

Management of Developmental Dysplasia of the Hip in Infants up to Six Months of Age – Intended for Use by General Pediatricians and Referring Physicians

Appropriate Use Criteria

Adopted by:

The American Academy of Orthopaedic Surgeons Board of Directors
March 5, 2018

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.

Funding Source

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FDA Clearance

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For a more user-friendly version of this AUC, or to view additional AUCs, please visit the AAOS AUC web-based app at:

www.OrthoGuidelines.org/auc

To view the clinical practice guideline for this topic, please visit <http://www.orthoguidelines.org/topic?id=1016>

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Writing Panel

- 1. Pablo Castaneda, MD**
Pediatric Orthopaedic Society of North America
- 2. Brian Shaw, MD**
Pediatric Orthopaedic Society of North America
- 3. Eduardo Novais, MD**
American Academy of Orthopaedic Surgeons
- 4. Ted Whitten, BA, RDMS, RVT, FSDMS**
Society of Diagnostic Medical Sonography
- 5. Hamad Ghazle, EDD, RDMS**
Society of Diagnostic Medical Sonography
- 6. Sarah Bixby, MD**
Society for Pediatric Radiology
- 7. Jie Chen Nguyen, MD, MS**
Society for Pediatric Radiology
- 8. Amisha J Shah, MD**
Society for Pediatric Radiology

- 9. Kishore Mulpuri, MD**
American Academy of Orthopaedic Surgeons
- 10. Cynthia N Baker, MD, FAAP**
American Academy of Pediatrics
- 11. Joseph A. Janicki, MD, MS, FAAP**
American Academy of Pediatrics
- 12. John P. Lubicky, MD, FAAP**
American Academy of Pediatrics
- 13. Harriet Paltiel, MD, FAIUM**
American Institute of Ultrasound in Medicine
- 14. Lynn Fordham, MD, FACR, FAIUM**
American Institute of Ultrasound in Medicine
- 15. Boaz Karmazyn, MD**
American College of Radiology
- 16. Sarah Milla, MD**
American College of Radiology
- 17. Shannon Dowler, MD, FAAFP**
American Academy of Family Physicians

Voting Panel

- 1. Sheryl Goss, MS, RT(R)(S), RDMS, RDCS, RVT, FSDMS**
Society of Diagnostic Medical Sonography
- 2. Nabile M. Safdar, MD, MPH**
American College of Radiology
- 3. Randall T. Loder, MD**
Pediatric Orthopaedic Society of North America
- 4. Vineeta Swaroop, MD**
Pediatric Orthopaedic Society of North America
- 5. Jennifer Lim-Dunham, MD**
American Institute of Ultrasound in Medicine
- 6. Lee Segal, MD, FAAP**
American Academy of Pediatrics
- 7. Vidyadhar Upasani, MD**
*American Academy of Orthopaedic Surgeons/
Pediatric Orthopaedic Society of North America*
- 8. Alfred A. Mansour, III, MD**
American Academy of Orthopaedic Surgeons
- 9. Travis Matheney, MD**
American Academy of Orthopaedic Surgeons
- 10. Stephanie Holmes, MD**
American Academy of Orthopaedic Surgeons
- 11. Keith Bachmann, MD**
American Academy of Orthopaedic Surgeons
- 12. Paul D. Choi, MD**
American Academy of Orthopaedic Surgeons

Voting Panel Round Two Discussion Moderator

Julie B. Samora, MD, PhD, MPH

Chair, AAOS Committee on Evidence-Based Quality and Value

Kevin Shea, MD

Chair, AAOS Council on Research and Quality

Robert H. Quinn, MD

AAOS Staff

William O. Shaffer, MD
Medical Director

Deborah S. Cummins, PhD
Director, Department of Research and Scientific Affairs

Jayson Murray, MA
Senior Manager, Quality and Value

Ryan Pezold, MA
Manager, Quality and Value Development

Kaitlyn Sevarino, MBA
Manager, Quality and Value Implementation

Peter Shores, MPH
Statistician, Evidence-Based Medicine

Anne Woznica, MLS
Medical Librarian

Mary DeMars
Administrative Assistant, Evidence-Based Medicine Unit

I. INTRODUCTION

OVERVIEW

The American Academy of Orthopaedic Surgeons (AAOS) has developed this Appropriate Use Criteria (AUC) to determine appropriateness of various treatments for the Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants up to Six Months of Age (DDH). This AUC is not intended for use for children who have teratologic hip abnormalities or hip abnormalities associated with neuromuscular, genetic, or acquired complex musculoskeletal or developmental abnormalities. These AUCs are intended for use by appropriately trained practitioners involved in the medical evaluation of typically developing children less than 6 months of age. This would include pediatricians, family physicians, qualified mid-level practitioners with appropriate physician oversight, radiologists who perform diagnostic imaging of children, and orthopedic surgeons.

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. To provide the evidence foundation for this AUC, the AAOS Evidence-Based Medicine Unit provided the writing panel and voting panel with the AAOS Clinical Practice Guideline on DDH, which can be accessed via the following link: <http://www.orthoguidelines.org/topic?id=1016>.

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 to assess the appropriateness of a particular treatment. This process includes 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 a 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 or download the OrthoGuidelines app from Google Play or Apple Store.

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 general pediatricians and other qualified physicians managing patients with developmental dysplasia of the hip. 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 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 AUCs are consulted, the user should read through and understand all contents of this document.

BURDEN OF DISEASE

DDH is a spectrum of anatomic abnormalities of the femoral head and acetabulum of the hip joint. There is inconsistent terminology used to describe these abnormalities and a lack of clarity around which recognized abnormalities of the hip in the newborn and early infancy periods are progressive and pathologic versus self-resolving and potentially within a range of normal development. While clinical terms such as “click, clunk, dislocatable, subluxatable, reducible, dysplastic, asymmetric thigh folds, and limited hip abduction” are common in papers related to this topic, no clear or widely accepted clinical definitions exist by which to compare patient populations to each other. In particular, the term “click” has been problematic as it has been used in screening literature as a term describing a range of situations from a normal snapping sensation to a surrogate for clinically detectable hip instability. Similarly, discussion of risk factors for terms such as “foot deformities, talipes, family history, first born, female, and intrauterine crowding/oligohydramnios” have been applied in a retrospective manner without specificity and without consideration of other variables. Imaging criteria are similarly vague. Included papers for this review demonstrated consistency of use of the Graf criteria for grading severity of sonographic hip dysplasia, but consistent radiographic criteria for defining dysplasia or dislocation were lacking.

