

A CLINICAL PRACTICE GUIDELINE FOR TREATMENT OF SEPTIC ARTHRITIS IN CHILDREN

EFFICACY IN IMPROVING PROCESS OF CARE AND EFFECT ON OUTCOME OF SEPTIC ARTHRITIS OF THE HIP

BY MININDER S. KOCHER, MD, MPH, RAHUL MANDIGA, BS, JANE M. MURPHY, RN, MS, DONALD GOLDMANN, MD,
MARVIN HARPER, MD, ROBERT SUNDEL, MD, KIRSTEN ECKLUND, MD, AND JAMES R. KASSER, MD

Investigation performed at the Children's Hospital, Boston, Massachusetts

Background: The development of clinical practice guidelines is a central precept of the evidence-based-medicine movement. The purposes of this study were to develop a guideline for the treatment of septic arthritis in children and to evaluate its efficacy with regard to improving the process of care and its effect on the outcome of septic arthritis of the hip in children.

Methods: A clinical practice guideline was developed by an interdisciplinary expert committee using evidence-based techniques. Efficacy was evaluated by comparing a historical control group of thirty consecutive children with septic arthritis of the hip managed before the utilization of the guideline with a prospective cohort group of thirty consecutive children treated with use of the guideline. Benchmark parameters of process and outcome were compared between groups.

Results: The patients treated with use of the guideline, compared with those treated without use of the guideline, had a significantly higher rate of performance of initial and follow-up C-reactive protein tests (93% compared with 13% and 70% compared with 7%), lower rate of initial bone-scanning (13% compared with 40%), lower rate of presumptive drainage (13% compared with 47%), greater compliance with recommended antibiotic therapy (93% compared with 7%), faster change to oral antibiotics (3.9 compared with 6.9 days), and shorter hospital stay (4.8 compared with 8.3 days). There were no significant differences between the groups with regard to other process variables, and there were no significant differences with regard to outcome variables, including readmission to the hospital, recurrent infection, recurrent drainage, development of osteomyelitis, septic osteonecrosis, or limitation of motion.

Conclusions: Patients treated according to the septic arthritis clinical practice guideline had less variation in the process of care and improved efficiency of care without a significant difference in outcome.

Level of Evidence: Therapeutic study, Level III-2 (retrospective cohort study). See Instructions to Authors for a complete description of levels of evidence.

A clinical practice guideline is a standardized set of recommendations for the management of patients with a specific clinical condition based on a systematic review of the best available evidence¹⁻⁵. The goals of guidelines are to minimize variation by standardizing the management process, to optimize clinical outcomes, and to allow cost efficiency¹⁻⁵. The development of guidelines is a major focus of the evidence-based-medicine movement^{6,7}. The National Guideline Clearinghouse was developed by the Agency for Healthcare Research

and Quality, in association with the American Medical Association and the American Association of Health Plans, to develop and disseminate clinical practice guidelines⁸. Although a large number of guidelines have been created to improve the management of a wide variety of medical conditions (the National Guideline Clearinghouse currently contains 903 guidelines), few have been formally studied to evaluate their efficacy in improving the process of care and clinical outcomes.

Septic arthritis in children is a serious medical condition with the potential for systemic and musculoskeletal sequelae. There is considerable variation in the management of septic arthritis in children regarding diagnostic workup, imaging studies, surgical management, antibiotic management,



A commentary is available with the electronic versions of this article, on our web site (www.jbjs.org) and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM).

and follow-up⁹⁻¹². The purposes of this study were to develop a clinical practice guideline for treatment of septic arthritis in children and to evaluate its efficacy in improving the process of care and its effects on the outcome of septic arthritis of the hip.

