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Brief Reports

DEFINITIVE DIAGNOSIS OF CHILDREN PRESENTING TO A PEDIATRIC EMERGENCY DEPARTMENT WITH FEVER AND EXTREMITY PAIN

Nicolas V. Vardiabasis, DO* and John A. Schlechter, DO†

*Department of Orthopedics, Riverside County Regional Medical Center, Moreno Valley and †Department of Orthopedics, Children's Hospital Orange County, Adult and Pediatric Orthopedic Specialists, Orange, California

Reprint Address: John A. Schlechter, DO, Children's Hospital Orange County, Adult and Pediatric Orthopedic Specialists, 1310 West Stewart Drive, Suite 508, Orange, CA 92868

☐ **Abstract—Background: Children who present to the emergency department (ED) with complaint of fever and new-onset joint or extremity pain can be a diagnostic dilemma for many emergency and consulting physicians. Objectives: The purpose of our study was to identify the etiologies of pediatric fever and extremity pain presenting to a tertiary care pediatric ED and to define factors that were associated with advanced imaging, admission, and surgical intervention. Methods: The electronic medical records of children presenting to our institution's pediatric ED with fever and extremity pain were retrospectively reviewed. Data collected included demographic characteristics, laboratory studies, diagnostic imaging, need for admission, and surgical procedures. Results: The initial ED diagnosis was consistent with the definitive diagnosis 42% of the time. Children with the inability to bear weight on the affected limb were more likely to have a bacterial infection, such as osteomyelitis, septic arthritis, or intramuscular abscess ($p = 0.016$). An erythrocyte sedimentation rate >36 mm/hour and C-reactive protein levels >60 mg/L were found in children with osteomyelitis or septic arthritis ($p = 0.043$ and <0.001, respectively). Magnetic resonance imaging was ordered in 63% of children with multiple visits compared to 34% of children with a single visit ($p = 0.05$). Conclusions: In addition to a thorough history and physical examination, a complete set of laboratory studies and diagnostic imaging is necessary to reach an accurate diagnosis. The inability to bear weight, elevated C-reactive protein levels, and an elevated erythrocyte sedimentation rate are associated with bacterial infection. Magnetic resonance imaging is a useful imaging modality in determining an accurate diagnosis.** © 2017 Elsevier Inc. All rights reserved.

☐ **Keywords—extremity; fever; osteomyelitis; pain; pediatric; septic arthritis**

INTRODUCTION

Fever is one of the most common presenting symptoms to pediatric emergency departments (EDs). Nearly one-third of children present with a chief complaint of fever, and a smaller portion of those children also present with pain in ≥1 extremity (1–3). Children who present to the ED with a complaint of fever and new-onset joint or extremity pain can be a diagnostic dilemma for many emergency and consulting physicians. Certain conditions, such as osteomyelitis and septic arthritis, warrant admission, whereas other children with more benign conditions can be safely discharged home. Given the limited time and resources and the large differential in diagnoses for a child presenting with fever and extremity pain, the decision to perform additional studies in the ED, admit, or discharge home is a difficult one. Also, the final diagnosis sometimes does not become evident until months or even years later. Despite the high volume of children who present with this complaint, few series exist documenting the difference in laboratory studies, diagnostic imaging, and clinical findings that are seen in this population. The

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purpose of our study was to identify the etiologies of pediatric fever and extremity pain presenting to a tertiary care pediatric ED and to define factors that were associated with advanced imaging, admission, and surgical intervention.

METHODS

After obtaining approval from the institutional review board at our hospital, the electronic medical records of children presenting to our institution's pediatric ED between April 1, 2013 and April 1, 2014 with *International Classification of Diseases, 9th revision* codes 719.4 (pain in joint, arthralgias), 729.5 (pain in limb), and 780.6 (fever and other physiologic disturbances of temperature regulation excludes: effects of reduced environmental temperature (991.0–991.9) effects of heat and light (992.0–992.9) fever, chills, or hypothermia associated with confirmed infection) were retrospectively reviewed. Our search yielded 294 children. Of those children, 48 met our inclusion criteria of age <18 years presenting directly to our ED with a documented parental fever at home or a documented fever in the ED, a complaint of extremity pain, follow-up until definitive diagnosis was made or symptoms resolved, and with a complete chart (Figure 1). Chief complaints and discharge or admission diagnoses were reviewed and were recorded along with demographic data, including age and sex. Individuals underwent a full chart review by a single observer, a senior orthopedic surgery resident, to determine the etiology of the complaint.