Early detection and early management of DDH must take into account the early natural history of physiologic hip development. The clinical practice guideline this AUC is based on included a search for articles that defined the natural history of early clinical instability and early hip dysplasia, as determined by either ultrasound or radiograph.

An estimation of the true incidence of the disorder is therefore uncertain. The reported incidence ranges are as high as 1:100 newborns for clinically detectable hip instability, to 1-28:1000 newborns for clinically and/or radiographic hip dislocation that prompted an intervention^{I-1, I-2}. Recent large ultrasound screening studies place the incidence of ultrasound detectable abnormalities leading to intervention at 5-7 percent of all newborns^{I-3, I-5}. In the United States, there were approximately 3,952,940 live births in 2012^{I-6} suggesting a potential impact from 4,000 up to 276,700 newborn children/year in the United States.

The true prevalence of adult hip pathology attributable to DDH is unknown. It is widely believed that DDH is a condition that can lead to impaired function and quality of life for children and adults^{I-2, I-8, I-10} and that detection of this condition in early childhood may allow interventions that can alter this. It is also believed that earlier treatment creates less potential harm to the child than later treatment with the aggregate risk of those harms being less than the risk of impaired function and quality of life of the untreated condition^{I-4, I-11, I-18}.

Current and evolving practice standards call for a musculoskeletal evaluation of all newborn children and demand that practitioners be good stewards of health care resources in making such assessments and decisions for management. These methods may involve both clinical and imaging resources. In clinically normal hips imaging evaluation would be the only viable method to assess for hip problems that could have a potential to evolve into a future pathologic condition with adverse impact upon an individual's quality of life. Population screening using ultrasound has been practiced in Europe^{I-3, I-10, I-19, I-20} and with an uncertain role in North America^{I-1, I-2, I-8}.

NATURAL HISTORY

Published works on the topic of DDH have used inconsistent terminology to describe abnormalities and have not clarified which recognized abnormalities of the hip in the newborn and early infancy are progressive and pathologic versus self-resolving and potentially within a range of normal development. The workgroup that built the clinical practice guideline on this topic, attempted to identify as best as possible the natural history of clinically unstable or ultrasound or radiographically abnormal hips detected in infancy with the natural duration of self-correction. The long-term natural history of DDH appears to be related to the type and severity of the hip abnormality. Mild dysplasia may never manifest clinically or become apparent until adult life, whereas severe dysplasia can present clinically with functional limitations during childhood. Interventions to alter the long-term natural history of DDH have included early bracing and a progressive range of manipulative and surgical options with advancing age of the child^{I-31 to I-43}. The literature review included articles that specifically included information related to the resolution of clinical instability or ultrasound and radiographic hip dysplasia in untreated infants. All of the studies identified indicate that most DDH discovered during the newborn period appear to represent hip laxity and immaturity. Approximately 60 percent to 80 percent of abnormalities identified by physical examination and more than 90 percent identified by ultrasound appear to resolve spontaneously in early infancy raising significant questions about whether or not such hips should be treated with bracing and at what age such treatment should be optimally applied.

ETIOLOGY

The etiology of DDH in typically developing children is unknown. Both genetic and environmental influences appear to play a role in the development of this condition^{I-10, I-21}. Absence of a femoral head from within an acetabulum and alteration of proximal femoral anatomy has been linked to progressive changes of the acetabulum over time^{I-22}. Risk factors for the development of progressive hip abnormality have been reported in observational series.

RISK FACTORS

The terminology used in defining risk factors for the presence of DDH is not precise in the published literature. Hip physical examination findings associated with DDH have semantic challenges, limited knowledge of normal ranges, and knowledge that the examination findings change over time. Case control and observational studies have suggested that “breech positioning at delivery, family history of DDH, limited hip abduction, talipes, female gender, swaddling, large birth size, and first born” have been associated with a higher probability of finding DDH^{I-2, I-8, I-23}.

POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS

Most treatments are associated with known risks. In the case of screening and early intervention programs, potential harms may be related to either over diagnosis with increased rates of further evaluation and treatment that may be unnecessary and to under diagnosis that can lead to a late diagnosis with progression of deformity. Clinician input based upon experience decreases the probability of harms in both scenarios.

Intervention with splintage devices, more frequent visits to providers and increased rates of imaging occur in observational and case control series where the diagnosis of DDH is given^{I-11, I-20, I-25, I-26, I-27, I-28, I-29}. Treatment of all forms for DDH has been associated with varying rates of avascular necrosis that represent a possibility of harm to individual patients.

Observational and case control studies suggest that the management of children who present with DDH at walking age or older have greater risk of being managed by open surgical hip reduction with its attendant risks of avascular necrosis, infection, hip stiffness, and early onset osteoarthritis as an adult^{I-1, I-4, I-8, I-9, I-18, I-30, I-31}. The harms of late diagnosis with no treatment are not established.

II. METHODS

This AUC for DDH 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 RAM². 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 DDH AUC, a writing panel and a voting panel. Members of the writing panel developed a list of 24 patient scenarios for General Pediatricians, with four treatments evaluated for appropriateness. Additional detail on how the writing panel developed the patient scenarios and treatments is below. The voting panel participated in two rounds of voting. During the first round, the voting panel was given approximately two months 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. How the voting panel rates for appropriateness is described in more detailed below. After the first round of voting/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 Sunday, October 22, 2017. During this meeting voting panel members addressed the scenarios/treatments which resulted in disagreement from round one voting. The voting panel members discussed the list of assumptions, patient indications, and treatments to identify areas that needed to be clarified/edited. After the discussion and subsequent changes, the group was asked to rerate their first round ratings during the voting panel meeting, only if they were persuaded to do so by the discussion and available evidence. There was no attempt to obtain consensus about appropriateness.

