9-2014

In the child with an irritable hip: Summary

Children's Mercy Kansas City

Specific Care Question (s):

1. In the child with an irritable hip (limping, refusing to walk) should an ultrasound (US) be obtained to identify children with high likelihood of septic arthritis?
2. In the child with irritable hip, should a Clinical Decision Rule (CDR) be used to identify children with high likelihood of septic arthritis?
3. In the child with irritable hip, should Magnetic Resonance Imaging (MRI) be obtained to identify children with high likelihood of septic arthritis?
4. Does the presence of a clinical practice guideline to manage children with irritable hip change the diagnostic tests ordered?

Question Originator:

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Plain Language Summary from The Office of Evidence Based Practice:

The child presenting with a painful irritable hip is a diagnostic challenge. Discerning between septic arthritis and transient synovitis or a deep musculoskeletal infection is complex since their onset is similar. The symptoms include spontaneous onset of pain in the hip, thigh or hip; inability to bear weight on the affected hip or limp; fever or history of fever. CDRs have been developed to assist the clinician in differentiating the diagnoses. Diagnostic tests such as US and MRI have been used to complete the diagnostic picture.

There is variation in how the diagnostic work-up for the painful irritable hip proceeds. Reported CDRs have had poor validation in subsequent populations, US is useful to discover an effusion in the joint space, but is not able to differentiate between bacterial and viral effusions without further aspiration of the affected joint space and evaluation of the synovial fluid. MRI provides more useful information, but children less than 8 years old usually have to be sedated for the procedure and MRI is not always available.

This review found 10 articles involving the use of US, four articles involving CDRs, and four articles involving MRI in the evaluation of the child who presents with a painful irritable hip. The final article assesses the affect of a clinical practice guideline (CPG) on providers' diagnosis and management a presumed septic hip. The outcomes assessed were the sensitivity and specificity of the technique compared to the gold standard of positive culture of fluid from the synovial space for the presence of infection.

Use of ultrasound

US of the hip is able to identify a joint effusion, but is not able to specify the cause of the effusion (bacterial vs. viral). Sensitivity (Sn) and specificity (Sp) could be calculated from the included studies on this question. Reported as median [range], They are Sn= 100 [67, 100] and Sp= 51 [6, 90].

Use of magnetic resonance imaging

MRI is able to identify an effusion in the synovial space and in soft tissue around the hip, but more importantly it is able to differentiate infection beyond the joint capsule such as osteomyelitis and other deep pyogenic infection that US will not. The risk of bias in the

included studies is high because the gold standard joint aspiration and culture of synovial fluid was not performed in children without findings on the MRI. Three studies are included for this question When MRI of the bone is reported (three studies) the range of sensitivities and specificities is 0.56-0.86 and 0.73-1.00, respectively. When MRI of the soft tissue is reported (two studies) the sensitivity in both studies is 0.89 and the range of specificity is 0.27-0.71.

Use of clinical decision rules

Three CDRs are included in this analysis, one is the initial CDR (Kocher 1999) and two are validation studies of the initial CDR. (Kocher, Zurakowski, & Kasser, 1999) was evaluated for internal validation by the same author in 2004 with the conclusion that it "demonstrated diminished, but nevertheless very good, diagnostic performance in a new patient population". (Kocher, et al., 1999) CDR was then examined by (Luhmann et al., 2004) and was unable to be externally validated. (Caird et al., 2006) then added the C-reactive peptide t (CRP) test to the 1999 Kocher CDR with the conclusion that a CRP > 2 mg/dl added to the predictive performance of the CDR. Table 1 is a summary of factors included in the three proposed CDRs. Each of the factors is easily obtained and a blood specimen is the most invasive diagnostic test included in the CDRs. The turn-around time for the blood tests at Children's Mercy is one hour for an order placed STAT, and four hours for a specimen processed in a routine manner.

Effect of using an clinical practice guideline

Grade of Evidence and Recommendations (Table 2):

US: based on very low quality evidence a weak recommendation is made to obtain an ultrasound during the initial evaluation of a child when factors from the CDR show increased probability of septic arthritis and MRI is not readily available or able to be safely performed. US approaches 100% sensitivity for effusion, but is on 50% specific for septic (bacterial) vs viral or other etiologies for effusion. We value obtaining the higher specificity MRI over US if MRI is available and can be done in a safe and timely manner.

MRI: based on low quality evidence, we strongly recommend an MRI be obtained when factors from the CDR show increased probability of septic arthritis or infection into the bone or extending beyond the joint space. In children with a positive CDR, the specificity of the MRI ranged from 0.73 -1.0. We value diagnostic tests that provide high specificity.