Methods

A clinical practice guideline for the management of septic arthritis in children was developed in 1995 by an interdisciplinary group of pediatric medicine, orthopaedic, infectious disease, emergency medicine, rheumatology, radiology, pharmacy, nursing, social work, and physical therapy specialists at a major tertiary-care children's hospital (see Appendix). Group members were selected because of their experience with treating pediatric musculoskeletal infection, with the process of systematic literature review, and with development of clinical practice guidelines. The systematic review of the literature included only level-1, 2, and 3 evidence (level 1B [an individual randomized clinical trial or prospective inception cohort study with a follow-up rate of >80%], 1C [all-or-none case series], 2B [an individual cohort study or low-quality randomized clinical trial], 2C [an ecological study], and 3B [an individual case-control study])⁹⁻⁴⁸. The MEDLINE database (1966 through 1995) was searched for articles regarding pediatric septic arthritis with the following process: Search 1 (septic arthritis [MeSH]); Search 2 (septic [tw] AND arthritis [tw]); Search 3 (Nos. 1 and 2); Search 4 (pediatric [MeSH]); Search 5 (Nos. 3 and 4); Search 6 (Limit human). This was supplemented by reviewing pertinent references from retrieved articles and textbooks. The search was limited to studies published in English. Abstracts for all articles were reviewed, and articles with any possibility for inclusion were retrieved and reviewed. An oral consensus approach was then utilized to make recommendations regarding inclusion criteria, exclusion criteria, standardized laboratory evaluation, standardized imaging criteria, indications for aspiration, indications for surgical drainage, indications for medical management, choice of antibiotics, dosage of antibiotics, transition from parenteral or enteral antibiotics, discharge criteria, and follow-up. Disagreements with regard to recommendations were resolved by consensus opinion. Annotations were developed regarding information concerning the laboratory workup, information concerning laboratory tests on aspiration specimens, rationale and references for decision points, and a discharge plan. A standardized order sheet was constructed (see Appendix).

The efficacy of the clinical practice guideline was evaluated by comparing a historical control group of thirty consecutive children with septic arthritis of the hip managed before utilization of the guideline (in 1993, 1994, or 1995) with a prospective cohort group of thirty consecutive children treated with use of the guideline (in 1995, 1996, or 1997). The relatively large number of patients seen with septic arthritis of the hip probably represents the tertiary-care nature of the hospital. The clinical practice guideline was developed for treatment of septic arthritis of all joints in children. However, we studied the efficacy of the guideline with regard to treatment

of septic arthritis of the hip with the rationale that it is relatively common, it has the potential for serious sequelae, the guideline had been developed in our institution because there was substantial variation in the management of septic arthritis of the hip, and studying the efficacy of the guideline for the treatment of a single joint would allow more uniformity of patient populations for comparison. Explicit exclusion criteria for both groups included an age of less than six months or more than eighteen years, major coexisting disease, postoperative infection, chronic joint infection, perforating injuries, psoriasis, polyarthritis, associated osteomyelitis or psoas abscess, less than one year of objective follow-up with physical examination and radiographic evaluation and less than two years of clinical follow-up (telephone interview). During the data-collection period for the group not treated according to the guideline, four patients were excluded because of neonatal sepsis; one, because of immunocompromise; and one, because of insufficient follow-up. During the data-collection period for the group treated according to the guideline, three patients were excluded because of neonatal sepsis; two, because of immunocompromise; one, because of postoperative septic arthritis; and one, because of insufficient follow-up. All patients in both groups underwent surgical drainage of the septic hip through an anterior approach. Institutional review board approval was obtained for the development of the guideline and for the review of patient records. Sample size determination demonstrated that thirty patients per group were necessary to have 85% power ($\beta = 0.15$) to detect a 20% reduction in hospital stay in the group treated according to the guideline compared with the baseline mean hospital stay of 8.3 days in the group not treated according to the guideline, with the assumption that the common standard deviation is 2.1, with use of a two-group t test with a 0.050 two-sided significance level. Hospital stay was chosen as the primary end point for determination of sample size because of the lack of a stable baseline estimate of the prevalence of septic osteonecrosis or recurrent infection.