The presence of either a measured fever in the ED or documented parental fever and the number of presentations to any outpatient clinic or ED were all recorded. Fever was defined as axillary, rectal, or oral temperature >38°C.

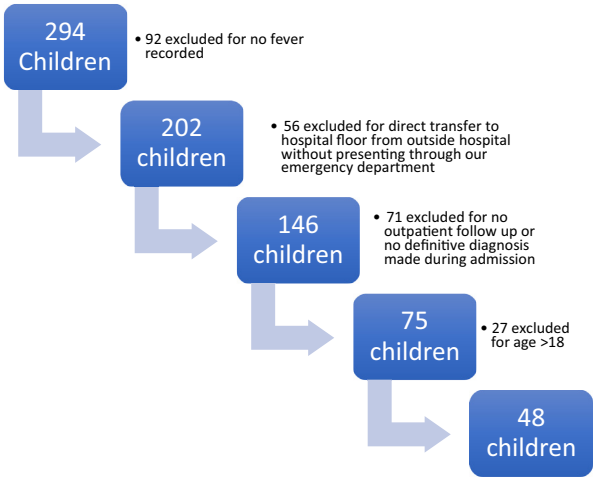

Figure 1. Patients included for final analysis in study.

The ability to bear weight, extremity involved, and if multiple extremities were involved were also documented. Inability to bear weight was defined as refusal to bear any weight on the affected limb. Limping was not defined as an inability to bear weight in our study.

Radiographic and advanced imaging was also recorded when obtained for each child. All imaging was reviewed by a radiologist, and their impression determined whether a study had "positive" findings. The specific type of advanced imaging was also investigated, as was the diagnostic result. Laboratory data were documented for each child, including serum white blood cell count (WBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) level. Lastly, if a child was admitted to the hospital and whether a surgical procedure was performed in the operating room was recorded. Details of each procedure were also reviewed.

Categorical data were analyzed using the chi-squared test or the alternative Fisher's exact test if the assumptions of the chi-square were violated. Interval data (i.e., CRP, WBC, and ESR) were analyzed using analysis of variance. Interval data were checked for normality and homogeneity of variances before application of parametric statistics. Alpha was set at $p < 0.05$, and SPSS software (version 12; SPSS, Inc., Chicago, IL) was used for all analyses.

RESULTS

The average age of children presenting to the ED with fever and extremity pain was 6.8 years (range 0.3–17 years). There were 21 females and 27 males. Twenty of the 48 children (42%) had a measured fever in the ED.

The initial ED diagnosis was consistent with the definitive diagnosis 42% of the time. The most common diagnoses were osteomyelitis (10 children), oncological/chemotherapy-induced (7 children), rheumatologic (7 children), and septic arthritis (4 children). The complete list of diagnoses is shown in Table 1.

Multiple ED visits (≥2) were seen in 19 of 48 children (40%). Children with multiple visits did not show a statistically significant increase in the number of radiographs, computed tomography, ultrasound, or bone scans ordered ($p = 0.725$, 0.372, 0.074, and 0.512, respectively). Magnetic resonance imaging (MRI), on the other hand, was ordered in 63% of children with multiple visits compared to 34% of children with a single visit ($p = 0.05$).

Documented parental fever versus measured fever in the ED showed no statistical difference in admission rates ($p = 0.342$) or with a diagnosis of bacterial infection ($p = 0.766$).

Children who presented with the inability to bear weight on the affected limb were more likely to have a