CDR: based on very low quality evidence a strong recommendation is made to obtain all six factors identified in the studies to guide the decision of continuing the work-up for septic arthritis. Since there is no validated CDR and obtaining all six factors does not add harm to the patient, including all six in the discussion seems prudent.

Using a CPG: based on one low quality study, we recommend an algorithm process model or guideline be used to manage children who present with an irritable hip. Detailed management of the factors used in our facility when making decisions regarding this diagnosis and the outcomes of the decisions add to the evidence that supports these recommendations.

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Method Used for Appraisal and Synthesis:
The Cochrane Collaborative computer program, Review Manager (RevMan 5.2) was used to synthesize randomized control trials and studies of diagnostic test accuracy. Observational cohort studies and studies evaluation clinical decision rules were synthesized using the Critical Appraisal Skills Programme (CASP) tools.

Updated February 10, 2014, March 17 2014, April 4 2014, April 14 2014, April 30 2014, May 23 2014, June 10 2014

Table 1.

Summary of factors in reported CDRs.

Factor	Fever or History of Fever	Non-weight bearing status	Previous Health Care Visit	C-reactive protein > 2.0 mg/dL	S. WBC > 12.0 X10^9/L	ESR > 40 mm/hr	Percent Probability
Kocher, Zurakowski, & Kasser, 1999	X	X			X	X	4 factors 99.3 % 3 factors 93.1 % 2 factors 40% 1 factor 3% 0 factors >0.2%
Luhmann et al., 2004	X		X		X		3 factors 71% 2 factors DNR* 1 factor DNR 0 factors DNR
Caird et al., 2006	X	X		X	X	X	5 factors 97.5 % 4 factors 93.1 % 3 factors 82.6 % 2 factors 62.4% 1 factor 36.0% 0 factors 16.9%

*DNR- did not report

Table 2

Plain language definitions for Grading the quality of evidence and assigning the strength of the recommendation

Definitions of terms grading the quality of evidence	
High	Further research is very unlikely to change our confidence in the estimate of he effect.
Moderate	Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low	Any estimate of effect is very uncertain
Definitions of terms for assigning the strength of the recommendations	
Strong	Based on the available evidence, we are very certain that benefits do, or do not, outweigh risks and burdens.
Weak	Based on available evidence, we believe that benefits and risks and burdens are finely balanced, or appreciable uncertainty exists about the magnitude of benefits and risks.

Note. Explanation of the plain language recommendation of the evidence for this document is based on the **GRADE system (Grading of Recommendations Assessment, Development and Evaluation)**, an internationally recognized and utilized approach to grading the quality of the evidence and the strength of the recommendation. This provides the clinician a systematic approach to grading the strength of management recommendations that can minimize bias and aid interpretation of the expert-created medical guideline.

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Alexander 1989	2	19	0	24	1.00 [0.16, 1.00]	0.56 [0.40, 0.71]
Dorr 1988	13	81	0	71	1.00 [0.75, 1.00]	0.47 [0.39, 0.55]
Eich 1999	8	68	0	13	1.00 [0.63, 1.00]	0.16 [0.09, 0.26]
Fink 1995	1	35	0	14	1.00 [0.03, 1.00]	0.29 [0.17, 0.43]
Gordon 2002	18	32	4	26	0.82 [0.60, 0.95]	0.45 [0.32, 0.58]
Luhmann 2004	46	64	0	117	1.00 [0.92, 1.00]	0.65 [0.57, 0.72]
Miralles 1989	6	229	3	262	0.67 [0.30, 0.93]	0.53 [0.49, 0.58]
Shiv 1990	25	5	0	20	1.00 [0.86, 1.00]	0.80 [0.59, 0.93]
Zamzam 2006	51	7	8	61	0.86 [0.75, 0.94]	0.90 [0.80, 0.96]
Zawin 1993	15	41	0	40	1.00 [0.78, 1.00]	0.49 [0.38, 0.61]

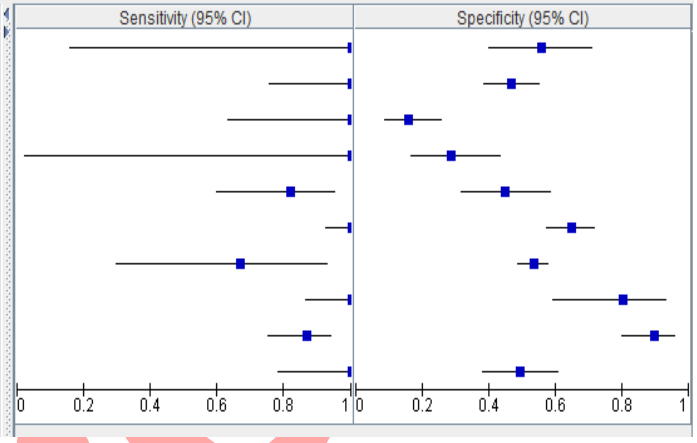

Figure 1: Sensitivity and specificity ultrasound (the index test) versus joint aspiration and I & D of the aspirate (gold standard).