Benchmark parameters of process and outcome were compared between groups. History process parameters included documentation of history regarding trauma, recent infections, antibiotic use, fever and/or chills, and limp. Physical examination process parameters included documentation of temperature at presentation, results of hip examination, walking status, and vital signs. Laboratory, radiographic, and treatment process parameters included determination of the initial complete blood-cell count with differential, initial erythrocyte sedimentation rate, and initial C-reactive protein level; performance of an initial blood culture, initial radiographic evaluation of the hip, initial ultrasonographic evaluation of the hip, initial bone scan, joint fluid cell count, and joint fluid culture; presumptive drainage; time (hours) from the initial presentation to surgical drainage; placement of a drain; obtaining a specimen for pathological evaluation; use of the recommended antibiotic and dosage; determination of the follow-up complete blood-cell count, follow-up erythrocyte sedimentation rate, and follow-up C-reactive protein level; time (days)

TABLE I Comparison of Patients Treated According to the Guideline with Those Not Treated According to the Guideline*

Variable	Patients Treated According to the Guideline (N = 30)	Patients Not Treated According to the Guideline (N = 30)	P Value
Age† (yr)	6.0 (2.5)	5.8 (3.2)	0.74
Male	16 (53%)	14 (47%)	0.81
Duration of symptoms† (days)	1.7 (1.5)	1.9 (1.7)	0.71
History of trauma documented	24 (80%)	19 (63%)	0.25
History of recent infections documented	26 (87%)	23 (77%)	0.51
History of antibiotic use documented	24 (80%)	22 (73%)	0.76
History of fever/chills documented	28 (93%)	25 (83%)	0.42
History of limp documented	29 (97%)	25 (83%)	0.20
Temperature measured	30 (100%)	29 (97%)	1.00
Results of hip examination documented	29 (97%)	29 (97%)	1.00
Walking status documented	28 (93%)	26 (87%)	0.67
Vital signs tested	28 (93%)	30 (100%)	0.49
Initial complete blood-cell count with differential determined	30 (100%)	30 (100%)	1.00
Initial erythrocyte sedimentation rate determined	30 (100%)	28 (93%)	0.49
Initial C-reactive protein level determined	28 (93%)	4 (13%)	<0.001
Initial blood cultures performed	29 (97%)	28 (93%)	1.00
Initial hip radiographs made	29 (97%)	25 (83%)	0.20
Initial hip ultrasonography performed	28 (93%)	27 (90%)	1.00
Initial bone scan performed	4 (13%)	12 (40%)	0.039
Joint fluid cell count determined	28 (93%)	28 (93%)	1.00
Joint fluid cultures performed	29 (97%)	30 (100%)	1.00
Presumptive drainage performed	4 (13%)	14 (47%)	0.010
Time to surgery† (hr)	10.0 (3.0)	10.3 (6.0)	0.80
Drain placed	27 (90%)	29 (97%)	0.61
Pathology specimen obtained	26 (87%)	25 (83%)	1.00
Recommended antibiotic and dosage used	28 (93%)	2 (7%)	<0.001
Follow-up erythrocyte sedimentation rate determined	23 (77%)	23 (77%)	1.00
Follow-up C-reactive protein level determined	21 (70%)	2 (7%)	<0.001
Follow-up complete blood-cell count determined	24 (80%)	23 (77%)	1.00
Time until change to oral antibiotics† (days)	3.9 (1.1)	6.9 (2.0)	<0.001
Hospital stay† (days)	4.8 (1.2)	8.3 (2.1)	<0.001
Readmission to hospital	0 (0%)	0 (0%)	1.00
Recurrent infection	0 (0%)	0 (0%)	1.00
Development of osteomyelitis	0 (0%)	0 (0%)	1.00
Recurrent drainage	0 (0%)	0 (0%)	1.00
Septic osteonecrosis	0 (0%)	0 (0%)	1.00
Limitation of motion at final follow-up	1 (3%)	0 (0%)	1.00

*The values are given as the number of patients with the percentage in parentheses unless otherwise indicated. †The values are given as the mean and standard deviation.