The AAOS Appropriate Use Criteria Section, the AAOS Council on Research and Quality, and the AAOS Board of Directors sequentially approved the DDH AUC. The 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

Panel members of the DDH AUC developed patient scenarios using the following guiding principles:

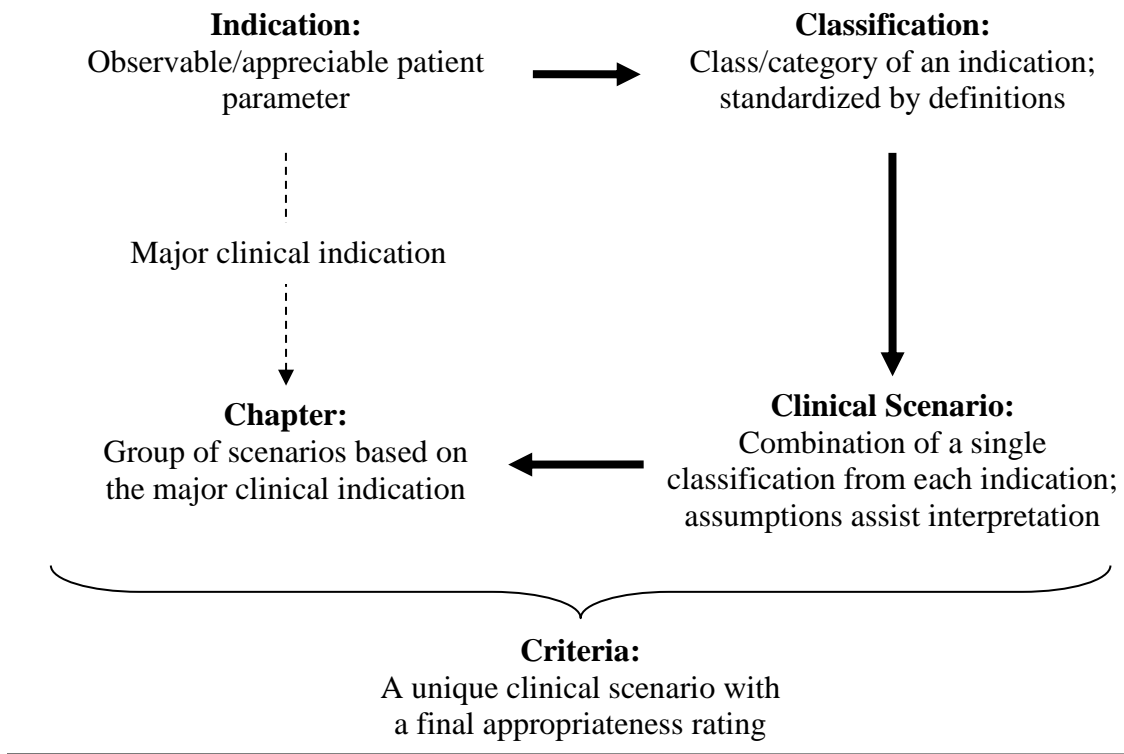
- 1) **Comprehensive** – Covers a wide range of patients.
- 2) **Mutually Exclusive** - There should be no overlap between patient scenarios/indications.
- 3) **Homogenous** –The final ratings should result in equal application within each of the patient scenarios.
- 4) **Manageable** – Number of total voting items (i.e. # of patient scenarios x # of treatments) should be practical for the voting panel. Target number of total voting items = 2000-6000. This means that not all patient indications and treatments can be assessed within one AUC.

The writing panel developed the scenarios by categorizing patients in terms of indications evident during the clinical decision-making process (**Error! Reference source not found.**). 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 pediatric patients commonly presenting with DDH 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 (<http://www.orthoguidelines.org/topic?id=1016>) served as a starting point for the writing panel, as well as ensured that these AUCs referenced the the evidence base for this topic. 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 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, risk factors, and physical exam findings for General Pediatrician.

CREATING DEFINITIONS AND ASSUMPTIONS

The Pediatric DDH AUC writing panel constructed concise and explicit definitions for the indications and classifications. This standardization helps ensure that the way the writing panel defined the patient indications is consistent among those reading the clinical scenario matrix or the final criteria. Definitions create explicit boundaries when possible and are 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. These assumptions differed from definitions in that they identified circumstances that exist outside of the control of the clinical decision-making process. Assumptions also address the use of existing published literature regarding the effectiveness of treatment and/or the procedural skill level of physicians. Assumptions also highlight 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 is 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. The list of definitions and assumptions accompanied the matrix of clinical scenarios in all stages of AUC development and appears in the Writing Panel section of this document.

LITERATURE REVIEW

The Clinical Practice Guideline on Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants up to Six Months of Age, was used as the evidence base for this AUC (see here: <http://www.orthoguidelines.org/topic?id=1016>). This guideline helped to inform the decisions of the writing panel and voting panel where available and necessary.

Direct links to the evidence for the treatments discussed in these AUCs can be found below:

General Pediatricians:

1. Continue routine well-baby exams
 - [Surveillance after Normal Hip Exam](#)
2. Additional screening diagnostic test: age-appropriate ultrasound (age > 4 weeks, unless ordered by orthopaedic specialist at younger age)
 - [Universal Ultrasound Screening](#)
 - [Evaluation of Infants with Risk Factors for DDH](#)
 - [Imaging of the Unstable Hip](#)
 - [Monitoring of Patients during Brace Treatment](#)
3. Additional screening diagnostic test: age-appropriate radiograph (>4 months)
 - [Imaging of the Infant Hip](#)
4. Referral to specialist
 - [Treatment of Clinical Instability](#)

VOTING PANEL MODIFICATIONS TO WRITING PANEL MATERIALS

At the start of the in-person voting panel meeting, the voting panel was reminded that they can amend the original writing panel materials if the amendments resulted in more clinically relevant and practical criteria. To amend the original materials, instructed voting panel 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 amendment/additions to the original AUC materials:

1. Add pop-up/assumption: Breech presentation is felt to be a particularly strong risk factor for DDH even in the face of a normal physical exam. Recommendation is for screening ultrasound at 6 weeks and a single AP pelvis radiograph at 6 months.