Figure 2. Ultrasound studies methodological quality summary. The Scholars' judgments about each methodological quality item for included studies for the ultrasound question. A green circle means low risk of bias, yellow means unclear risk of bias and red means high risk of bias.

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Lee 1999 -Bone	8	0	1	14	0.89 [0.52, 1.00]	1.00 [0.77, 1.00]
Lee 1999 effusion	9	12	0	2	1.00 [0.66, 1.00]	0.14 [0.02, 0.43]
Lee 1999 Soft Tissue	8	10	1	4	0.89 [0.52, 1.00]	0.29 [0.08, 0.58]
Yang 2006 Other hip	3	31	15	18	0.17 [0.04, 0.41]	0.37 [0.23, 0.52]
Yang 2006 Soft tissue	16	14	2	35	0.89 [0.65, 0.99]	0.71 [0.57, 0.83]
Yang 2006-Bone	10	0	8	49	0.56 [0.31, 0.78]	1.00 [0.93, 1.00]

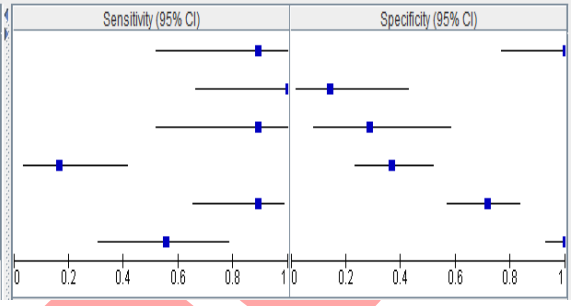

Figure 3. Sensitivity and specificity MRI (the index test) versus joint aspiration and I & D of the aspirate (gold standard).

Study	TP	FP	FN	TN	Sensitivity (95% CI)	Specificity (95% CI)
Yang soft tissue 2006	16	14	2	35	0.89 [0.65, 0.99]	0.71 [0.57, 0.83]
Yang other hip 2006	3	31	15	18	0.17 [0.04, 0.41]	0.37 [0.23, 0.52]
Yang Bone 2006	10	0	8	49	0.56 [0.31, 0.78]	1.00 [0.93, 1.00]

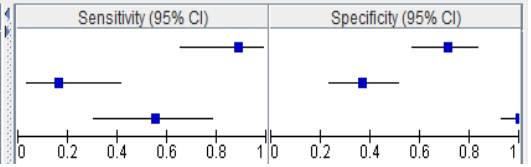

Figure 4. Sensitivity and Specificity of MRI for differentiation septic arthritis from transient synovitis (Yang, et al., 2006). Definitions:

- Yang- Bone 2006 – bone marrow signal intensity alteration and contrast enhancement (+PV= 100%)
- Yang -other hip 2006- the contra lateral hip was affected (+PV= 9%)
- Yang- soft tissue 2006- signal intensity alteration and contrast enhancement in the soft tissue (+PV = 53%)

Figure 5. MRI studies methodological quality summary. The Scholars' judgments about each methodological quality item for included studies for the MRI question. A green circle means low risk of bias, yellow means unclear risk of bias and red means high risk of bias.

Table 3
The effect of a clinical practice guideline on providers' diagnosis and management of the child with an irritable hip (Kocher, et al., 2004)

If the guideline was followed did the provider:		Odds ratio, [95% CI]
Obtain a history of recent infection	Did not change	1.98 [0.81, 7.63]
Obtain an initial CRP	Significantly increased	91 [15.36, 539.26]
Obtain an initial bone scan	Significantly decreased	0.23 [0.06, 0.83]
Perform a presumptive drainage	Significantly decreased	0.18 [0.05,0.63]
Use a recommended antibiotic and dosage	Significantly increased	196 [25.77, 1490.50]
Obtain a follow up C reactive protein	Significantly increased	10.50 [2.70, 40.88]
Time until change to oral antibiotics (days)	Significantly decreased	-3.00 [-3.85,-2.15]
Hospital stay (days)	Significantly decreased	-3.50 [-4.37,-2.63]