until the change to oral antibiotics; and duration (days) of hospital stay. Presumptive drainage was defined as surgical drainage in cases in which a joint fluid cell count and a gram stain or cultures had not been performed preoperatively or in cases in

which the joint fluid cell count was <50,000 white blood cells per high-power field and the gram stain was negative. The recommended initial intravenous antibiotic treatment was defined as 50 mg/kg of cefazolin every eight hours (maximum

dose, 12 g/day) or 40 mg/kg/day of clindamycin in divided doses every eight hours (maximum dose, 4.8 g/day) for patients allergic to penicillin. The recommended oral antibiotic treatment was defined as 100 mg/kg/day of cephalexin in divided doses four times per day. Nonrecommended antibiotic treatment was defined as use of any other antibiotic or dosage.

Outcome parameters included readmission to the hospital, recurrent infection, development of osteomyelitis, recurrent drainage, septic osteonecrosis, and limitation of motion. All patients had a minimum two-year subjective follow-up (mean, 6.2 years; range, 4.7 to 9.5 years) of their clinical course by means of a telephone interview and a minimum one-year objective follow-up (mean, 1.5 years; range, 1.1 to 2.7 years) with a physical examination and radiographic evaluation.

A priori hypotheses were that utilization of the clinical practice guideline would result in more thorough documentation of history and findings of physical examination, more complete initial and follow-up laboratory evaluation, a shorter hospital stay, a faster change to oral antibiotics, less frequent presumptive drainage, and greater standardization of antibiotic treatment, with no increase in complications.

Statistical comparisons between the group treated according to the guideline and the group not treated according to the guideline were made with use of the chi-square test or the Fisher exact test for comparison of proportions and with use of the independent sample t test with the Levene test for equality of variances for comparison of continuous variables. Statistical analysis was performed with SPSS (version 10.1; SPSS, Chicago, Illinois), SAS (version 6.12; SAS Institute, Cary, North Carolina), and nQuery Advisor (version 4.0; Statistical Solutions, Saugus, Massachusetts) software packages. All reported p values are two-tailed with an alpha level of 0.05 indicating significance.

Results (Table I)

The clinical practice guideline, order sheets, and discharge information sheet are shown in the Appendix.

The group treated with use of the guideline, compared with the group treated before utilization of the guideline, had significantly higher rates of performance of initial and follow-up C-reactive protein tests (93% compared with 13% and 70% compared with 7%), a lower rate of initial bone-scanning (13% compared with 40%), a lower rate of presumptive drainage (13% compared with 47%), a greater compliance with recommended antibiotic therapy (93% compared with 7%), a faster change to oral antibiotics (3.9 compared with 6.9 days), and a shorter hospital stay (4.8 compared with 8.3 days) (Table I).

There were no significant differences between the groups with regard to age, gender, or duration of symptoms. There were also no significant differences with regard to the process variables regarding documentation of a history of trauma, recent infections, antibiotic use, fever and/or chills, or limp; documentation of initial temperature, results of hip examination, walking status, or vital signs; determination of initial complete blood-cell count with differential or initial erythrocyte sedimentation rate; performance of initial blood cultures,

initial radiographic examination of the hip, initial ultrasonographic examination of the hip, joint fluid cell count, or joint fluid cultures; obtaining a specimen for pathological evaluation; determination of a follow-up complete blood-cell count or follow-up erythrocyte sedimentation rate; time (hours) from the initial presentation to surgical drainage; or drain placement.

In terms of outcome, there was no significant difference between the groups regarding limitation of motion. No patient in either group was readmitted to the hospital or had recurrent infection, recurrent drainage, development of osteomyelitis, or septic osteonecrosis.

Discussion

We developed a clinical practice guideline for treatment of septic arthritis in children and validated its efficacy in improving the process of care without adversely affecting outcome. Although septic arthritis in children is a relatively uncommon condition, there was a perceived need for the development of this guideline at our institution because of considerable variation in management regarding diagnostic workup, imaging studies, surgical management, antibiotic management, and follow-up. The guideline was developed by an interdisciplinary group comprised of the pediatric specialties involved in the management of children with septic arthritis. A systematic review of the best available evidence⁹⁻⁴⁸ was performed, and consensus recommendations were made to develop an algorithm for the workup and management of children with septic arthritis. Our a priori hypotheses were that the guideline would result in greater standardization of care and enhanced efficiency of care without an increase in complications or sequelae.