DETERMINING APPROPRIATENESS

VOTING PANEL

As mentioned above, a multidisciplinary panel of clinicians was assembled to determine the appropriateness of treatments for the Pediatric DDH AUC. A non-voting moderator, who is an orthopaedic surgeon, but is not a specialist in the treatment of DDH, moderated the voting panel. The moderator was familiar with the methods and procedures of AAOS Appropriate Use Criteria and led the panel (as a non-voter) in discussions. Additionally, no member of the voting panel was involved in the development, i.e. writing 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 treatments for DDH.

RATING APPROPRIATENESS

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

“An appropriate treatment for DDH 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.”

The voting panel 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:

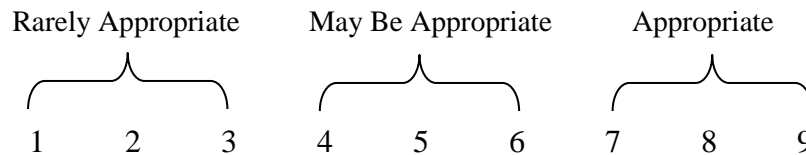
FIGURE 2. INTERPRETING THE 9-POINT APPROPRIATENESS SCALE

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	<p>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).</p>
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Each panelist uses the scale below to record their response for each scenario:

Appropriateness of [Topic]



ROUND ONE VOTING

The first round of voting occurred after approval of the final indications, scenarios, and assumptions by the writing panel. The voting panel rated the scenarios electronically using the AAOS AUC Electronic Ballot Tool, a personalized ballot created by AAOS staff. . There was no interaction between voting 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 October 22, 2017. Prior to the in-person meeting, each voting panelist received a personalized document that included his/her 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 add or edit the assumptions list, patient indications, and/or treatments if clarification was needed. Voting panel members were also able to record a new rating for any scenarios/treatments, if they were persuaded to do so by the discussion and/or the evidence. There was no attempt to obtain consensus among the panel members. 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.

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 11-13 voting members (see Figure 3 below). The 11-13 panel member disagreement cutoff was used for this voting panel. For this panel size, disagreement is defined as when ≥ 4 members’ appropriateness ratings fell within the appropriate (7-9) and rarely appropriate (1-3) ranges for any scenario (i.e. ≥ 4 members’ ratings fell between 1-3 and ≥ 4 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 last round of voting, that voting item is labeled as “5” regardless of median score. Agreement is defined as ≤ 3 panelists rated outside of the 3-point range containing the median.

FIGURE 3. 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)
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.

FIGURE 4. INTERPRETING FINAL RATINGS OF CRITERIA

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

REVISION PLANS

These criteria represent a cross-sectional view of current use of treatments for DDH 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



All AAOS AUCs can be accessed via a user-friendly app that is available via the OrthoGuidelines website (www.orthoguidelines.org/auc) or as a native app via the Apple and Google Play stores.

Publication of the 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

ASSUMPTIONS

1. Double diapering is not an effective treatment of DDH.
2. This AUC addresses typical non-teratogenic/non-syndromic DDH. This addresses DDH in an otherwise healthy, normally developing child.
3. The literature definitions of family history of DDH range from unspecified hip disorders to hip dislocation and from first degree relative (parents and siblings), to any relative (even if distant or vague) with hip problems or DDH.
4. Corrected gestational age: Infant age should be based on corrected gestational age.
5. Skilled and quality ultrasound evaluation should be available.
6. Breech presentation is felt to be a particularly strong risk factor for DDH even in the face of a normal physical exam. Recommendation is for screening ultrasound at 6 weeks and a single AP pelvis radiograph at 6 months.

INDICATIONS - GENERAL PEDIATRICIAN REFERRING PHYSICIAN

FIGURE 5. PATIENT INDICATIONS AND CLASSIFICATIONS

Indication	Classification(s)
Age	<ul style="list-style-type: none"> • Birth – 4 weeks • 4 weeks – 4 months • 4 months – 6 months
Risk Factors	<ul style="list-style-type: none"> • Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability) • No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability)
Physical Exam Findings	<ul style="list-style-type: none"> • Normal Physical Exam Findings • Hip instability • Limited abduction • Limb length discrepancy

TREATMENTS

1. Continue routine well-baby exams
2. Additional screening diagnostic test: age-appropriate ultrasound (age > 4 weeks, unless ordered by orthopaedic specialist at younger age)
3. Additional screening diagnostic test: age-appropriate radiograph (>4 months)
4. Referral to specialist

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. The OrthoGuidelines native app can also be downloaded via the Apple or Google Play stores.

Web-Based AUC Application Screenshot – General Pediatrician Referring Physician

Indication Profile	Procedure Recommendations
<p>Age i</p> <p><input checked="" type="radio"/> Birth – 4 weeks</p> <p><input type="radio"/> 4 weeks – 4 months</p> <p><input type="radio"/> 4 months – 6 months</p>	<p><input checked="" type="checkbox"/> Obtain ultrasound at 4-6 weeks of age, or upon presentation if older than 6 weeks of age + 8</p>
<p>Risk Factors</p> <p><input checked="" type="radio"/> Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability)</p> <p><input type="radio"/> No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability)</p>	<p><input type="checkbox"/> Continue physical exams and obtain single AP pelvis radiograph at 4-6 months of age - 5</p>
<p>Physical Exam Findings</p> <p><input checked="" type="radio"/> Normal Physical Exam Findings</p> <p><input type="radio"/> Hip instability</p> <p><input type="radio"/> Limited abduction</p> <p><input type="radio"/> Limb length discrepancy</p>	<p><input type="checkbox"/> Continue routine well-baby exams only + 2</p>
	<p><input type="checkbox"/> Referral to specialist + 3</p>
<p>Submit ➔</p>	<p>E-mail Results Print ➔</p>

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

Results

The following Appropriate Use Criteria tables contain the final appropriateness ratings assigned by the 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 treatment rows. These criteria are formatted by appropriateness, median rating, and + or - indicating agreement or disagreement amongst the voting panel, respectively.

Out of 96 total voting items, 43 (45%) voting items were rated as “Appropriate”, 10 (10%) voting items were rated as “May Be Appropriate”, and 43 (45%) voting items were rated as “Rarely Appropriate” (Figure 1). Additionally, the voting panel members were in statistical agreement on 76 (79%) voting items and were in statistical disagreement on 4 (4%) voting items (Figure 2).

