ORIGINAL ARTICLE

ACR Appropriateness Criteria Fever Without Source or Unknown Origin—Child

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Abstract

The cause of fever in a child can often be determined from history, physical examination, and laboratory tests; infections account for the majority of cases. Yet in 20%, no apparent cause can be found, designated as fever without source (FWS). The yield of chest radiography in children with FWS is low, and it is usually not appropriate. However, in children with respiratory signs, high fever (>39°C), or marked leukocytosis (≥20,000/mm^3), chest radiography is usually appropriate, as it has a higher yield in detecting clinically occult pneumonia. In newborns with FWS, there is higher risk for serious bacterial infection, and the routine use of chest radiography is controversial. In children with neutropenia, fever is a major concern. In some clinical circumstances, such as after hematopoietic stem cell transplantation, chest CT scan may be appropriate even if the results of chest radiography are negative or nonspecific, as it has higher sensitivity and can demonstrate specific findings (such as lung nodule and "halo sign") that can guide management. In a child with prolonged fever of unknown origin despite extensive medical workup (fever of unknown origin), diagnosis is usually dependent on clinical and laboratory studies, and imaging tests have low yield.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision include an extensive analysis of current medical literature from peer reviewed journals and the application of well-established methodologies (RAND/UCLA Appropriateness Method and Grading of Recommendations Assessment, Development, and Evaluation or GRADE) to rate the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where evidence is lacking or equivocal, expert opinion may supplement the available evidence to recommend imaging or treatment.

Key Words: Appropriateness Criteria, infants and children imaging, fever without source, fever of unknown origin, occult pneumonia, sepsis workup

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The ACR seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

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SUMMARY OF LITERATURE REVIEW

Introduction/Background

A febrile pediatric patient, especially an infant, represents a dilemma for a primary care physician. The definition of fever is generally regarded as a rectal temperature of ≥38°C [1-3]. Oral temperatures are less reliable in infants and young children, although they are the usual method of measuring temperature in older children and adults. The cause of fever in a pediatric patient can often be determined from history, physical examination, and laboratory tests [4-9]. Prior medical conditions, medications, foreign travel, and immunization history are all important in directing subsequent investigations [2,10-14]. However, 20% of cases will have no apparent source and thus are defined as having fever without source (FWS) [5]. FWS is therefore defined as an acute illness in which the origin of the fever is not apparent after initial careful history and examination [2,5,6,8,9,14,15]. Most FWS are caused by infections [2,6,8,9,14,16]. The approach to a febrile child is generally divided into infants younger than three months and older infants and children between 3 and 36 months of age [3,5-7]. Infants younger than 1 month deserve more aggressive evaluation because these children have more immature immune systems, are more difficult to evaluate, and do not have the protection afforded by the *Haemophilus influenza* and *Streptococcus pneumoniae* vaccines [2,3,6,9,17].

Although FWS is mostly self-limited and of little clinical concern, the burden on clinicians is to decide which children actually have serious bacterial infections (SBIs) that require antibiotic treatment and even hospitalization [18,19]. Febrile neonates are at higher risk; the reported incidence of SBI in all febrile neonates presenting to emergency departments varies between 6% and 28% [3,20]. In children, the usual sources or causes of SBI are urinary tract infection, pneumonia, bloodstream infection, and meningitis. With the advent of vaccines for the most common pathogenic serotypes of *H influenza* and *S pneumoniae*, the incidence of SBI has dropped significantly [2,3,6,10,13,14]. Although it is implied by the definition of FWS that the etiology of fever is unknown, many studies and guidelines include children with respiratory symptoms [2,3,5,6,8,16,21-24]. For this reason, we were compelled to include in our guidelines for FWS children with respiratory symptoms.