Table 4
Studies included in this review

Ultrasound	
Alexander et al., 1989	Luhmann et al., 2004
Dorr, Zieger, & Hauke, 1988	Miralles et al., 1989
Eich, Superti-Furga, Umbricht, & Willi, 1999	Shiv, Jain, Taneja, & Bhargava, 1990
Fink, Berman, Edwards, & Jacobson, 1995	Zamzam, 2006
Gordon et al., 2002	Zawin, Hoffer, Rand, & Teele, 1993
Clinical Decision Rule	
Caird, et al., 2006	Kocher, Mandiga, Zurakowski, Barnewolt, & Kasser, 2004
Kocher, Zurakowski, & Kasser, 1999	Luhmann, et al., 2004
Magnetic Resonance Imaging	
Gottschalk, Moor, Muhamad, Wenger, & Yaszay, 2014	Lee et al., 1999
Kwack et al., 2007	
Yang et al., 2006	
Use of a Clinical Practice Guideline	
Kocher et al., 2003	

Table 5
Studies excluded from the review and the reason for exclusion

Study ID	Reason for Exclusion
Ultrasound	
Al Saadi 2009	The only report true positives.
Del Beccaro, Champoux, Bockers, & Mendelman, 1992	They did not use ultrasound
Morina 2009	They included all joints, knee, elbow, hip and unable to calculate sensitivity and specificity
Golden, 1993	Letter to the editor
Kariminasab 2009	Does not answer the question. Includes only hips that were ultrasound positive and went on to surgery. The study was done to ascertain the final outcome of subjects identify factors for "poor result"
Klein et al., 1997	Did not use ultrasound. However did assess body temperature, WBC, and sedimentation rate
Liberman et al., 2013	Report includes transient synovitis only
Nunn, Cheung, & Rollinson, 2007	Does not answer the question. Assessed rate of complications and reasons for delay of presentation in South Africa.
Paakkonen 2010	Does not include ultrasound as a diagnostic tool. It compares sedimentation rate to C-reactive protein.
Yagupsky, Bar-Ziv, Howard, & Dagan, 1995	Does not report on ultrasound, only describes characteristics of children with septic arthritis.
Clinical Decision Rule	
Gafur et al., 2008	Does not answer the question.
Hariharan & Kabrhel, 2011	Includes adults only Mean age 49 +/- 22 years. Only 18% were septic hips, 31% had prosthetic joints, and 15% had malignancies.
Magnetic Resonance Imaging	
Gutierrez, 2012	Narrative review
Jackson & Newland, 2011	Narrative review
Ju, Zurakowski, & Kocher, 2011	Narrative review

Bierry, Huang, Chang, Torriani, & Bredella, 2012	Narrative review
Kim, Kwack, Cho, Lee, & Yoon, 2012	Uses dynamic enhancement curves as the index test, which is not a test that will be performed at hour hospital.
Ranner, Ebner, Fotter, Linhart, & Justich, 1989	Does not answer the question. Uses bone scintography as the gold standard for diagnosis of Legg-Calves-Perthes disease.
Vander Have et al., 2009	Does not use MRI for diagnosis.

Table 6:

Characteristics of included studies:

Alexander 1989

Clinical features and settings	Children with a limp or hip pain, whose diagnosis was not evident on plain radiographs, were evaluated for hip effusions by hip ultrasound
Participants	**N** = 45 painful hips **Age:** newborn to 13 years (mean = 5.5 years) **Study location:** Arkansas Children's Hospital Additional demographics were not reported.
Study design	Single prospective group cohort. It is unclear if the patients were consecutively enrolled.
Target condition and reference standard(s)	**Target condition:** Septic arthritis **Reference standard:** Hip joint fluid I & D from aspiration or surgical exploration.
Index and comparator tests	**Index test--Ultrasound:** Definition of hip joint effusions--effusion was present when the width of the hip capsule was greater than 6.3 mm (± 1.5 mm), especially if the capsule was bulging. The opposite hip, if asymptomatic, provides a comparison value. A difference between hips of 3 mm or greater was considered abnormal, while an inequality of less than 2 mm was read as normal.
Follow-up	No subjects were lost, all data was not reported.

Notes	An assumption was made that the 132 patients not reported upon were true negatives.