In evaluating the effect of this clinical practice guideline on the management of septic arthritis of the hip in children, we found that the patients treated with use of the guideline had less variation of care: there were higher rates of performance of initial and follow-up C-reactive protein tests, less use of initial bone scintigraphy, lower rates of presumptive drainage, and greater compliance with recommended antibiotic therapy. In addition, use of the guideline resulted in greater efficiency of care. The decreases in the hospital stay (from 8.3 to 4.8 days) and in the time until the change to oral antibiotics (from 6.9 to 3.9 days) were dramatic and have great potential for cost savings and ease of management for both the child and the family. Most importantly, there was no increase in the rates of adverse events such as readmission to the hospital, recurrent infection, recurrent drainage, development of osteomyelitis, septic osteonecrosis, or limitation of motion.

Limitations of this study include the difficulties inherent in standardizing the medical process. Although the guideline was based on a systematic review of evidence, some specific decisions within the algorithm were nevertheless based on clinical opinion. In step 5 of the guideline (see Appendix), the decision to proceed with hip aspiration is contingent on clinical suspicion of septic arthritis after the initial recording of the history (step 1), physical examination (step 2), laboratory

evaluation (step 4), and imaging (step 4). At our institution, we utilize a previously published clinical prediction algorithm for the differentiation of septic arthritis from transient synovitis³³; however, the use of prediction rules and clinical practice guidelines is not intended to replace clinical judgment.

The recommended dosage for antibiotic therapy is higher than the usual perioperative antibiotic dosage. This recommendation was based primarily on reports in the infectious disease literature that showed that higher dosages are required for adequate bone and joint penetration and that such dosages resulted in lower rates of recurrent or persistent infection^{12,26,35-39,42-44,47}. Although use of the guideline dramatically increased compliance with recommendations regarding antibiotic therapy (93% compared with 7%), and although there was underdosing in the group not treated according to the guideline, none of the patients who were not treated according to the guideline were readmitted to the hospital or had recurrent infection, recurrent drainage, osteomyelitis, or septic osteonecrosis. Contemporaneous changes in the management of musculoskeletal bone and joint infections over the study period (1993 through 1997) may have contributed to the faster change to oral antibiotics and shorter hospital stay that we observed in the group treated according to the guideline. The relatively early switch to oral antibiotics (after seventy-two hours of intravenous antibiotic therapy) recommended by the guideline applies only to patients with uncomplicated septic arthritis (without risk factors for a poor outcome) who have had a good response to initial drainage and intravenous antibiotics. When an infant or child has a delay in diagnosis, lack of improvement with drainage and intravenous antibiotic therapy, or associated osteomyelitis, use of the guideline is discontinued. Such patients are typically managed with infectious disease consultation, additional imaging to look for associated osteomyelitis, and prolonged intravenous antibiotic therapy.


Presumptive drainage was operationally defined as drainage in patients for whom joint fluid analysis had not been performed preoperatively or was not clearly consistent with septic arthritis (<50,000 white blood cells per high-power field and a negative gram stain). Although the rate of presumptive drainage decreased in the group managed according to the guideline (from 47% to 13%), in some instances presumptive drainage was probably indicated. Examples include clinically obvious cases of septic arthritis, in which preoperative aspiration might have delayed drainage, and patients with intermediate values for the joint-fluid parameters but a high clinical index of suspicion or pretreatment with antibiotics before aspiration. In these cases, the risks of not draining a potentially septic hip likely outweigh the risks of draining a possibly nonseptic hip. As such, the guideline was written to allow for this index of clinical suspicion for cases with intermediate values for joint fluid parameters.