Although the terms are sometimes used interchangeably, FWS is different from fever of unknown origin (FUO). Pediatric FUO refers to a fever of ≥38.3°C with no apparent diagnosis after initial outpatient or hospital evaluation that includes a careful history and physical examination and initial laboratory assessment. There is much variability in published studies of FUO, with the required duration of fever ranging from one to three weeks [9,20,25]. The majority of children with FUO have infectious causes, although inflammatory, neoplastic, and autoimmune conditions are also in the differential diagnosis [9,20,24-27]. The distinction between FWS and FUO is more than just academic because the clinical and imaging approaches to these conditions can differ.

Overview of Imaging Modalities

A detailed and thorough history and physical examination are the most important components of the diagnostic evaluation of a child with FWS or FUO. Chest radiography has a role in the evaluation of occult pneumonia and should be performed in neonates with FWS and respiratory symptoms and in selected older children with high fever, leukocytosis, and respiratory signs and symptoms [28]. However, chest radiography is limited in the evaluation of pneumonia in young children because of poor differentiation between viral and bacterial pneumonia and considerable intraobserver and interobserver variability in interpretation [29-34]. CT of the paranasal sinus, chest, and abdomen is important for the evaluation of fungal infection in neutropenic patients, especially after bone marrow transplantation, and in patients who do not respond to broad-spectrum antibiotics [35,36]. There are small series on the use of fluorine-18-2-fluoro-2-deoxy-D-glucose PET (FDG-PET)/CT in the evaluation of FUO that show its potential to detect occult infection, inflammatory processes, and malignancy. It can be used in selected children with FUO with negative extensive workup [37-39].

Discussion of Imaging Modalities by Variant

Variants 1 and 2: Neonate Younger Than One Month of Age With FWS. In febrile neonates younger than 28 days, history and physical examination alone may not be able to completely exclude SBI, even in children who appear clinically well or mildly ill [40]. Therefore, a full sepsis workup is frequently performed. This includes complete blood count, blood culture, urinalysis and urine culture, lumbar puncture with evaluation of cerebrospinal fluid, and administration of antibiotics in the emergency department, followed by hospitalization pending results of cultures [2,3,8,9,22,27].

Variant 1. Neonate younger than one month of age with fever without source and no respiratory symptoms

Radiologic Procedure	Rating	Comments	Relative Radiation Level
X-ray chest	5	This procedure may be appropriate, but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating.	☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Chest radiography is indicated in neonates with FWS and respiratory symptoms [3,21]. In addition, chest radiography in a septic-appearing neonate with FWS may disclose an occult pneumonia [6,8,16,27]. Some investigators advocate routine chest radiography in all neonates with FWS because these infants are relatively immunocompromised compared with older infants and children, and the consequences of a missed SBI or occult infection are felt to be greater [6]. Chest radiography can help exclude congenital or acquired cardiac disease in a child who is febrile and ill. However, the benefit of routine use of chest radiography in neonates without respiratory symptoms has not been established [3,21].

Variant 3: Infant or Child Aged 1 to 36 Months With FWS With Low Risk for Occult Pneumonia (No Respiratory Signs or Symptoms, Fever <39°C, Leukocytosis <20,000/mm^3). In the absence of a "toxic" appearance, respiratory distress, poor peripheral perfusion, high fever, and leukocytosis, the risk for SBI is low in children with FWS, and there is no indication for routine chest radiography. Patterson et al [41] retrospectively studied 105 infants who had fever. Of the 37 patients who had no respiratory symptoms or signs, only one had a chest radiograph showing a focal parenchymal airspace disease. Hyperinflation and peribronchial thickening were not classified as abnormal. In a prospective study, the same authors included 121 infants who were free of signs or symptoms of lower respiratory tract infection but who had fever [41]. None had chest radiographs that showed abnormalities. Even in younger children at the age of one to three months who are at increased risk for SBI, there is no role for routine chest radiography. Heulitt et al [42] showed that only 6% of infants with fever without respiratory manifestations developed pneumonia and that all of those infants did well. A meta-analysis of 361 febrile infants younger than three months without clinical evidence of pulmonary disease on history or physical examination showed that none of these children had pneumonia [43]. Baraff et al [44] reported a 3.3% incidence of positive results on chest radiography on the basis of collected reviews of infants and children from birth to 36 months of age with fever and no respiratory symptoms or signs. McCarthy [45], summarizing a number of clinical series dealing with acute episodes of fever in infants, also believes that chest radiographs should be obtained only when there are clinical symptoms or signs of pneumonia. A later study by Baraff reports that occult pneumonia is seen in only 3% of infants without respiratory findings on physical examination. Given that the risk for SBI in febrile infants and children has dropped in the era of pneumococcal vaccination and that most FWS cases will be related to urinary tract or viral infections, some authors recommend obtaining urinalysis first and considering chest imaging only if the results are negative [2,9,46].