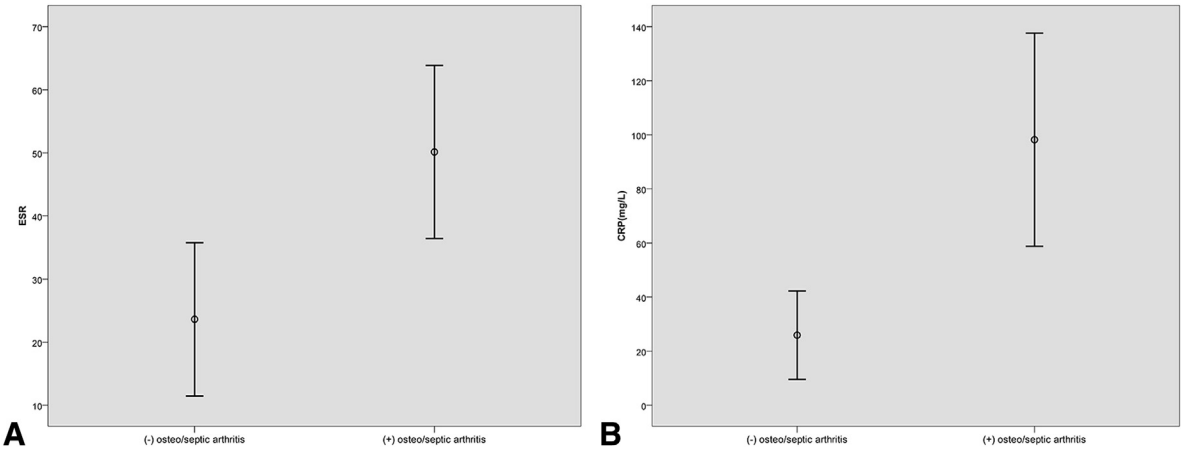

Figure 2. (A) Erythrocyte sedimentation rate (ESR) and (B) C-reactive protein (CRP) levels in children with and without osteomyelitis or septic arthritis.

bacterial infection, such as osteomyelitis, septic arthritis, or abscess ($p = 0.016$).

Setting our confidence interval at 95% an ESR >36 mm/hour was found in all children diagnosed with osteomyelitis or septic arthritis ($p = 0.043$). A CRP of >60 mg/L was observed in those with a definitive diagnosis of osteomyelitis or septic arthritis ($p < 0.001$). Like previous studies, we also observed an inability to bear weight as another associated finding in children with osteomyelitis or septic arthritis ($p = 0.016$).

A statistical difference in ESR and CRP between children with a diagnosis of osteomyelitis or septic arthritis with those without a diagnosis of osteomyelitis and septic arthritis was found ($p = 0.043$ and < 0.001, respectively) (Figure 2).

Children with a diagnosis of osteomyelitis or septic arthritis had a mean WBC of 11,700/mm^3 (range 5,600–23,900/mm^3) compared to a mean WBC of 9600/mm^3 (range 100–28,200/mm^3) in children without osteomyelitis or septic arthritis. This was not statistically significant ($p = 0.774$).

Thirty-seven of the children were admitted, and 15 of them underwent surgery for biopsy or incision and drainage of the abscess/infection.

DISCUSSION

Children who present with fever and extremity pain could have one of a myriad of clinical diagnoses. Determining the appropriate work-up and diagnosis is paramount to preventing rapid deterioration and permanent impairment of the affected bone or joint. Our study sought to identify the etiologies of pediatric fever and extremity pain in patients presenting to a tertiary care pediatric ED and to define factors that were associated with advanced imaging, admission, and surgical intervention.

Previous studies have highlighted the importance of elevated laboratory values as a marker of serious infection. Kocher et al. developed a clinical prediction algorithm to distinguish septic arthritis from transient synovitis (4). Their study showed that an elevated temperature of >38.5°C, ESR of >40 mm/hour, refusal to bear weight, and a WBC of >12,000/mm^3 were predictive of septic arthritis of the hip. Other studies have verified the Kocher algorithm, and have added CRP >20 mg/L as another criterion to aid in the diagnosis of septic arthritis (5). Our study showed a similar cutoff for ESR as a marker for bacterial bone and joint infection, but a slightly higher cutoff for CRP—36 mm/hour and 60 mg/L, respectively.

In addition to obtaining inflammatory markers, our study showed that multiple diagnostic studies were routinely ordered in the ED for children presenting with fever and extremity pain. The most common diagnostic study obtained was radiography, with 70.8% of children having ≥1 radiographs obtained. The diagnostic value of these radiographs, however, was not as high; 17.6% of the images had positive findings. While not highly diagnostic, routine radiographs for children with fever and extremity pain are recommended as an initial study by several researchers (6,7). The sensitivity and specificity of radiographs range from 43% to 75% and from 75% to 83%, respectively (6). Plain radiographs are relatively inexpensive and easy to obtain; they can show soft tissue swelling, loss of tissue planes, or joint space widening, which may aid in the diagnosis or prompt the clinician to pursue additional imaging. In addition, other causes of extremity pain, such as fracture or dislocation, can be easily diagnosed.