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	
Differential verification avoided?	No	
Incorporation avoided?	No	
Reference standard results blinded?	Unclear	
Index test results blinded?	Unclear	
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Unclear	

Dorr 1988

Clinical features and settings	Children presenting with an acute or sub-acute painful hip joint were investigated
Participants	**N** = 165 **Age:** 3 days to 72 years, mean = 12 years of age **Study location:** Germany
Study design	Single prospective group cohort. It is unclear if the patients were consecutively enrolled.
Target condition and reference standard(s)	**Target condition:** Septic arthritis **Reference standard:** Hip joint fluid I & D from aspiration or surgical exploration.
Index and comparator tests	**Index test:** Ultrasound scanned both hip joints of the patient. Diagnosis of septic hip with ultrasound: joint effusion
Follow-up	No subjects were lost, all data are reported.
Notes	

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	
Differential verification avoided?	No	
Incorporation avoided?	Unclear	
Reference standard results blinded?	No	
Index test results blinded?	Unclear	
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Unclear	

Eich 1999

Clinical features and settings	Data acquired from patient records that had a consultation of acute hip pain. The University Children's Hospital, Zurich, Switzerland
Participants	**Subjects:** 114 patients identified having an acute hip pain consultation. Twenty five patients were excluded due to incomplete clinical or imagining data, or lack of follow-up. Per protocol analysis occurred for the N = 89. Gender: 52 (58%) males Age: .5 years to 12.25 years, mean = 5.5 years
Study design	Retrospective cohort (chart review)
Target condition and reference standard(s)	**Target condition:** Septic arthritis **Reference standard:** Pus aspirated from hip joint, and/or growth of pathogenic bacteria from the aspirate.
Index and comparator tests	**Index test:** Ultrasound scanned both hip joints of the patient. Diagnosis of septic hip with ultrasound: joint effusion if an echo-poor or echo-free biconvex space was visualized between the femoral neck and the joint capsule.

Follow-up	Twenty five patients were identified but failed inclusion due to incomplete clinical or imagining data, or lack of follow-up
Notes	Findings related to transient synovitis and Perthes disease are not included in this report.

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	
Differential verification avoided?	No	
Incorporation avoided?	No	
Reference standard results blinded?	Unclear	
Index test results blinded?	Unclear	
Relevant clinical information?	Unclear	
Uninterpretable results reported?	No	
Withdrawals explained?	Unclear	

Fink 1995

Clinical features and settings	Evaluated a protocol whose goal was to avoid hospital admission while detecting serious cause of septic hip, specifically septic arthritis. United Kingdom
Participants	50 children with painful hips are in the sample, 36 had aspiration of hip effusion performed. Age range is 1 to 10 years.
Study design	Prospective. All 50 children had immediate ultrasound guided aspiration and I&D of all hip effusions.
Target condition and reference standard(s)	Target condition is septic arthritis of the hip. Reference standard is I&D of hip effusion. Aspiration guided by ultra sound was performed immediately after it was found.
Index and comparator tests	Index and comparator test- is hip ultrasound

Follow-up If the immediate gram stain was negative, the child was discharged. If the subject's symptoms did not improve, another sonogram and aspiration if fluid present and a technetium-99m methylene diphosphonate bone scan was performed.

Notes

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	Culturing the synovial fluid is the gold standard
Acceptable delay between tests?	Yes	Tapping the effusion was done immediately
Partial verification avoided?	No	It would not be ethical to tap a sterile joint where an effusion was not present on US
Differential verification avoided?	No	It would not be ethical to tap a sterile joint where an effusion was not present on US
Incorporation avoided?	No	The index test which is less invasive was performed to decide who needed to go on to the more invasive reference test
Reference standard results blinded?	No	
Index test results blinded?	No	The results of index test were used to determine who went on to tapping the effusion
Relevant clinical information?	Unclear	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Yes	There were none

Gordon 2002

Clinical features and settings All ultrasound studies of the hip over 18 month time frame were identified (N= 596) Of these, 136 studies in 132 subjects who had an ultrasound for painful hip(s) evaluated.

Participants N= 132
Average age of patients with true positive ultrasounds was 6 years (range 1Y 9M to 13 years).
Average age of patients with true-negative ultrasounds was 4 years 6 months (range 1-15 years).

Study design	Retrospective. Reviewed all hip ultrasounds done over an 18 month time period.
Target condition and reference standard(s)	Target condition - septic arthritis. Reference standard: I&D of hip effusion.
Index and comparator tests	Ultrasound of the hip(s), Ultrasound was interpreted by the radiologist when the study was complete, and got final review the next morning.
Follow-up	
Notes	

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	
Differential verification avoided?	No	
Incorporation avoided?	No	
Reference standard results blinded?	No	
Index test results blinded?	No	
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Yes	There were none.

Haraharan 2011

Patient Selection

A. Risk of Bias

Patient Sampling: Adult patients to validate CRP and ESR for septic arthritis. Adults with septic arthritis in the emergency department over a 5 year period (2003-2008). They only included subjects with discharge diagnosis of pyogenic arthritis plus any one of the following:

- plus synovial fluid bacterial culture

- plus synovial Gram stain for bacteria
- operative irrigation for septic arthritis

Subjects were only included if the arthrocentesis or surgery was performed within 24 hours of their ED registration. Excluded if neither ESR nor CRP was performed.

