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Are Chest Radiographs and Electrocardiograms Still Valuable in Evaluating New Pediatric Patients With Heart Murmurs or Chest Pain?

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ABSTRACT. *Objectives.* To determine the usefulness of electrocardiography (ECG) and chest radiography (CXR) in evaluation of patients referred to the pediatric cardiologist for the evaluation of heart murmur or chest pain.

Design. In this prospective study, 106 consecutive outpatients were categorized with no heart disease, possible heart disease, or definite heart disease based on history and physical examination; they then underwent ECG and CXR. Studies were reviewed and the examining cardiologist could change the diagnosis and order an echocardiogram.

Setting. Academic pediatric cardiology practice.

Results. In patients thought to have no heart disease, the diagnosis was changed to definite heart disease in four solely on the basis of abnormal CXR or ECG. In 25 patients thought to have possible heart disease, the diagnosis was changed to no heart disease (7) or definite heart disease (5) after review of the CXR and ECG. All 25 patients diagnosed with definite heart disease had this confirmed by abnormal CXR (2), ECG (3), both abnormal CXR and ECG, or echocardiogram (18).

Conclusions. ECG and CXR helped diagnose heart disease in four patients thought to have no heart disease, helped to rule out lesions in seven patients with possible heart disease, helped diagnose heart disease in five patients thought to have possible heart disease, and helped confirm heart disease in nine patients. In these days of cost containment, routine ECG and CXR continue to be valuable tools for the pediatric cardiologist in evaluation of patients with heart murmurs or chest pain. *Pediatrics* 1997;99:1-3; heart murmur, chest pain, ECG, CXR.

ABBREVIATIONS. CXR, chest radiography; ECG, electrocardiograms.

Referral for evaluation of heart murmurs accounts for the largest group of new patients seen by the pediatric cardiologist.¹ Our experience has been that referrals for evaluation of chest pain also represent a large segment of our practice. Although several studies in the pediatric literature have found a complete history and physical examination by a pediatric cardiologist to be the most valuable and cost effective initial step in evaluating new patients, conclusions about routine chest radiographs (CXR) and electrocardiograms (ECG) have been mixed.¹⁻⁹ A study from Boston in 1983 done by Newburger et al³ concluded that diagnostic tests such as ECG, CXR, and M-mode echocardiography were unlikely to change the clinical diagnosis of heart disease if it was determined on the basis of history and physical examination by a skilled pediatric cardiologist. Smythe et al¹ (1990) compared clinical diagnoses of heart murmurs by a pediatric cardiologist with those obtained after ECG and echocardiogram and concluded that, as supplementary tests, ECG and echocardiogram were unlikely to reveal clinically unsuspected heart disease.

Recent advances in echocardiographic technology over the last 10 years have revolutionized the image quality and data acquisition capabilities; however, it has also substantially increased the cost of this test. Danford et al⁷ (1997) showed that it is not cost effective to order an echocardiogram on every patient before evaluation by a pediatric cardiologist.

Our purpose was to determine the value of CXR and ECG in the complete evaluation of new patients with heart murmurs or chest pain who were referred to the pediatric cardiologist.

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METHODS

Our study population consisted of 106 consecutive outpatients from 1 month through 14 years (median age 5.5 years) who were seen at the Children's Hospital of Pittsburgh between March and May 1993. Each patient was specifically referred for the evaluation of a heart murmur (79%) or chest pain (21%). New patients referred for other reasons were excluded.

Each patient underwent an initial history and physical examination by a qualified pediatric cardiologist. The cardiologist was then asked to make the diagnosis of no heart disease, possible heart disease, or definite heart disease on the basis of history and physical examination. All patients had a CXR and ECG performed. These were reviewed later by the cardiologist. The examining cardiologist was then given the opportunity to change the previous diagnosis and to order an echocardiogram if indicated. After analyzing the available information, each patient was given a final diagnosis before their departure. For the purpose of this study, definite heart disease was defined as any cardiac lesion that would potentially cause patient morbidity, require cardiac follow-up, and/or require endocarditis prophylaxis.