Other imaging obtained after radiography in our study included ultrasound, computed tomography, bone scan, and MRI, with the latter ordered most

Table 1. All Patients Included in the Study

Age	Sex	No. of ED Visits	Fever in the ED	T_{max}	Extremity Involved	Able to Bear Weight	WBC	ESR	CRP	BCx	WCx	XR	MRI	Admitted?	ED Diagnosis	Final Diagnosis
2	F	3	No	0	Leg	Yes	0	0	0	0	0	0	0	No	Transient synovitis	Transient synovitis
5	F	2	Yes	38.6	Shoulder, ankles	Yes	0	0	0	0	0	0	0	No	Chronic joint pain	Benign joint hypermobility
7	F	2	No	0	Legs, ankles	Yes	15.9	28	49	–	0	0	–	Yes	Leg pain	Addison's disease
3	M	1	No	0	Ankle	Yes	0	0	0	0	0	0	0	No	Viral myositis	Viral myositis
2	M	1	No	0	Knee	Yes	9.7	0	0	0	0	0	0	No	Knee pain	Knee pain
9	F	1	No	0	Leg	Yes	5.4	0	0	0	0	–	0	Yes	Rhabdomyolysis	Rhabdomyolysis
2	M	1	No	0	Foot	Yes	0	0	0	0	0	–	0	No	Foot pain	Foot pain
8	M	1	Yes	38.5	Foot	Yes	0	0	0	0	0	–	0	No	Arthralgia	Familial Mediterranean fever
2	F	1	Yes	38.8	Ankles	No	13.1	82	77.9	–	0	0	0	No	Ankle pain	Juvenile arthritis
16	M	1	No	0	Knee	Yes	6.9	10	16.6	0	0	0	0	No	Knee effusion	Knee effusion
17	F	2	No	0	Hip	Yes	8.9	52	155.2	0	0	–	–	No	Hip pain	Trochanteric bursitis
11	M	3	Yes	40	Legs	No	15.2	122	212	0	0	–	0	Yes	Erythema nodosum	Erythema nodosum
4	F	2	No	0	Legs	No	2.9	0	0	0	0	–	0	Yes	ALL	Chemotherapy-induced neuropathy
3	F	1	No	0	Legs	Yes	21.9	0	0	0	0	0	0	Yes	Sickle crisis	Sickle crisis
7	F	1	Yes	38.4	Thigh	No	9.4	0	0	0	0	+	0	Yes	Leg pain	Neuroblastoma metastasis
4	M	3	No	0	Leg	Yes	12.3	17	25.8	0	0	+	–	Yes	Leg pain	Transient synovitis
6	F	1	Yes	38.6	Legs	Yes	0.4	0	0	–	0	–	–	Yes	Febrile neutropenia	Febrile neutropenia
1	M	1	No	0	Legs, arms	Yes	25.5	0	26.3	0	0	–	0	Yes	Sickle crisis	Sickle crisis
2	F	1	Yes	40	Knee	Yes	28.2	0	0	–	0	0	0	Yes	Pyelonephritis	Pyelonephritis
11	F	2	Yes	38	Hands, feet	Yes	10.5	10	27.7	–	0	0	0	Yes	Viral myositis	Viral myositis
7	F	1	Yes	39	Feet	Yes	0.1	0	0	0	0	0	0	Yes	Febrile neutropenia	Febrile neutropenia
4	F	1	Yes	38.9	Legs	Yes	5.1	41	5.6	0	0	0	0	Yes	Acute febrile illness	Chemotherapy-induced neuropathy
3 mo	M	1	Yes	38.7	Shoulder	Yes	13.1	22	21.9	–	0	–	0	Yes	Acute febrile illness	Acute febrile illness
5	F	2	No	0	Legs	No	22.5	87	52.8	–	0	0	0	Yes	Acute febrile illness	Henoch–Schönlein purpura
6	M	1	Yes	38.3	Arms, legs	Yes	6	127	42.5	–	0	+	0	Yes	Acute febrile illness	ALL
9 mo	M	1	No	0	Hip	No	19.8	57	30.8	–	–	–	+	Yes	Transient synovitis	Juvenile arthritis
17	M	1	No	0	Legs, arms	Yes	14.3	0	0	–	0	–	0	Yes	Sickle crisis	Sickle crisis
2	M	1	No	0	Elbow, knees	Yes	7.4	9	0	0	0	0	0	No	Reactive arthritis	Transient hypogammaglobulinemia of infancy
13	F	1	No	0	Foot	No	7.8	32	0	0	0	–	0	No	Foot pain	Poststreptococcal reactive arthritis
7	F	2	No	0	Foot	Yes	7	14	<5	0	+	–	+	Yes	Cellulitis	Paronychia
11	M	1	Yes	39.4	Leg	Yes	9.2	40	70.7	–	–	–	+	Yes	Tibia osteomyelitis	Tibia osteomyeltis
4	M	1	No	0	Knee	Yes	9.8	38	34.5	–	0	–	0	Yes	Septic arthritis	Knee cellulitis
15	M	4	No	0	Ankle	No	10.8	29	127.2	+	+	–	+	Yes	Tibia osteomyelitis	Tibia osteomyeltis
6	M	1	No	0	Knee	Yes	9.9	32	68.2	–	–	–	+	Yes	Leg pain	Tibia osteomyeltis
7	M	1	No	0	Hip	No	10.1	67	27.5	+	0	–	+	Yes	Transient synovitis	Pelvis osteomyelitis
11	M	1	Yes	38.2	Knee, hip	No	17.4	23	27.9	0	–	–	–	Yes	Knee effusion	Juvenile arthritis
6 mo	M	2	No	0	Ankle	No	23.9	59	73.6	+	+	–	+	Yes	Hip effusion	Ankle septic arthritis
6	M	1	No	0	Knee	Yes	5.5	32	47.8	–	–	–	+	Yes	Femur osteomyelitis	ALL