Was a consecutive or random sample of patients enrolled?	Yes
Was a case-control design avoided?	Yes
Did the study avoid inappropriate exclusions?	Yes
Could the selection of patients have introduced bias?	High risk
B. Concerns regarding applicability	
Patient characteristics and setting Yes, they are adult subjects.	
Are there concerns that the included patients and setting do not match the review question?	High concern

Index Test

Index tests	Erythrocyte sedimentation rate > and CRP > to diagnosis septic arthritis. Since this is a retrospective review, knowledge of the index test results and reference standard would not affect each other. The index test threshold was 20-30 mm/h for ESR and for CRP cutoff of 10-100 mG/L

All Tests

A. Risk of Bias	
Were the index test results interpreted without knowledge of the results of the reference standard?	Yes
If a threshold was used, was it pre-specified?	Yes
Could the conduct or interpretation of the index test have introduced bias?	Low risk
B. Concerns regarding applicability	
Are there concerns that the index test, its conduct, or interpretation differ from the review question?	Low concern

Reference Standard

A. Risk of Bias	
Target condition and reference standard(s)	The target condition is septic arthritis. The reference standard is + culture on aspirated joint space fluid.

Is the reference standard likely to correctly classify the target condition?	Yes
Were the reference standard results interpreted without knowledge of the results of the index tests?	No
Could the reference standard, its conduct, or its interpretation have introduced bias?	Low risk
B. Concerns regarding applicability	
Are there concerns that the target condition as defined by the reference standard does not match the question?	Low concern
Flow and Timing	
A. Risk of Bias	
Flow and timing	
Was there an appropriate interval between index test and reference standard?	No
Did all patients receive the same reference standard?	Unclear
Were all patients included in the analysis?	No
Could the patient flow have introduced bias?	High risk
Notes	I have a difficult time including this study because it includes adults who have many reasons to have elevated ESRs. Thirteen percent of the study population had rheumatologic disease including SLE.

Kallio 1985

Clinical features and settings	Goal was to study the value of ultrasound in the diagnosis of painful hip in children. Children were examined by two of the authors, x-rays were obtained. Immediately after that ultrasound was obtained. F/u ultrasound was done 2 weeks later. Inclusion criteria- children with limp without history of severe trauma, painful and limited motion of the hip or suspicion of hip joint problem based on "radiographic swelling". Children's Hospital, Aurora Finland
Participants	N= 149 children and 166 hips 71% male (n= 106)
Study design	Prospective, consecutive
Target condition and reference standard(s)	Target condition is septic arthritis

	Standard used is the volume of fluid aspirated from the synovial joint space
Index and comparator tests	Ultrasound finding "ultrasonographic capsular blurring (UCB)
Follow-up	All subjects had an ultrasound 2 weeks after index presentation
Notes	This study uses a different reference test

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	Yes	
Differential verification avoided?	Yes	
Incorporation avoided?	Yes	
Reference standard results blinded?	No	
Index test results blinded?	No	
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Yes	There were none

Kocher 2003

Methods	Compared a historical control group of 30 consecutive children with septic arthritis managed before the guideline was in place (1995-1997) with a prospective cohort of 30 consecutive children with septic arthritis
Participants	Children with irritable hip
Interventions	**Intervention:** 30 subjects whose providers followed the guideline **Control:** 30 subjects prior to implementation of the guideline
Outcomes	Process outcomes: Did the history include: history of trauma, recent infections, antibiotic use, fever adn/or chills, limp.

	Did physical exam include: temperature at presentation, results of hip examination, Walking status, vital signs. Laboratory, radiographic and treatment process parameters: Laboratory tests (CBC with diff, ESR, CRP, Blood culture, hip xray, hip ultrasound, bone scan, joint fluid cell count, joint fluid culture, presumptive drainage, time in hours from initial presentation to surgical drainage, placemen of a drain, obtaining a specimen for pathological evaluation, ATB use, time to change to oral ATB, duration of hospitalization Outcome parameters: readmission to the hospital, recurrent infection, development of osteomyelitis, recurrent drainage, septic osteonecrosis, limitation of motion.
Notes	All patients had a two year subjective follow-up (phone call) and a one year objective follow up physical exam and radiographic evaluation.