With reduction of inpatient hospital stays, there is the potential for cost-shifting to the outpatient setting. A multicenter evaluation of clinical practice guidelines for hip replacement, knee replacement, and treatment of hip fracture demonstrated a reduced hospital stay without a change in out-

come, but there was substantial cost-shifting to rehabilitation centers and home services⁴⁹. In our very different population of children with septic arthritis of the hip, cost-shifting to intensive home services was less likely since patients were discharged to home, were taking oral antibiotics, and needed minimal home services. However, formal cost identification was not performed in the present study.

Evidence-based medicine involves the conscientious, explicit, and judicious use of current best evidence for making decisions about the care of individual patients⁶. The development of clinical practice guidelines has been a major emphasis of the evidence-based-medicine movement in order to standardize the process of care, optimize outcomes, and enhance efficiency¹⁻⁵. However, a guideline is only as strong as the evidence on which it is based and the flexibility, clinical experience, and practical wisdom used to apply it¹⁻⁵. Disadvantages of guidelines include the potential to harm patients when inappropriately rigid guidelines fail to account for individual variation, loss of physician autonomy, and the potential for forced acceptance of inherent clinical value judgments¹⁻⁵. The overall goal of our guideline was to provide clinicians with an analytical framework for the evaluation and treatment of children with septic arthritis. The guideline is not intended as a strict protocol for all patients, nor is it intended to replace clinical judgment. When a patient is atypical, has risk factors for a poor outcome, or is not responding to treatment, the guideline should be abandoned and treatment should be carried out as clinically indicated.

Appendix

 The clinical practice guideline, order sheets, and discharge orders can be found with the electronic versions of this article, on our web site at www.jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

Mininder S. Kocher, MD, MPH

Rahul Mandiga, BS

Jane M. Murphy, RN, MS

Donald Goldmann, MD

Marvin Harper, MD

Robert Sundel, MD

Kirsten Ecklund, MD

James R. Kasser, MD

Departments of Orthopaedic Surgery (M.S.K., R.M., and J.R.K.), Nursing (J.M.), Infectious Disease (D.G.), Emergency Medicine (M.H.), Rheumatology (R.S.), and Radiology (K.E.), Children's Hospital, 300 Longwood Avenue, Boston, MA 02115. E-mail address for M.S. Kocher: mininder.kocher@tch.harvard.edu

The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or associated.