(*Continued*)

Table 1. Continued

Age	Sex	No. of ED Visits	Fever in the ED	T_{max}	Extremity Involved	Able to Bear Weight	WBC	ESR	CRP	BCx	WCx	XR	MRI	Admitted?	ED Diagnosis	Final Diagnosis
6	M	1	Yes	39	Leg	No	13.3	25	43.1	–	–	–	+	Yes	Leg pain	Hip septic arthritis
14	M	1	Yes	38.4	Ankle	No	13.6	85	179.5	–	+	+	+	Yes	Tibia osteomyelitis	Tibia osteomyelitis
2	F	1	No	0	Leg	No	9.1	48	59.4	+	+	–	+	Yes	Leg pain	Tibia osteomyelitis
10	F	2	No	0	Hip	No	10.9	67	194.2	+	+	–	+	Yes	Hip effusion	Hip septic arthritis
13	M	3	Yes	38.1	Shoulder	Yes	5.3	68	126.3	+	0	–	+	Yes	Humerus osteomyelitis	Humerus osteomyelitis
11	M	2	No	0	Foot	No	5.6	12	169.7	+	0	1	+	Yes	Foot Pain	Calcaneal osteomyelitis
22 mo	F	2	Yes	38.3	Hip	No	23.5	30	14.7	–	+	–	0	Yes	Hip effusion	Hip septic arthritis
6	F	2	No	0	Hip	No	7.1	0	0	+	+	–	+	Yes	Sepsis	Gluteal abscess
5	M	2	No	0	Ankle	Yes	11.3	92	13.4	–	+	+	+	Yes	Fibula osteomyelitis	Fibula osteomyelitis
13	M	4	Yes	38.3	Knee	Yes	7.4	48	207.3	–	+	+	+	Yes	Bone lesion	Tibia osteomyeltis

0 = not obtained; + = positive finding/result; – = negative finding/result; ALL = acute lymphocytic leukemia; BCx = blood culture; CRP = C-reactive protein; ED = emergency department; ESR = erythrocyte sedimentation rate; F = female; M = male; MRI = magnetic resonance imaging; T_{max} = temperature maximum; WBC = white blood cell count; WCx = wound, bone, or synovial culture; XR = radiography results.