Luhmann 2004

Clinical features and settings	
Participants	227 had hip ultrasounds. Those with unknown hip ultrasound status include malignant tumor (7), Rheumatoid arthritis (5), Osteomyelitis (5) Sickle Cell crisis (3), Legg-Perthes (3), Immuno-compromised (3) Gunshot wound/ infection/ fracture/ (6), and cellulites, phlebitis, dermatomyositis and systemic sepsis (4).
Study design	Retrospective review of 8 years.
Target condition and reference standard(s)	Target condition: septic arthritis Reference standard: culture of synovial fluid aspirate
Index and comparator tests	Ultrasound
Follow-up	
Notes	

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	

Acceptable delay between tests?	Yes
Partial verification avoided?	No
Differential verification avoided?	No
Incorporation avoided?	No
Reference standard results blinded?	No
Index test results blinded?	No
Relevant clinical information?	Yes
Uninterpretable results reported?	Yes
Withdrawals explained?	Yes

Miralles 1989

Clinical features and settings	Clinical symptoms of hip disease specifically pain and limp. Spain
Participants	500 children (352 M/ 148 F) Mean age 4Y 10 MO (Range 10 months - 14 years)
Study design	prospective cohort
Target condition and reference standard(s)	Target condition- septic arthritis Reference standard culture of the effusion
Index and comparator tests	Sonogram
Follow-up	2 weeks
Notes	

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	Subjects who had effusion on US had either aspiration of the effusion or follow up sonograms, as "dictated by clinical setting" Not sure what this means
Differential verification avoided?	No	

Incorporation avoided?	No
Reference standard results blinded?	No
Index test results blinded?	No
Relevant clinical information?	Yes
Uninterpretable results reported?	Yes
Withdrawals explained?	Yes

Shiv 1990

Clinical features and settings	
Participants	50 patients with fever, hip pain and hip and flexion deformities Age range 9 M to 30 Years. Average age 12 years (median would be helpful). All had plain films
Study design	sampling technique not stated
Target condition and reference standard(s)	Target condition Septic arthritis reference standard: Arthrotomy with I&D of synovial fluid aspirate
Index and comparator tests	Hip Ultrasound
Follow-up	
Notes	

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Unclear	Sampling technique not described, Wide age range, uncertain how many adults were in the sample
Acceptable reference standard?	Yes	
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	
Differential verification avoided?	No	
Incorporation avoided?	No	
Reference standard results blinded?	No	
Index test results blinded?	No	

Relevant clinical information?	Unclear	Not clear who was included in the study group
Uninterpretable results reported?	Yes	
Withdrawals explained?	Yes	There were none

Zamzam 2006

Clinical features and settings	Aim of the study is to identify the role of ultrasound examination in the diagnosis of hip septic arthritis. Saudi Arabia
Participants	Children admitted with suspected septic arthritis of the hip. Subjects showed changes on radiograph, before an ultrasound was performed. OR subjects who had hip or "extra-hip" problems similar to septic arthritis or transient synovitis. Excluded subjects with diagnoses that predispose children to septic arthritis or transient synovitis. (N=189). Final cohort = 154 children - 91 boys and 63 girls. Those who were diagnosed with transient synovitis and discharged from the ED or primary care clinic were excluded. Mean age 4.3 years (range 1.1-10.9 years)
Study design	Retrospective chart review.
Target condition and reference standard(s)	Target condition: septic hip Reference standard: hip aspiration and culture
Index and comparator tests	Index test ultrasound, MRI Comparator: effusion culture
Follow-up	at least a one year follow up for satisfactory versus unsatisfactory results
Notes	The charts were separated into two groups. **Group 1** (provisional diagnosis of SA) included 79 subjects who underwent hip US. MRI was performed on seven patients in this group, sedation was needed for two subjects and five subjects required general anesthesia. Mean time to ultrasound was 3.2 days (range 1-7 days from onset of symptoms. **Group 2** (provisional diagnosis of TS) included 75 subjects who required hospitalization. 41 were admitted on first presentation, and 34 were had delayed admission after the symptoms persisted or got worse. All underwent hip US. Twelve went on to MRI all under general anesthesia. Mean time to ultrasound was 5.2 days (range 1-12 days from onset of symptoms.

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	at the outset the diagnosis was not known
Acceptable reference standard?	Yes	yes
Acceptable delay between tests?	No	For those in group 2, and had delayed admission the time between tests was prolonged
Partial verification avoided?	No	Those who negative hip ultrasounds did not have I & D of the effusion they did not have
Differential verification avoided?	No	Those who had negative hip ultrasounds did not have I & D of an effusion they did not have
Incorporation avoided?	No	
Reference standard results blinded?	No	
Index test results blinded?	No	
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	There were no uninterpretable results
Withdrawals explained?	Yes	