References

1. **Committee to Advise the Public Health Service on Clinical Practice Guidelines, Institute of Medicine.** *Clinical practice guidelines: directions for a new program.* Field MJ, Lohr KN, editors. Washington, DC: National Academy; 1990.
2. **Grimshaw J, Eccles M.** Clinical practice guidelines. In: Silagy C, Haines A, editors. *Evidence-based practice in primary care.* 2nd ed. London: BMJ Books; 2001. p 110-22.
3. **Ellrodt AG, Conner L, Riedinger M, Weingarten S.** Measuring and improving physician compliance with clinical practice guidelines. A controlled interventional trial. *Ann Intern Med.* 1995;122:277-82.
4. **Hayward RS, Wilson MC, Tunis SR, Bass EB, Guyatt G.** Users' guides to the medical literature. VIII. How to use clinical practice guidelines. A. Are the recommendations valid? The Evidence-Based Medicine Working Group. *JAMA.* 1995;274:570-4.
5. **Wilson MC, Hayward RS, Tunis SR, Bass EB, Guyatt G.** Users' guides to the Medical Literature. VIII. How to use clinical practice guidelines. B. What are the recommendations and will they help you in caring for your patients? The Evidence-Based Medicine Working Group. *JAMA.* 1995;274:1630-2.
6. **Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS.** Evidence based medicine: what it is and what it isn't. *BMJ.* 1996;312:71-2.
7. **Cook DJ, Greengold NL, Ellrodt AG, Weingarten SR.** The relation between systematic reviews and practice guidelines. *Ann Intern Med.* 1997;127:210-6.
8. **Agency for Healthcare Research and Quality.** AHRQ profile: Quality research for quality health care. www.ahrq.gov/about/profile.htm.
9. **Barton LL, Dunkle LM, Habib FH.** Septic arthritis in childhood. A 13-year review. *Am J Dis Child.* 1987;141:898-900.
10. **Bennett OM, Namnyak SS.** Acute septic arthritis of the hip joint in infancy and childhood. *Clin Orthop.* 1992;281:123-32.
11. **Chen CH, Lee ZL, Yang WE, Lin TY, Shih CH.** Acute septic arthritis of the hip in children—clinical analyses of 31 cases. *Changcheng Yi Xue Za Zhi.* 1993;16:239-45.
12. **Dan M.** Septic arthritis in young infants: clinical and microbiologic correlations and therapeutic implications. *Rev Infect Dis.* 1984;6:147-55.
13. **Del Beccaro MA, Champoux AN, Bockers T, Mendelman PM.** Septic arthritis versus transient synovitis of the hip: the value of screening laboratory tests. *Ann Emerg Med.* 1992;21:1418-22.
14. **Edwards EG.** Transient synovitis of the hip joint in children. *JAMA.* 1952;148:30-4.
15. **Fabry G, Meire E.** Septic arthritis of the hip in children: poor results after late and inadequate treatment. *J Pediatr Orthop.* 1983;3:461-6.
16. **Gillespie R.** Septic arthritis of childhood. *Clin Orthop.* 1973;96:152-9.
17. **Jackson MA, Nelson JD.** Etiology and medical management of acute suppurative bone and joint infections in pediatric patients. *J Pediatr Orthop.* 1982;2:313-23.
18. **Jacobs BW.** Synovitis of the hip in children and its significance. *Pediatrics.* 1971;47:558-66.
19. **Klein DM, Barbera C, Gray ST, Spero CR, Perrier G, Teicher JL.** Sensitivity of objective parameters in the diagnosis of pediatric septic hips. *Clin Orthop.* 1997;338:153-9.
20. **Kunnamo I, Kallio P, Pelkonen P, Hovi T.** Clinical signs and laboratory tests in the differential diagnosis of arthritis in children. *Am J Dis Child.* 1987;141:34-40.
21. **Molteni RA.** The differential diagnosis of benign and septic joint disease in children. Clinical, radiologic, laboratory, and joint fluid analysis, based on 37 children with septic arthritis and 97 with benign aseptic arthritis. *Clin Pediatr (Phila).* 1978;17:19-23.
22. **Petersen S, Knudsen FU, Andersen EA, Egeblad M.** Acute haematogenous osteomyelitis and septic arthritis in childhood. A 10-year review and follow-up. *Acta Orthop Scand.* 1980;51:451-7.
23. **Sharwood PF.** The irritable hip syndrome in children. A long-term follow-up. *Acta Orthop Scand.* 1981;52:633-8.
24. **Spock A.** Transient synovitis of the hip joint in children. *Pediatrics.* 1959;24:1042-9.
25. **Wopperer JM, White JJ, Gillespie R, Obletz BE.** Long-term follow-up of infantile hip sepsis. *J Pediatr Orthop.* 1988;8:322-5.