Bramson et al [43] combined their data with those of two prior studies [42,47] and subjected these to a statistical meta-analysis. The larger number of patients in the combined study allowed more valid conclusions concerning the accepted practice of performing chest radiography in febrile infants as part of the sepsis workup. These three series had 671 infants. In 361 infants with no clinical evidence of pulmonary disease on history and

Variant 2. Neonate younger than one month of age with fever without source and respiratory symptoms

Radiologic Procedure	Rating	Comments	Relative Radiation Level
X-ray chest	8		☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 3. Infant or child aged 1 to 36 months with fever without source with low risk for occult pneumonia (no respiratory signs or symptoms, fever <39°C, leukocytosis <20,000/mm^3)

Radiologic Procedure	Rating	Comments	Relative Radiation Level
X-ray chest	2		☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

physical examination, all had normal chest radiographic results. A finding of only hyperinflation on a chest radiograph was interpreted as normal because it was felt that the infants would likely have a viral illness or reactive airway disease and would not usually be receiving antibiotics, unlike older children and adults [48]. Bramson et al indicated that chest radiography in a patient with no pulmonary symptoms or signs would have positive results <1.2% of the time. In the current era of *S pneumoniae* and *H influenza* vaccine use, this rate might fall even further. Murphy et al [49] found an incidence of radiographic pneumonia in 5.3% of 2,128 children younger than ten years with no lower respiratory symptoms (other than cough) and concluded that there was low utility in obtaining chest radiographs in febrile children without cough. A longer duration of cough, fever, and leukocytosis increased the likelihood of radiographic pneumonia in these children.

Variant 4: Infant or Child Aged 1 to 36 Months With FWS With Any of the Following: Respiratory Signs or Symptoms, Fever ≥39°C, or White Blood Cell Count ≥20,000/mm^3. Patients with high fever, signs of respiratory distress, or white blood cell (WBC) count >20,000/mm^3 are at increased risk for pneumonia; therefore, chest radiography is indicated [2,5,6,8,16,22-24]. The presence of rales is the single best clinical indicator of pneumonia in infants and children. Tachypnea, intercostal retractions, and nasal flaring are also predictive of pneumonia in the pediatric population [50-53]. Other clinical factors that can be predictive of pneumonia in children of all ages, such as degree of fever, WBC count, and pulse oximetry, have been studied [16,52,54-56].