Zawin 1993

Clinical features and settings	Child presents with limp or refusal to bear weight and the hip is held in flexion, abduction and external rotation. May have had a recent viral infection, otitis media or minor trauma
Participants	96 children with irritable hip; 6 weeks to 15 years of age (mean age 5.2 years). 70% male.
Study design	Prospective; all subjects referred with acute symptoms referable to the hip were enrolled. All were examined by an orthopedic surgeon, for hip pain, appearance, fever, range of motion in the hip, laboratory including WBC, ESR and blood cultures. Plain x-ray in all. Only those with radiographic evidence of effusion (n=56) are evaluated further. 12 went directly to surgery for I&D; only 6 had a discharge diagnosis of septic arthritis. Thirteen were thought to be low risk and no intervention; no septic arthritis. Of the remaining 31 subjects, US guided aspiration was attempted, 29 successes. and 15 went to the OR for I&D. All of the latter 15 had a discharge diagnosis of septic arthritis.
Target condition and reference	Septic hip, operative intervention to drain effusion

standard(s)	
Index and comparator tests	the index test is drainage in the OR, the comparator test is US guided aspiration
Follow-up	
Notes	USA

Assessment of methodological quality table

Item	Scholars' judgment	Support for judgment
Representative spectrum?	Yes	At the outset it was the diagnosis was unknown.
Acceptable reference standard?	Yes	yes, draining the effusion and culture is the gold standard, in this article the gold standard is to accomplish this in the OR
Acceptable delay between tests?	Yes	
Partial verification avoided?	No	Only those who had effusion, and aspirate guided by US went to the OR
Differential verification avoided?	No	Those who did not have an effusion and a positive culture did not go to the OR
Incorporation avoided?	No	The reference test was done first, only those who had positive results went on to have surgical drainage
Reference standard results blinded?	No	the reference standard was only done if the index test was abnormal
Index test results blinded?	No	the reference standard was only done if the index test was abnormal
Relevant clinical information?	Yes	
Uninterpretable results reported?	Yes	
Withdrawals explained?	Yes	There were none

Search Strategy and Results:

Ultrasound:

EMBASE January 22 2014

No.QueryResults

#8 #2 AND #3 AND #5 AND ([newborn]/lim OR [infant]/lim OR [preschool]/lim OR [school]/lim OR [child]/lim OR [adolescent]/lim) AND [humans]/lim AND [english]/lim AND [2008-2014]/py 49

#6 #2 AND #3 AND #5 386

#5 'echography'/exp OR ultrasonography OR ultrasound 661,762

#3 'hip'/exp OR **'hip disease'**/exp **84,964**

#2 'synovitis'/exp OR 'osteomyelitis'/exp OR 'infectious arthritis'/exp 71,041

PubMed:January 22 2014

Search: ("Hip"[Mesh] OR "Hip Injuries"[Mesh] OR "Hip Joint"[Mesh] OR "hip"[tiab]) AND ("Osteomyelitis"[Mesh] OR "Arthritis, Infectious"[Mesh] OR "Synovitis"[Mesh] OR "toxic synovitis"[All Fields] OR "transient synovitis"[All Fields]) AND ("Ultrasonography"[Mesh] OR "ultrasonography"[Subheading]) AND ("humans"[MeSH Terms] AND English[lang] AND ("infant"[MeSH Terms] OR "child"[MeSH Terms] OR "adolescent"[MeSH Terms])) No. Query Results 86

Clinical Decision Rule:

Pub Med March 11 2014

("Decision Support Techniques"[Mesh] AND "Hip"[Mesh] OR "Hip Injuries"[Mesh] OR "Hip Joint"[Mesh] OR "hip"[tiab]) AND ("Osteomyelitis"[Mesh] OR "Arthritis, Infectious"[Mesh] OR "Synovitis"[Mesh] OR "toxic synovitis"[All Fields] OR "transient synovitis"[All Fields]) AND ("humans"[MeSH Terms] AND English[lang] AND ("infant"[MeSH Terms] OR "child"[MeSH Terms] OR "adolescent"[MeSH Terms])) AND Clinical Trial[ptyp] Query Results 21

Additional article were supplied by team members.

Magnetic Resonance Imaging:

PubMed March 11 2014

Search: ("Magnetic Resonance Imaging"[Mesh] AND (("Hip"[Mesh] OR "Hip Injuries"[Mesh] OR "Hip Joint"[Mesh] OR "hip"[tiab]) AND ("Osteomyelitis"[Mesh] OR "Arthritis, Infectious"[Mesh] OR "Synovitis"[Mesh] OR "toxic synovitis"[All Fields] OR "transient synovitis"[All Fields]))) AND ("humans"[MeSH Terms] AND English[lang] AND ("infant"[MeSH] OR

"child"[MeSH] OR "adolescent"[MeSH])) NOT (Case Reports[ptyp] OR Editorial[ptyp] OR Letter[ptyp] OR Review[ptyp]) No. Query Results 31

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