26. **Welton CJ, Long SS, Fisher MC, Alburger PD.** Pyogenic arthritis in infants and children: a review of 95 cases. *Pediatr Infect Dis.* 1986;5:669-76.
27. **Wiley JJ, Fraser GA.** Septic arthritis in childhood. *Can J Surg.* 1979;22:326-30.
28. **Peltola H, Vahvanen V, Aalto K.** Fever, C-reactive protein, and erythrocyte sedimentation rate in monitoring recovery from septic arthritis: a preliminary study. *J Pediatr Orthop.* 1984;4:170-4.
29. **McCarthy PL, Wasserman D, Spiesel SZ, Dolan TF, Jekel JF.** Evaluation of arthritis and arthralgia in the pediatric patient. *Clin Pediatr (Phila).* 1980;19:183-90.
30. **Zawin JK, Hoffer FA, Rand FF, Teele RL.** Joint effusion in children with an irritable hip: US diagnosis and aspiration. *Radiology.* 1993;187:459-63.
31. **Miralles M, Gonzalez G, Pulpeiro JR, Millan JM, Gordillo I, Serrano C, Olcoz F, Martinez A.** Sonography of the painful hip in children: 500 consecutive cases. *AJR Am J Roentgenol.* 1989;152:579-82.
32. **Jaramillo D, Treves ST, Kasser JR, Harper M, Sundel R, Laor T.** Osteomyelitis and septic arthritis in children: appropriate use of imaging to guide treatment. *AJR Am J Roentgenol.* 1995;165:399-403.
33. **Kocher MS, Zurakowski D, Kasser JR.** Differentiating between septic arthritis and transient synovitis of the hip in children: an evidence-based clinical prediction algorithm. *J Bone Joint Surg Am.* 1999;81:1662-70.
34. **Caksen H, Ozturk MK, Uzum K, Yuksel S, Ustunbas HB, Per H.** Septic arthritis in childhood. *Pediatr Int.* 2000;42:534-40.
35. **Kim HK, Alman B, Cole WG.** A shortened course of parenteral antibiotic therapy in the management of acute septic arthritis of the hip. *J Pediatr Orthop.* 2000;20:44-7.
36. **Fink CW, Nelson JD.** Septic arthritis and osteomyelitis in children. *Clin Rheum Dis.* 1986;12:423-35.
37. **Nelson JD, Bucholz RW, Kusmiesz H, Shelton S.** Benefits and risks of sequential parenteral-oral cephalosporin therapy for suppurative bone and joint infections. *J Pediatr Orthop.* 1982;2:255-62.
38. **Nelson JD.** The bacterial etiology and antibiotic management of septic arthritis in infants and children. *Pediatrics.* 1972;50:437-40.
39. **Yagupsky P, Dagan R, Howard CW, Einhorn M, Kassis I, Simu A.** High prevalence of *Kingella kingae* in joint fluid from children with septic arthritis revealed by the BACTEC blood culture system. *J Clin Microbiol.* 1992;30:1278-81.
40. **Shmerling RH.** Synovial fluid analysis. A critical reappraisal. *Rheum Dis Clin North Am.* 1994;20:503-12.
41. **Volberg FM, Sumner TE, Abramson JS, Winchester PH.** Unreliability of radiographic diagnosis of septic hip in children. *Pediatrics.* 1984;74:118-20.
42. **Nelson JD, Howard JB, Shelton S.** Oral antibiotic therapy for skeletal infections of children. I. Antibiotic concentrations in suppurative synovial fluid. *J Pediatr.* 1978;92:131-4.
43. **Tetzlaff TR, McCracken GH Jr, Nelson JD.** Oral antibiotic therapy for skeletal infections of children. II. Therapy of osteomyelitis and suppurative arthritis. *J Pediatr.* 1978;92:485-90.
44. **Kolyvas E, Ahronheim G, Marks MI, Gledhill R, Owen H, Rosenthal L.** Oral antibiotic therapy of skeletal infections in children. *Pediatrics.* 1980;65:867-71.
45. **Jackson MA, Burry VF, Olson LC.** Pyogenic arthritis associated with adjacent osteomyelitis: identification of the sequela-prone child. *Pediatr Infect Dis J.* 1992;11:9-13.
46. **Steere AC, Schoen RT, Taylor E.** The clinical evolution of Lyme arthritis. *Ann Intern Med.* 1987;107:725-31.
47. **Ho G Jr, Su EY.** Therapy for septic arthritis. *JAMA.* 1982;247:797-800.
48. **Samilson RL, Bersani FA, Watkins MB.** Acute suppurative arthritis in infants and children: the importance of early diagnosis and surgical drainage. *Pediatrics.* 1958;21:798-805.
49. **Weingarten S, Riedinger MS, Sandhu M, Bowers C, Ellrodt AG, Nunn C, Hobson P, Greengold N.** Can practice guidelines safely reduce hospital length of stay? Results from a multicenter interventional study. *Am J Med.* 1998;105:33-40.