In a meta-analysis [43], it was found that 33.2% (85 of 256) of infants younger than three months with at least one clinical finding of pulmonary disease (ie, tachypnea >50 breaths/min, cyanosis, oxygen saturation <95%, rales, rhonchi, retractions, wheezing, coryza, grunting, stridor, nasal flaring, or cough) had positive results on chest radiography. In a study by Mahabee-Gittens et al [52] of 510 children from 2 to 59 months of age presenting with symptoms of lower respiratory tract infection who underwent chest radiography, 8.6% showed pneumonia. Clinical variables found to correlate with positive radiographic findings included age >12 months, respiratory rate >50 breaths/min, oxygen saturation ≤96%, and nasal flaring in children younger than 12 months. Combinations of these clinical variables produced likelihood ratios of radiographic pneumonia from 3.6 to 11.0. In a similar study by Lynch et al [53] of 570 children older than one year, the presence of decreased breath sounds, crackles, and tachypnea in various combinations had high sensitivity but poor specificity to predict pneumonia, defined as "focal infiltrates on chest radiographs." Bachur et al [56] found that 26% of children with fever ≥39°C and a WBC count ≥20,000/mm^3 had pneumonia on chest radiography. The use of polyvalent *S pneumoniae* vaccine has been shown to reduce pneumonia with radiographic consolidation by 73% [57]. This led Baraff [5] to suggest that chest radiography should be obtained in patients with high fever and elevated WBC counts who have not received the pneumococcal vaccine, regardless of respiratory findings. Rutman et al [14] reported that since the institution of pneumococcal vaccination, the incidence of radiographically evident pneumonia has dropped by 20% to 39%. In their study of 355 children younger than five years with fever >39°C, WBC count >20,000/mm^3, and respiratory symptoms, pneumonia was present in 18%, making chest radiography a reasonable study under those circumstances. Brook [16] also recommends performing chest radiography in all patients younger than 36 months with oxygen saturation <95%, although no supporting evidence is given, nor are there data as to the diagnostic yield of such radiography.

The American College of Emergency Physicians states that chest radiography should be considered in patients older than three months with fever ≥39°C and WBC counts ≥20,000/mm^3 [58]. Similar recommendations have been made by the British Thoracic Society for children younger than five years [59].

Variant 5: Child With FWS and Neutropenia. Fever is a cause of great concern in a child with cancer or immunodeficiency who is neutropenic. In neutropenic patients, a significant fever is usually defined as a single oral temperature of ≥38.3°C or two measurements of ≥38.0°C at least one hour apart [60]. Neutropenia is an absolute neutrophil count of <500/mm^3, or <1,000/mm^3 with

Variant 4. Infant or child aged 1 to 36 months with fever without source with any of the following: respiratory signs or symptoms, fever ≥39°C, or white blood cell count ≥20,000/mm^3

Radiologic Procedure	Rating	Comments	Relative Radiation Level
X-ray chest	9		☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

Variant 5. Child with fever without source and neutropenia

Radiologic Procedure	Rating	Comments	Relative Radiation Level
CT chest with contrast	6	This procedure may be appropriate if that patient has respiratory symptoms or has had stem cell transplantation.	☢☢☢☢
X-ray chest	5	This procedure may be appropriate, but there was disagreement among panel members on the appropriateness rating as defined by the panel's median rating. This procedure may be appropriate if the patient has respiratory symptoms.	☢
CT chest without contrast	5	This procedure may be appropriate if the patient has respiratory symptoms or has had stem cell transplantation.	☢☢☢☢
CT abdomen with contrast	5	Consider in patients who have had stem cell transplantation.	☢☢☢☢
CT paranasal sinuses with contrast	4	Contrast and brain imaging are essential if central nervous system invasion is a concern.	☢☢☢
CT paranasal sinuses without contrast	4	Consider in patients who have had stem cell transplantation.	☢☢☢
CT abdomen without contrast	2		☢☢☢☢
CT chest without and with contrast	1		☢☢☢☢
CT abdomen without and with contrast	1		☢☢☢☢☢
CT paranasal sinuses without and with contrast	1		☢☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

the expectation of rapid decrease [60]. Such children are more susceptible to the common infections facing all children; gram-positive organisms are responsible for 70% of SBIs in these patients, but gram-negative organisms are responsible for most SBI-related fatalities [60]. These patients are also at risk for viral and other atypical infections, and invasive fungal infections are a particular concern for high-risk patients with persistent febrile neutropenia [60]. Because of the heightened clinical concern, chest radiography is usually performed in addition to other assessments, including cultures of the blood and urine.