FIGURE 6. BREAKDOWN OF APPROPRIATENESS RATINGS

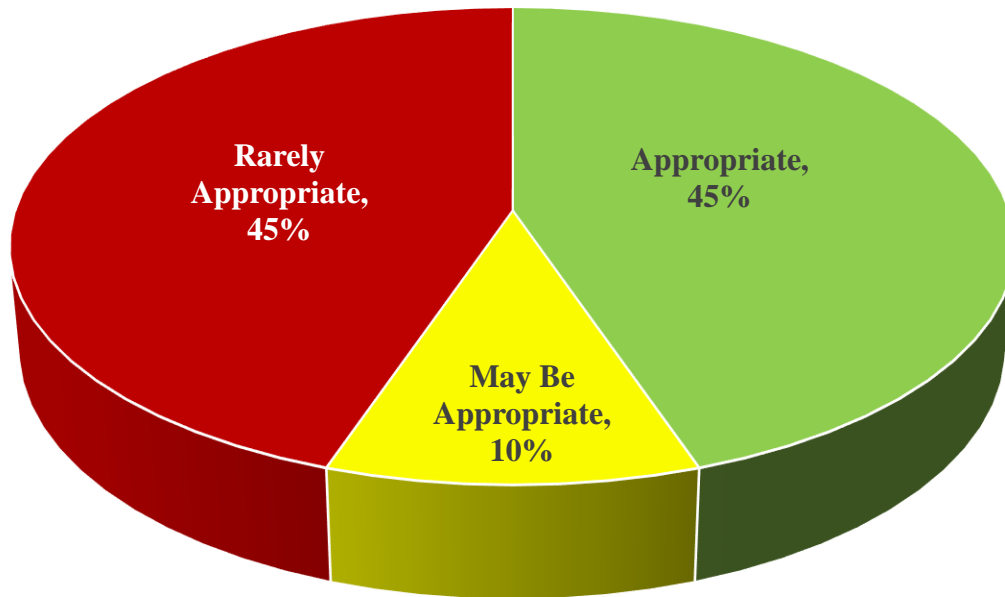


FIGURE 7. BREAKDOWN OF AGREEMENT AMONGST VOTING PANEL

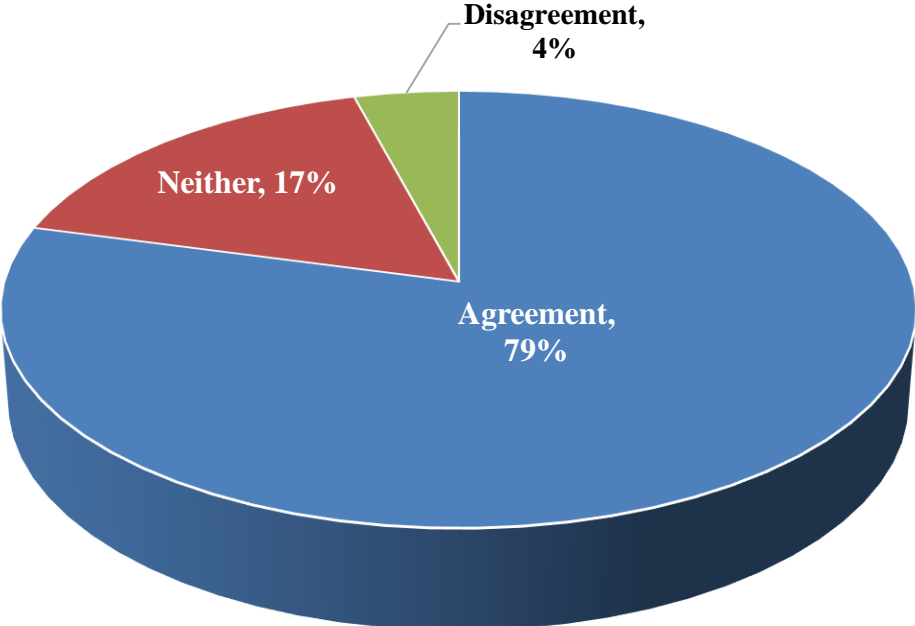


FIGURE 8. DISTRIBUTION OF APPROPRIATENESS RATINGS ON 9-POINT RATING SCALE

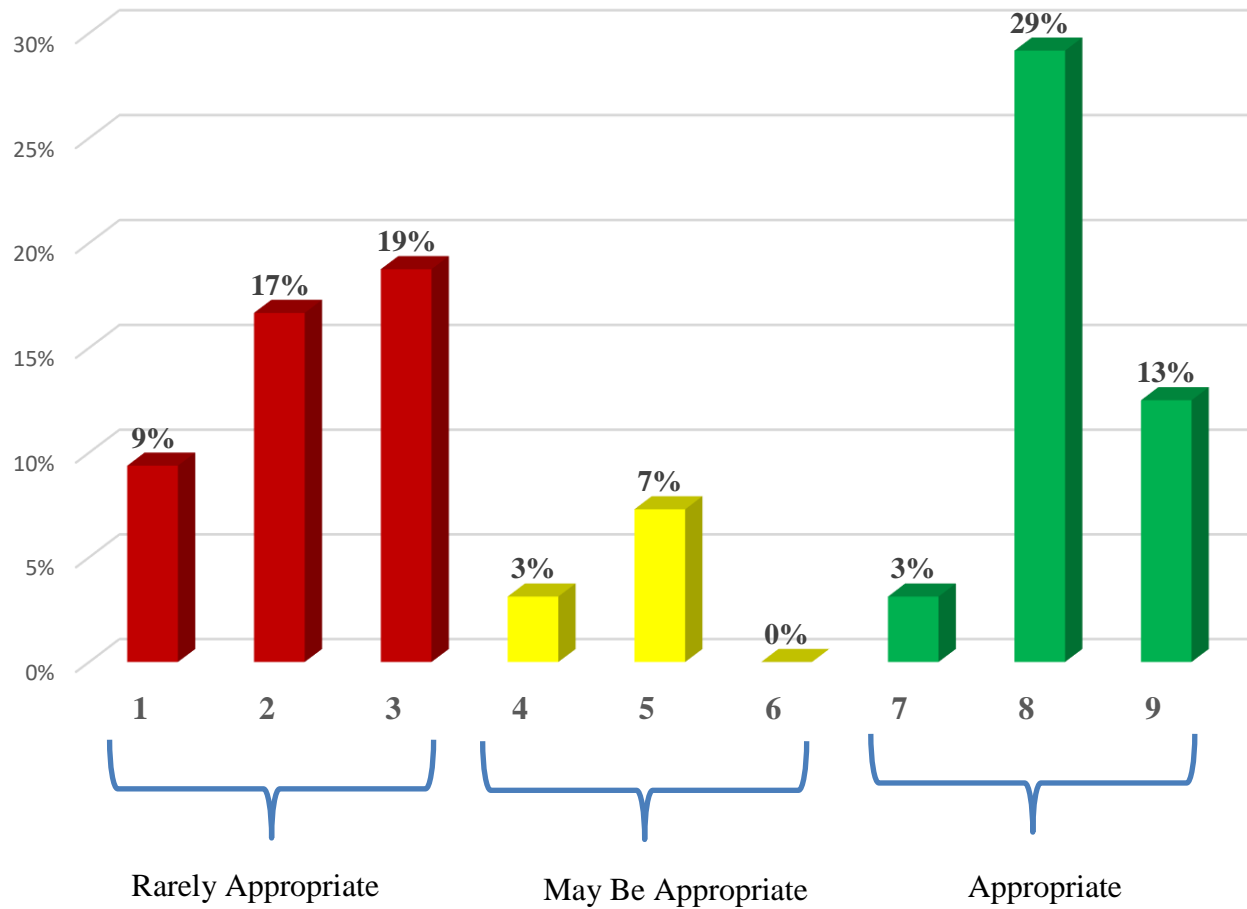
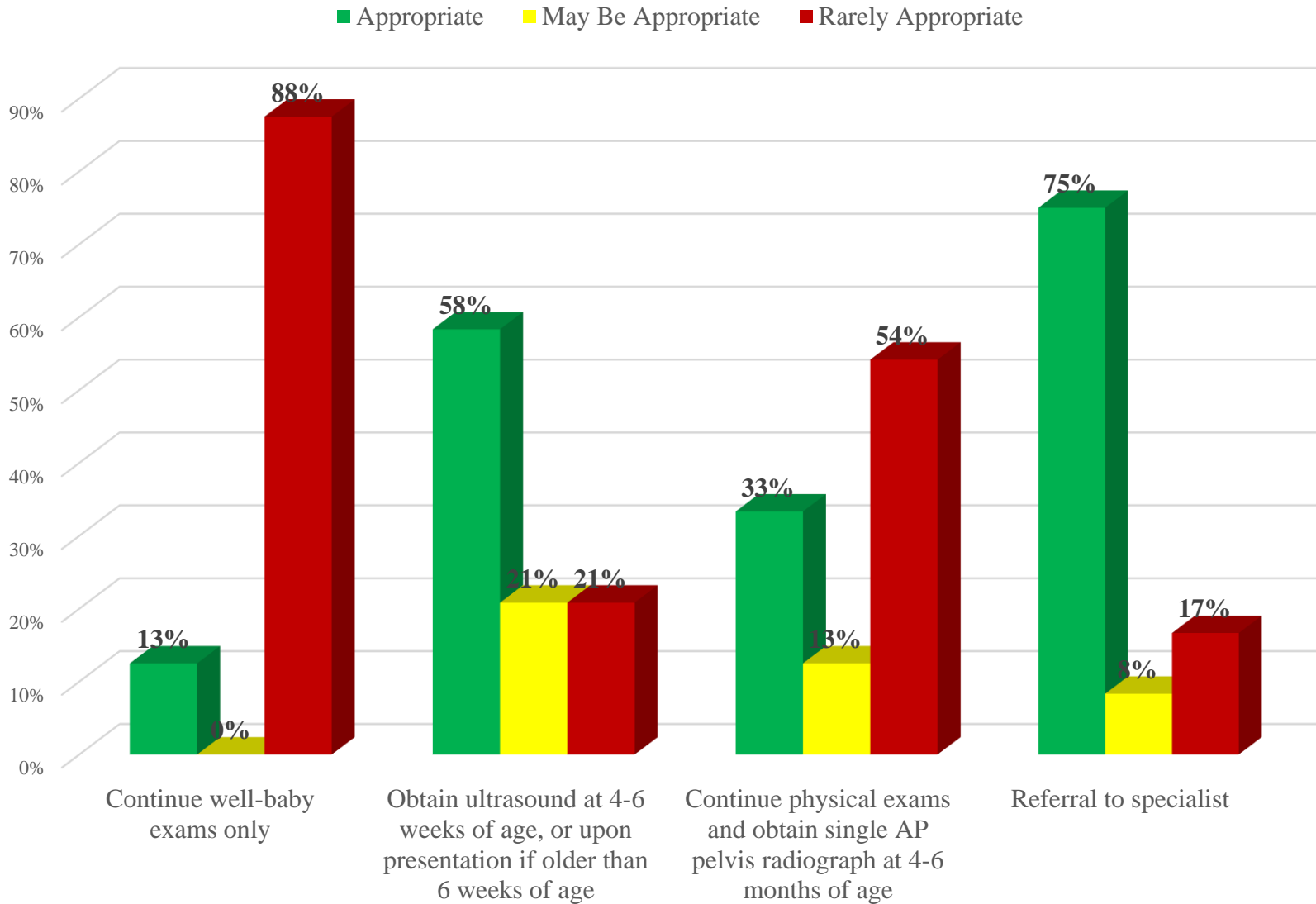


FIGURE 9. WITHIN TREATMENT APPROPRIATENESS RATINGS



APPROPRIATE USE CRITERIA FOR THE DETECTION AND NONOPERATIVE MANAGEMENT OF PEDIATRIC DEVELOPMENTAL DYSPLASIA OF THE HIP IN INFANTS UP TO SIX MONTHS OF AGE

Interpreting the AUC tables:

- Each procedure contains the appropriateness (i.e. appropriate, may be appropriate, or rarely appropriate) for each patient scenario, followed by the median panel rating, and the panel’s agreement in parentheses.