Standard two-view CXRs were obtained in the posteroanterior and lateral projections. ECG (standard 12-lead plus V₃R) were performed by trained technicians using either a Marquette MAC 15 or MAC VU electrocardiographic machine (Marquette Electronics Inc., Milwaukee, WI). Echocardiograms were performed by certified ultrasonographers using either a Hewlett-Packard Sonos 1500 (Hewlett-Packard Co, Andover, MA) or Acuson 128 model (Acuson Corp, Mountain View, CA). CXR and ECG were interpreted by the examining cardiologist and by another cardiologist.

RESULTS

Initial diagnosis after history and physical examination alone were: no heart disease in 60/106 (57%), possible heart disease in 25/106 (23%), and definite heart disease 21/106 (20%).

Initial Diagnosis: No Heart Disease

Of 60 patients initially diagnosed with no heart disease, 53 (88%) had a normal CXR and ECG. Only two of these patients subsequently underwent an echocardiogram with indications being a family history of hypertrophic cardiomyopathy and a loud systolic murmur. Both of these echocardiograms were normal. ECG was abnormal in five patients (8%) and led to further investigation with echocardiography: one patient with right ventricular hypertrophy was found to have an atrial septal defect and one patient with left ventricular hypertrophy was diagnosed with hypertrophic cardiomyopathy. The other three of these five patients had normal echocardiograms and were diagnosed to have Wolff-Parkinson-White syndrome (1) and innocent murmur (2). CXR was interpreted as abnormal in two patients (3%) and both underwent echocardiograms. One study was normal and the other confirmed the diagnosis of partial absence of the pericardium.

In summary, 60 patients were initially diagnosed with no heart disease and 4 (7%) were subsequently found to have heart disease due to an abnormal ECG (3) or CXR (1). These diagnoses included asymptomatic Wolff-Parkinson-White syndrome, small atrial septal defect, hypertrophic cardiomyopathy, and partial absence of the pericardium. In three-fourths of these patients the definitive anatomical diagnosis was made by echocardiogram. Overall, only 7 of 60 patients (12%) in this group required echocardiograms.

Initial Diagnosis: Possible Heart Disease

Twenty-five patients were initially diagnosed with possible heart disease. The diagnosis was changed to no heart disease (7) or definite heart disease (5) after review of the CXR and ECG. Seventeen of these 25 patients had a normal CXR and ECG (68%). Three patients had an abnormal ECG (12%) and five had an abnormal CXR (20%). Echocardiograms were performed in 17 of 25 (68%) of this patient group. Table 1 illustrates the diagnostic tests performed on each patient and the subsequent discharge diagnosis.

Initial Diagnosis: Definite Heart Disease

Twenty-one patients were initially diagnosed with definite heart disease and this clinical impression was supported by an abnormal CXR (2), abnormal ECG (3), or both (2). Echocardiograms were performed in 19 of 21 (90%) of these patients, and the discharge diagnoses are listed in Table 2.

DISCUSSION

Previous studies have concluded that initial history and physical examination by a qualified pediatric cardiologist is cost-effective, sensitive, and specific in the evaluation of new pediatric cardiology patients.^{1,3,5} Our study suggests that the addition of routine CXR and ECG to this evaluation is warranted. Review of these tests in our study helped to make the diagnosis of definite heart disease in four patients (7%) where the diagnosis would probably have been missed based on clinical evaluation alone if CXR and ECG were not obtained. Also, in the 25 patients with possible heart disease, the diagnosis was changed to no or definite heart disease in 12