The practice of routinely performing chest radiography has been challenged. Korones et al [61] evaluated 54 children with cancer who were hospitalized for hundreds of episodes of fever and neutropenia. They found an incidence of radiographic pneumonia of only 3% to 6%. The children without respiratory findings had no evidence of pneumonia on chest radiography, and children who did not undergo chest radiography showed no significant outcome differences from those who did. Phillips et al [62] confirmed in a meta-analysis the low use of routine chest radiography in this setting but stated that in those with a predisposition to pneumonia and those not responding to a short empiric course of antibiotics, chest radiography should be performed despite the absence of clinical signs of a lower respiratory tract infection.

Children with neutropenia and FWS often undergo advanced imaging, but there are few evidence-based data on which studies are most efficacious. In its 2002 guidelines (not pediatric specific), the Infectious Diseases Society of America noted that one-half of febrile neutropenic patients with normal results on chest radiography will have evidence of pneumonia on chest CT [63]. Archibald et al [36] evaluated the performance of CT in 83 neutropenic pediatric patients with cancer who had 109 instances of fever lasting four days or more. Rates of positive CT findings varied by body region: head and neck, 8%; paranasal sinus, 41%; chest, 49%; and abdomen, 19%. Findings on paranasal sinus and chest CT led to changes in therapy in 24% and 30% of cases, respectively. However, they added that CT was rarely abnormal in the absence of localizing signs or symptoms and that in the absence of symptoms, CT findings rarely led to therapeutic changes. In a more recent study, Agrawal et al [35] demonstrated a similar distribution of positive findings among body regions but found that only two of the initial positive CT scans led to a change in management (6.5% of positive scans, 0.8% of all initial

scans). They therefore recommend limiting initial empiric CT imaging to the chest only in patients without localizing signs or symptoms. Regarding the use of FDG-PET/CT, Blokhuis et al [39] found 78% sensitivity and 67% specificity in 12 such children.

An important subset of neutropenic children is those who have undergone hematopoietic stem cell transplantation. Cox et al [64] studied 81 hematopoietic stem cell transplantation patients who underwent chest radiography as part of the evaluation of initial fever during transplantation. None of the chest radiographs provided sufficient information for further management. In 2 of 14 episodes in patients with normal results on chest radiography and in 9 of 22 episodes in patients with nonspecific findings on chest radiography, CT scanning resulted in changes in clinical management. Findings of large lung nodules and "halo sign" are suggestive of fungal infection [65].

Variant 6: Infant or Child More Than One Month of Age With FUO. Occult infection is the usual cause of FUO in children and is less commonly due to rheumatologic, autoimmune, neoplastic, or other inflammatory conditions [9,20,21,24,66,67]. In some children, a specific diagnosis is never reached [9,24]. Evaluation of FUO in children is based mainly on thorough physical examination, history, and laboratory studies such as a complete blood cell count and peripheral smear, erythrocyte sedimentation rate, C-reactive protein, aerobic blood cultures, urinalysis, urine culture, tuberculin skin test, electrolytes, blood urea nitrogen, creatinine, hepatic enzymes, and human immunodeficiency virus serology [9,20,21,24,68,69]. Chest radiography is usually performed to evaluate for occult pneumonia and lymphadenopathy. Although many studies describe the clinical course of such patients, few of them examine the utility of diagnostic imaging modalities in these difficult patients. In general, if a detailed review of the history, physical examination, and screening evaluation fail to suggest a diagnosis, more extensive imaging can be considered. This includes abdominal ultrasound and CT studies of the chest, abdomen, and paranasal sinus [4]. Steele et al [70] evaluated 109 children with FUO with conventional radionuclide techniques. These studies often had positive results but rarely led to an unsuspected diagnosis.