#	Patient Scenario	Continue well-baby exams only	Obtain ultrasound at 4-6 weeks of age, or upon presentation if older than 6 weeks of age	Continue physical exams and obtain single AP pelvis radiograph at 4-6 months of age	Referral to specialist
1	Birth – 4 weeks, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Rarely Appropriate (2, Agreement)	Appropriate (8, Agreement)	May Be Appropriate (5, Disagreement)	Rarely Appropriate (3, Neither)
2	Birth – 4 weeks, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (2, Agreement)	Appropriate (8, Agreement)	Rarely Appropriate (3, Agreement)	Appropriate (9, Agreement)
3	Birth – 4 weeks, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)
4	Birth – 4 weeks, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (2, Agreement)	Appropriate (8, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)
5	Birth – 4 weeks, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Appropriate (9, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)

#	Patient Scenario	Continue well-baby exams only	Obtain ultrasound at 4-6 weeks of age, or upon presentation if older than 6 weeks of age	Continue physical exams and obtain single AP pelvis radiograph at 4-6 months of age	Referral to specialist
6	Birth – 4 weeks, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)
7	Birth – 4 weeks, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)	Rarely Appropriate (3, Agreement)	Appropriate (7, Agreement)
8	Birth – 4 weeks, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)
9	4 weeks – 4 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Rarely Appropriate (3, Agreement)	Appropriate (8, Agreement)	Appropriate (7, Agreement)	May Be Appropriate (5, Neither)
10	4 weeks – 4 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (2, Agreement)	Appropriate (9, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (9, Agreement)
11	4 weeks – 4 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (2, Agreement)	Appropriate (9, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)
12	4 weeks – 4 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (2, Agreement)	Appropriate (9, Agreement)	May Be Appropriate (5, Disagreement)	Appropriate (8, Agreement)
13	4 weeks – 4 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Appropriate (9, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)

#	Patient Scenario	Continue well-baby exams only	Obtain ultrasound at 4-6 weeks of age, or upon presentation if older than 6 weeks of age	Continue physical exams and obtain single AP pelvis radiograph at 4-6 months of age	Referral to specialist
14	4 weeks – 4 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (2, Agreement)	Appropriate (9, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)
15	4 weeks – 4 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (2, Agreement)	Appropriate (9, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (7, Agreement)
16	4 weeks – 4 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (2, Agreement)	Appropriate (8, Agreement)	May Be Appropriate (5, Neither)	Appropriate (8, Agreement)
17	4 months – 6 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Rarely Appropriate (3, Agreement)	May Be Appropriate (5, Disagreement)	Appropriate (8, Agreement)	May Be Appropriate (4, Neither)
18	4 months – 6 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (2, Agreement)	Rarely Appropriate (3, Neither)	Appropriate (8, Agreement)	Appropriate (9, Agreement)
19	4 months – 6 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (2, Agreement)	May Be Appropriate (5, Disagreement)	Appropriate (8, Agreement)	Appropriate (8, Agreement)
20	4 months – 6 months, Risk factor(s) present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (2, Agreement)	Rarely Appropriate (2, Neither)	Appropriate (8, Agreement)	Appropriate (8, Agreement)
21	4 months – 6 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Normal Physical Exam Findings	Appropriate (9, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)	Rarely Appropriate (1, Agreement)

#	Patient Scenario	Continue well-baby exams only	Obtain ultrasound at 4-6 weeks of age, or upon presentation if older than 6 weeks of age	Continue physical exams and obtain single AP pelvis radiograph at 4-6 months of age	Referral to specialist
22	4 months – 6 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Hip instability	Rarely Appropriate (2, Agreement)	May Be Appropriate (4, Neither)	Appropriate (8, Agreement)	Appropriate (9, Agreement)
23	4 months – 6 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limited abduction	Rarely Appropriate (2, Agreement)	May Be Appropriate (4, Neither)	Appropriate (8, Agreement)	Appropriate (8, Agreement)
24	4 months – 6 months, No risk factors present (breech presentation, family history, history of improper swaddling, or history of clinical instability), Limb length discrepancy	Rarely Appropriate (2, Agreement)	May Be Appropriate (5, Neither)	Appropriate (8, Agreement)	Appropriate (8, Agreement)

V. APPENDICES

APPENDIX A. DOCUMENTATION OF APPROVAL

AAOS BODIES THAT APPROVED THIS APPROPRIATE USE CRITERIA

Evidence-Based Quality and Value Committee: Approved on February 1, 2018

The AAOS Committee on Evidence Based Quality and Value consists of 19 AAOS members. The overall purpose of this committee is to plan, organize, direct, and evaluate initiatives related to Clinical Practice Guidelines and Appropriate Use Criteria.

Council on Research and Quality: Approved on February 13, 2018

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 March 5, 2018

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

DDH WRITING PANEL MEMBER DISCLOSURES

Pablo Castaneda, MD Submitted on: 01/23/2017

Orthopediatrics: Unpaid consultant

Revista Mexicana de Ortopedia Pediátrica: Editorial or governing board (\$0)

Sociedad Mexicana de Ortopedia Pediátrica/Sociedad de Especialistas en Cirugía Ortopédica del Centro

Médico ABC: Board or committee member (\$0)

Brian A Shaw, MD Submitted on: 01/21/2017

American Academy of Pediatrics: Board or committee member (\$0)

Pediatric Orthopaedic Society of North America: Board or committee member (\$0)

Eduardo N. Novais, MD Submitted on: 01/23/2017

(This individual reported nothing to disclose)

Winslow E. Whitten, BA, RDMS, RVT, FSDMS Submitted on: 01/31/2017

Society of Diagnostic Medical Sonography: Board or committee member (\$0) Ethics Committee (Self)

Hamad Ghazle, EDD RDMS (This individual reported nothing to disclose); Submitted on: 02/07/2017

Sarah Bixby, MD (This individual reported nothing to disclose); Submitted on: 02/05/2017

Jie Nguyen, MD, MS (This individual reported nothing to disclose); Submitted on: 03/03/2017

Amisha J. Shah (This individual reported nothing to disclose); Submitted on: 02/03/2017

Kishore Mulpuri, MD Submitted on: 02/20/2017

Allergan: Research support (\$30,000) N/A (Self)

Canadian Orthopaedic Association: Board or committee member (\$0) (Self) Chair, Pediatrics section

