC; HCA; MAKO; TIva Pharmaceuiticals; Vertex); 8 (Evidence Based Spine Journal (Ad Hoc Reveiwer),CLinical Journal of Pain (Ad Hoc Reviewer),CORR(Ad Hoc Reviewer)); Submitted on: 08/06/2014

Kevin J Little, MD: 9 (American Association for Hand Surgery); Submitted on: 04/01/2014

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John Lovejoy III, MD: 9 (Pediatric Orthopaedic Society of North America); Submitted on: 01/28/2014

Douglas Lundy, MD: 4 (Livengood Engineering); 8 (Clinical Orthopaedics and Related Research; Journal of Orthopaedic Trauma; Journal of the Southern Medical Association; Orthopedics); 9 (AAOS; American Board of Orthopaedic Surgery, Inc.; American College of Surgeons; Georgia Orthopaedic Society; Orthopaedic Trauma Association); Submitted on: 05/17/2014

Stephen A Mendelson, MD: (n); Submitted on: 08/07/2014

Joshua Murphy, MD: (n); Submitted on: 04/01/2014

Sara Rasmussen, MD, PhD: (n); Submitted on: 02/17/2014

Jeff E Schunk, MD: No disclosure available

Richard M Schwend, MD: 2 (Medtronic); 9 (Pediatric Orthopaedic Society of North America,American Academy of Pediatrics, Project Perfect World, Miracle Feet); Submitted on: 06/16/2014

Mauricio Silva, MD: 9 (World Federation of Hemophilia); Submitted on: 08/09/2014

Vikas Trivedi,MBBS, MS (Ortho), MD, DNB (Ortho), MNAMS (Ortho), **FASIF :** (n); Submitted on: 08/07/2014

Voting Panel

Teresa Cappello, MD: (n); Submitted on: 04/08/2014

Robert Boyd Carrigan, MD: 3A (GlaxoSmithKline); 4 (GlaxoSmithKline); Submitted on: 01/27/2014

Prasad V Gourineni, MD: 4 (G2Healthcare); Submitted on: 04/01/2014

William L Hennrikus Jr, MD: 9 (Pediatric Orthopaedic Society of North America; Society of Military Orthopaedic Surgeons); Submitted on: 04/01/2014

Danielle Katz, MD: 4 (Procter & Gamble); 9 (American College of Surgeons); Submitted on: 01/26/2014

Annalise Noelle Larson, MD: 9 (Scoliosis Research Society); Submitted on: 04/01/2014

Kevin H Latz, MD: 9 (Pediatric Orthopaedic Society of North America); Submitted on: 04/12/2014

William M Mirenda, MD: (n); Submitted on: 06/10/2014

Norman Yoshinobu Otsuka, MD: 3C (Medsonics); 8 (American Journal of Orthopedics; Journal of Children's Orthopaedics; Journal of Orthopaedic Surgical Advances; Journal of Pediatric Orthopedics, Part B); 9 (AAOS; American Academy of Pediatrics; American College of Surgeons; Bone and Joint Decade, U.S.A.; Pediatric Orthopaedic Society of North America; Pediatric Orthopaedic Society of North America); Submitted on: 04/08/2014

Min Jung Park, MD, MSc: (n); Submitted on: 04/01/2014

Moderators:

Michael H Heggeness, MD: 1 (K2M; Relievant Medsystems); 4 (Relievant medsystems.); 8 (Spine; The Spine Journal Deputy Editor); 9 (North American Spine Society); Submitted on: 10/02/2013

James O Sanders, MD 4 (Abbott; Abbvie; GE Healthcare; Hospira); 8 (Journal of Pediatric Orthopedics); 9 (AAOS; Pediatric Orthopaedic Society of North America; Scoliosis Research Society); Submitted on: 04/01/2014

(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.