FDG-PET/CT is sensitive in the detection of infection, inflammatory diseases, vasculitis, arthritis, and malignancies and was found to be helpful in the evaluation of FUO in several adult series [71,72] and meta-analyses [73,74]. The highest yield of FDG-PET can be expected in patients with adenopathy, low hemoglobin, and increased C-reactive protein levels [75]. There are only a few small series on the use of FDG-PET/CT in children with FUO [29]. Blokhuis et al [39] found sensitivity of 80% and specificity of 78% in 16 of such children. In the largest series to date by Jasper et al [38], FDG-PET/CT was used in the evaluation of 44 children with

Variant 6. Infant or child more than one month of age with fever of unknown origin

Radiologic Procedure	Rating	Comments	Relative Radiation Level
X-ray chest	7		☢
Ultrasound abdomen	6		○
CT chest with contrast	5		☢☢☢
CT chest without contrast	4		☢☢☢
CT abdomen with contrast	4		☢☢☢
CT paranasal sinuses without contrast	4		☢☢☢
FDG-PET/CT skull base to midthigh	4	This procedure should not be used as the initial study. Consider if extensive clinical and imaging workup is negative.	☢☢☢☢
CT paranasal sinuses with contrast	3		☢☢☢
MRI whole body without contrast	3		○
CT abdomen without contrast	2		☢☢☢
MRI whole body without and with contrast	2	This procedure should not be used as the initial study. Consider if extensive clinical and imaging workup is negative.	○
CT chest without and with contrast	1		☢☢☢
CT abdomen without and with contrast	1		☢☢☢☢
CT paranasal sinuses without and with contrast	1		☢☢☢

Note: Rating scale: 1, 2, and 3 = usually not appropriate; 4, 5, and 6 = may be appropriate; 7, 8, and 9 = usually appropriate.

FUO and 33 children with unexplained signs of inflammation without fever. According to the authors, the PET findings contributed to the final diagnoses in 35 patients (45%). The study methodology was limited, with no defined selection criteria for children with FUO in whom PET was performed and a vague definition of the benefits of FDG-PET/CT in reaching the final diagnosis.

Whole-body MRI on the basis of inversion-recovery, T1, and diffusion sequences is an evolving technique that was used in several small series in the evaluation of systemic diseases, such as multifocal osteomyelitis and tumors, but there is not yet sufficient evidence for its use for evaluation of FUO [76-78]. The same applies to PET/MRI [79].

SUMMARY OF EVIDENCE

Of the 79 references cited in the *ACR Appropriateness Criteria Fever Without Source—Child* document, 73 are categorized as diagnostic references, including 1 well-designed study, 3 good-quality studies, and 16 quality studies that may have design limitations. Additionally, 2 references are categorized as therapeutic references, including 1 well-designed study. There are 54 references that may not be useful as primary evidence. There are 4 references that are meta-analyses.

The 79 references cited in the *ACR Appropriateness Criteria Fever Without Source—Child* document were published from 1972 through 2014.

Although there are references that report on studies with design limitations, five well-designed or good-quality studies provide good evidence.

RELATIVE RADIATION LEVEL INFORMATION

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that seems to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower compared with those specified for adults (see Table 1). Additional information regarding radiation dose assessment for imaging examinations can be found in *ACR Appropriateness Criteria: Radiation Dose Assessment Introduction* [80].

Table 1. Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
☢	<0.1	<0.03
☢☢	0.1-1	0.03-0.3
☢☢☢	1-10	0.3-3
☢☢☢☢	10-30	3-10
☢☢☢☢☢	30-100	10-30

Note: Relative radiation level (RRL) assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "varies."

SUPPORTING DOCUMENTS

For additional information on the ACR Appropriateness Criteria methodology and other supporting documents, go to www.acr.org/ac.

TAKE-HOME POINTS

- Neonates younger than one month with FWS are a high-risk group; however, the yield of routine chest radiography is low in the absence of respiratory symptoms.
- In a child with FWS, chest radiography should be performed when there is clinical evidence of a respiratory illness and for those with fever ≥39°C or WBC count ≥20,000/mm^3.
- In children with neutropenia and FWS, especially those after bone marrow transplantation with persistent fever despite the administration of antibiotics, CT of the chest should be considered even if the results of chest radiography are negative. There is lower yield for CT of the abdomen and paranasal sinus.
- Imaging studies in children with FUO have a low yield.
- More studies are needed to evaluate the potential role of FDG-PET/CT and whole-body MRI in the management of children with fever.

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