DePuy, A Johnson & Johnson Company: Research support (\$58,874) (Self) Funding to support two research projects through OREF: A Clinical Prediction Model for Growth Arrest in Pediatric Physeal Fractures (\$33,874.66) and Taping versus Splinting versus Above Elbow Casting for Type I Supracondylar Fractures of the Humerus in Children: A Randomized Controlled Trial (\$25,000)

International Hip Dysplasia Institute: Board or committee member (\$0) Research Director (Self)

Journal of Pediatric Orthopedics: Editorial or governing board (\$0)

Pediatric Orthopaedic Society of North America: Board or committee member (\$0) publication committee- member (Self)

Pega medical: IP royalties (\$0)

Pega Medical: Research support (\$20,000) N/A (Self)

Vancouver Area Telugu Association: Board or committee member (\$0)

Cynthia N Baker, MD (This individual reported nothing to disclose); Submitted on: 02/20/2017

Joseph A Janicki, MD Submitted on: 02/07/2017

Pediatric Orthopaedic Society of North America: Board or committee member (\$0)

Pfizer: Stock or stock Options Number of Shares: 100 n/a(Self)

John Peter Lubicky, MD Submitted on: 02/06/2017

Pediatric Orthopaedic Society of North America: Board or committee member (\$0)

(Self)Member of several committees

Scoliosis Research Society: Board or committee member (\$0) (Self)member of several committees

Spine: Editorial or governing board; Editorial or governing board (\$0) Member, Assoc editorial board Reviewer

Harriet Joan Paltiel, MD Submitted on: 02/12/2017

American College of Radiology: Board or committee member; Board or committee member (\$0) Member, Ultrasound

Practice Parameter Committee(Self)

American Institute of Ultrasound in Medicine: Board or committee member (\$0) Member, Board of Governors(Self)

Journal of Ultrasound in Medicine: Editorial or governing board (\$0) Pediatrics Section Editor(Self)

Pediatric Radiology: Editorial or governing board (\$0) Editorial Board(Self)

Radiology: Editorial or governing board (\$0) Associate Editor, Pediatrics(Self)

Society for Pediatric Radiology: Board or committee member (\$0) Member, Ultrasound Committee(Self)

Society of Radiologists in Ultrasound: Board or committee member (\$0) President-Elect(Self)

Lynn Fordham, MD (This individual reported nothing to disclose); Submitted on: 02/16/2017

Boaz Karmazyn, MD (This individual reported nothing to disclose); Submitted on: 02/14/2017

Sarah Sarvis Milla, MD (This individual reported nothing to disclose); Submitted on: 03/01/2017

Shannon Dowler Submitted on: 02/28/2017

AAFP (Commission Health of the Public and Science),

ACOG (Adolescent Health Committee): Board or committee member (\$0)

GlaxoSmithKline: Stock or stock Options Number of Shares: 0

DDH VOTING PANEL MEMBER DISCLOSURES

Moderator

Julie B. Samora, MD Submitted on: 10/06/2017

AAOS: Board or committee member (\$0); American Society for Surgery of the Hand: Board or committee member (\$0); Ruth Jackson Orthopaedic Society: Board or committee member (\$0);

American Academy of Orthopaedic Surgeons

Keith Bachmann, MD (This individual reported nothing to disclose); Submitted on: 06/05/2017

Paul D. Choi, MD (This individual reported nothing to disclose); Submitted on: 05/30/2017

Stephanie M. Holmes, MD Submitted on: 06/05/2017

Pediatric Orthopaedic Society of North America: Board or committee member (\$0); QSVI committee (Self)

Alfred A. Mansour, III MD Submitted on: 06/07/2017

AAOS: Board or committee member (\$0); Pediatric Orthopaedic Society of North America: Board or committee member (\$0)

Travis H. Matheny, MD Submitted on: 06/14/2017

Orthopaedics: Unpaid consultant N/A(Self);
Pediatric Orthopaedic Society of North America:
Board or committee member; Board or committee member (\$0) (Self);
Children's Orthopaedics in
Underserved Regions Committee

American Academy of Orthopaedic Surgeons/ Pediatric Orthopaedic Society of North America

Vidyadhar Vinayak Upasani, MD Submitted on: 06/06/2017

DePuy, A Johnson & Johnson Company: Paid presenter or speaker (\$0) Number of Presentations: 0;

OrthoPediatrics: Paid presenter or speaker (\$0) Number of Presentations: 0; OrthoPediatrics:
Paid consultant (\$0)

American Academy of Pediatrics

Lee S. Segal, MD Submitted on: 07/12/2017

Clinical Orthopaedics and Related Research: Editorial or governing board (\$0); Pediatric Orthopaedic Society of North America: Board or committee member (\$0)

American College of Radiology

Nabile M. Safdar, MD Submitted on: 07/18/2017

American College of Radiology, American Roentgen Ray Society, American Board of Radiology, Radiological Society of North America: Board or committee member (\$0)

American Institute of Ultrasound in Medicine

Jennifer Eden Lim-Dunham, MD (This individual reported nothing to disclose); Submitted on: 06/13/2017

Pediatric Orthopaedic Society of North America

Randall T. Loder, MD Submitted on: 06/03/2017

Hodder Publishing, UK: Publishing royalties, financial or material support (\$0); Journal of Pediatric Orthopedics/Journal of Childrens Orthopedics: Editorial or governing board (\$0); Orthopediatrics: Unpaid consultant

Vineeta T. Swaroop, MD Submitted on: 06/09/2017

Up to Date (online publication): Publishing royalties, financial or material support (\$0)

Society of Diagnostic Medical Sonography

Sheryl E Goss, MS, RT(R)(S), RDMS, RDCS, RVT, FSDMS Submitted on: 06/21/2017

Joint Review Committee on Education in Diagnostic Medical Sonography: Board or committee member (\$0) N/A(Self); Society on Diagnostic Medical Sonography: Board or committee member (\$0) N/A(Self)

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) American Academy of Orthopaedic Surgeons. Detection and Nonoperative Management of Pediatric Developmental Dysplasia of the Hip in Infants up to Six Months of Age. <http://www.orthoguidelines.org/topic?id=1016>. Published September 5, 2014.