TABLE 1. Patients Initially Diagnosed With Possible Heart Disease (N = 25)*

	ECHO	Final Diagnosis
Normal CXR and ECG (n = 17)	Yes	VSD
	No	VSD
	Yes	ASD, valvar pulmonic stenosis
	No	Valvar pulmonic stenosis (n = 2)
	Yes	Bicuspid aortic valve
	Yes	Coarctation of the aorta
	Yes	Innocent murmur (n = 4)
	No	Innocent murmur
	No	PVCs
	No	Dysrhythmia (n = 2)
Abnormal ECG (n = 3)	Yes	Noncardiac chest pain (n = 2)
	Yes	Cardiomyopathy, PVCs
Abnormal CXR (n = 5)	Yes	Valvar aortic stenosis
	No	PACs, R/O SVT
	Yes	Innocent murmur (n = 2)
Abnormal CXR and ECG (n = 0)	Yes	Peripheral pulmonic stenosis
	Yes	Patent foramen ovale (normal)
	Yes	Valvar pulmonic stenosis

* VSD, ventricular septal defect; ASD, atrial septal defect; PAC, premature atrial contraction; PVC, premature ventricular contraction; SVT, supraventricular tachycardia.

† 17/25 (68%) of these patients had echocardiograms.

TABLE 2. Patients Initially Diagnosed With Definite Heart Disease (N = 21)*

	ECHO	Final Diagnosis
Normal CXR and ECG (n = 14)	Yes	VSD (n = 7)
	No	VSD (n = 2)
	Yes	Subaortic stenosis (n = 2)
	Yes	Valvar pulmonic stenosis
Abnormal ECG (n = 3)	Yes	Bicuspid aortic valve
	Yes	Partial AVSD
	Yes	VSD
	Yes	Valvar aortic stenosis
Abnormal CXR (n = 2)	Yes	Partial AVSD
	Yes	VSD
Abnormal CXR and ECG (n = 2)	Yes	Valvar aortic stenosis
	Yes	ASD (n = 2)

* VSD, ventricular septal defect; ASD, atrial septal defect; AVSD, atrioventricular septal defect.

† 19/21 (90%) of these patients had echocardiograms.

(48%) with the additional information provided by the CXR and ECG.

Without echocardiogram or cardiac catheterization, we cannot prove the diagnosis of no heart disease in 85% of the patients with a normal cardiac examination or innocent heart murmur and normal CXR and ECG. However, Geva et al⁸ validated the diagnosis of an innocent heart murmur by a pediatric cardiologist with a 96% incidence of echocardiographic agreement. The additional information provided by a normal CXR and normal ECG supports the clinical diagnosis of no heart disease.

When the initial diagnosis is possible or definite heart disease and the pediatrician is more likely to order an echocardiogram, the value of routine CXR and ECG is more questionable. In the patient group with the initial diagnosis of possible heart disease, ECG and CXR helped to rule out significant lesions in 28% of patients and diagnose definite heart disease in 20% of patients. In the patients diagnosed with definite heart disease, ECG and CXR helped to confirm the diagnosis of heart disease in 33% of patients. It is clear that there is a large group (67%) of patients with definite cardiac pathology without having any abnormalities in either CXR or ECG.

Because of cost containment, one must justify the addition of screening tests to a routine evaluation. In studying cost of evaluation of heart murmurs in children Danford et al⁷ found that initial consultation

with a pediatric cardiologist including use of ECG and CXR is the preferred approach to not-clearly-innocent murmurs, and that echocardiography is not a cost-effective screen for murmur evaluation. The value of CXR and ECG had not been separately assessed with a cost analysis; however, the implication from the Danford study is that ECG and CXR are still desirable. We conclude from our study that the addition of CXR and ECG to complete history and physical examination by a pediatric cardiologist in evaluation of new pediatric patients with heart murmurs or chest pain is indeed clinically valuable. It may be that these tests are most crucial in those patients where history and physical examination do not otherwise suggest the presence of cardiac pathology. We would also add our endorsement for reserving more expensive tests such as echocardiograms for those in whom it is clinically warranted.

An intrinsic weakness to this study is the inclusion of groups of patients referred for both heart murmur and chest pain evaluation. The usefulness of additional testing may differ between these categories of patients, but our numbers are not sufficiently large to make these distinctions evident. Further studies using larger numbers of patients are warranted.

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