frequently and having positive findings in 77.3% of children. MRI has been shown to have a high sensitivity and specificity, with values ranging from 88% to 100% and 75% to 100%, respectively (8,9). MRI is useful in distinguishing, among other diagnoses, transient synovitis from septic arthritis, which has been shown to not be easily distinguishable on ultrasound (10,11). In our study, as in previous studies, MRI was also found to be helpful in diagnosing other bacterial infections, such as osteomyelitis and soft tissue abscess (12,13). In addition, MRI has been shown to be useful in differentiating infectious from noninfectious causes of fever and extremity pain, such as sickle cell crisis and acute lymphocytic leukemia (14–16). MRI was noted in our study to be more frequently ordered in children with multiple ED visits (p = 0.05). The cost, need for sedation, and possible admission are all factors that may keep emergency and consulting physicians from ordering MRI on the initial visit. In addition, the child's return to the ED may signal a more serious diagnosis and warrant more extensive work-up at the subsequent visit, which may be the reason for the increased number of MRIs ordered at the return visit. We believe, however, that MRI of the involved extremity is a valuable diagnostic tool. Clinicians should have a low threshold to obtain an MRI at the initial visit in every child who presents to the ED with fever, localized extremity pain, and significantly elevated ESR and CRP.

Several infectious and noninfectious conditions were diagnosed in our study population. Bacterial infection was commonly diagnosed by the emergency physician and confirmed as the definitive diagnosis by the admitting or consulting physician. Less likely to be diagnosed on initial presentation were oncologic and rheumatologic conditions that typically require extensive imaging, tissue biopsy, special serologic tests, and persistence of joint inflammation for ≥6 weeks (17). Juvenile arthritis, benign joint hypermobility, and reactive arthritis were some of the rheumatologic conditions that were diagnosed by the consulting physicians several months after the child's initial presentation to the ED. Given that these conditions are often diagnoses of exclusion, it is reasonable to expect that the correct diagnosis may not be made upon the initial ED visit. Appropriate use of laboratory studies, diagnostic imaging, and close follow-up is warranted when an inflammatory or oncologic condition is suspected (18).

It was also noted that despite appropriate work-up and follow-up in the outpatient clinics for all patients included in our study, the definitive diagnosis was found to sometimes be as equally vague as the initial ED diagnosis (Table 1). We believe—and this is well established in the literature—that children often develop intermittent,

self-limiting bouts of extremity pain, such as growing pains, which can account for some of the vague definitive diagnoses in our study (19).

In addition, the inclusion of patients without documented fever in the ED but with fever reported by the parents while at home was supported by our statistical analysis. Documented parental fever versus measured fever in the ED showed no statistical difference in admission rates ($p = 0.342$) or with a diagnosis of bacterial infection ($p = 0.766$). In addition, some patients with measured fever ultimately had noninfectious definitive diagnoses, such as benign joint hypermobility and juvenile arthritis, whereas there were several patients without documented fever in the ED that were diagnosed with osteomyelitis, septic arthritis, and acute lymphocytic leukemia. We believe that fever reported by parents as being measured at home to be reliable. The lack of an elevated temperature in the ED could possibly be related to parental administration of antipyretic medications before arriving to the hospital.

Limitations

Limitations of our study include its retrospective nature, relatively small sample size, and our dependence on appropriate coding by the ED in order to capture all children that presented with fever and extremity pain, which could introduce a selection bias to our study. In addition, a single data abstractor collected the data and input all data. This could be a possible source of abstractor bias and another limitation of our study.

CONCLUSIONS

Children with fever and extremity pain represent a common chief complaint to our ED. The inability to bear weight and elevated CRP levels and ESR are associated with bacterial infection. MRI is a useful imaging modality in determining an accurate diagnosis. Despite a thorough initial work-up, the definitive diagnosis of rheumatologic and oncologic conditions is not always evident until a later time.

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ARTICLE SUMMARY

1. Why is this topic important?

Pediatric fever and extremity pain is a common presenting symptom, but initiating the appropriate work-up and making the correct diagnosis can be difficult. This study supports the use of clinical findings such as the inability to bear weight and a laboratory work-up that includes a complete blood cell count, erythrocyte sedimentation rate, and C-reactive protein to guide further imaging modalities, admission, and surgical intervention.

2. What does this study attempt to show?

Bacterial infections of the bones and joints present with highly elevated inflammatory markers. Magnetic resonance imaging should be ordered frequently in these patients. Rheumatologic and oncologic diagnoses are difficult to make and require close follow-up.

3. What are the key findings?

Inability to bear weight and elevated erythrocyte sedimentation rate and C-reactive protein levels are diagnostic for bacterial infection.

4. How is patient care impacted?

Ordering appropriate laboratory and diagnostic studies in the emergency department can help make the correct diagnosis and initiate proper treatment.