

CHILDREN WITH CHEST PAIN PRESENTING TO A PEDIATRIC CARDIOLOGY SERVICE OR EMERGENCY DEPARTMENT IN AN ACADEMIC CENTRE

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Aim: To assess the etiology of chest pain among children referred to an emergency department or to a cardiology clinic

Method: All echocardiograms performed on 50 consecutive children (27 girls, 23 boys) (aged 1.8 -16 years) who were referred to pediatric cardiology services for evaluation of chest pain in two years were reviewed. One pediatric cardiologist reviewed the patient records and echocardiograms. All cases had 6 months follow up.

Result: Analysis of the history showed that 71% of patients had chest pain only, 17 % had chest pain with heart disease, and 1 % had chest pain related to miscellaneous causes. Causes of chest pain were: chest-wall pain (CW) (67%), and pulmonary (17%), psychological (3%), cardiac (14 %), traumatic (5%), and gastrointestinal problems (4%). The most common physical finding was chest tenderness (41% of cases). Investigations included echocardiogram (86%), chest radiography (50%), electrocardiography (46 %) and determination of the hemoglobin concentration and of the leukocyte count (14%); the results were rarely positive. Two patients required admission to hospital; there were no cases of myocardial ischemia.

Conclusion: Chest pain is an uncommon and usually benign complaint in the pediatric population. Most causes are evident on careful physical examination.

Key words: Chest pain--Children—Echocardiography-Heart disease--

IN CHILDREN CHEST PAIN USUALLY SIGNALS a benign process, but, perhaps as a result of parental anxiety,¹ children are frequently brought to the emergency department for evaluation. Cavalier dismissal of symptoms may lead to missed diagnoses, whereas inappropriate labeling of "cardiac disease" has been shown to lead to unnecessary restriction of activity and heightened anxiety.¹ In previous studies of chest pain in children the authors described small numbers of patients¹⁻⁶ or did not consider a representative sample of patients presenting to an emergency department.¹⁻⁷ The validity of recommendations for clinicians is complicated by the retrospective nature of some of these studies^{3,8} and the selection bias of others.⁵⁻⁹ The results of recent large studies may not be generalizable to all geographic areas owing to the

racial mix and socioeconomic status of their populations.⁸⁻⁹

Not surprisingly, the frequency of specific diagnoses varies considerably among these studies. For example, costochondritis has been reported to be the cause of 23% to 80% of cases of chest pain,^{2,6} and up to 30% of children with chest pain were thought to have psychogenic disorders.⁴

We carried out a retrospective study to describe the demographic characteristics of children presenting with a complaint of chest pain to the pediatric clinic or Emergency Department at King Abdul Aziz University, a major teaching hospital in the western region of Saudi Arabia. We tried to identify causes of chest pain in children, to estimate the relative frequencies of various diagnoses, and to determine the value of signs and symptoms in deciding which patients should not undergo certain laboratory tests. We also hoped that these results would enable us to generate clinical guidelines on the use of investigations in this setting. Secondary objectives included identification of serious cases.

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Methods

This retrospective study was performed on fifty consecutive patients referred by pediatricians or primary care physicians to a pediatric cardiology service in a 24-month period (June 2005-June 2007) at King Abdul Aziz University Hospital with the primary complaint of chest pain. The children were determined to be eligible for the study if they had no prior cardiology evaluations, did not have a pre-existing cardiac diagnosis, and were referred by their primary care provider because of the sole complaint of chest pain.

The clinical records and echocardiograms of the 50 children who were referred for evaluation of chest pain were reviewed. One pediatric cardiologist (RSB) who was blinded to the indication of referral and clinical outcomes later reviewed the patient records and echocardiograms. There was no chest pain protocol available; however, all patients were examined first by a pediatrician or primary care physician to evaluate possible extracardiac causes of the pain before referral to a pediatric cardiologist. The evaluation included a thorough systematic history taking (Table 1) and physical examination. The parents were interviewed about the child's emotional state, behavior, and school performance, whenever possible. Additional cardiac studies, which were thought by the primary care provider to be individually necessary to assist in the management of the child's complaints, were obtained. These tests included echocardiograms, chest radiograph, electrocardiogram (ECG), exercise ECG (Bruce protocol), echocardiogram, complete blood count, erythrocyte sedimentation rate (ESR), antistreptolysin O titer, C-reactive protein titer, latex agglutination, throat culture, total lipid and cholesterol levels, and lipid electrophoresis. Psychiatric evaluation was done by a child psychiatrist when needed.

Results

The 50 patients consisted of 27 girls and 23 boys whose ages ranged between 2.5 and 16.0 years (mean $7.6 \pm$ SD 4.7: median 8 years) the female: male ratio was 27:23.

There was no significant difference in the age distributions by sex or in the sex distribution. History and physical examination was done in all patients.

Table 2. Diagnostic categories of patients based on clinical examination

Category	Conditions
Chest wall	Costochondritis, musculoskeletal chest pain, Tietze's syndrome, breast problem, idiopathic pain
Respiratory disease	Asthma Pneumonia, bronchitis, pleurisy, pleurodynia, upper respiratory tract infection, asthma
Traumatic	Abrasion, bruise, soft-tissue injury, pneumothorax,
Idiopathic, Psychogenic	Anxiety, depression, hyperventilation, chest
Cardiac	Carditis, arrhythmias, conduction disturbances, mitral valve prolapse, myocardial ischemia, mitral regurgitation
Digestive	Esophagitis, gastritis, gastric ulcer, constipation
Miscellaneous	Sickle cell disease

Medical history (Table 1)

Analysis of the history of the patients showed that 71% had chest pain only, 17% of patients had chest pain with heart disease in the family, and 12% had chest pain secondary to miscellaneous causes including psychological stresses (recent death, divorce in the family, loss of a close friend). The family history was usually uneventful. Twenty percent of patients had a history of taking medication such as antibiotics and antipyretics during their complaint.

The duration of the chest pain in 39% of the patients was longer than a week, and the duration of the pain was between 2 and 20 minutes in 18 cases. In most of the patients the frequency of the pain was more than one episode a day, and between one and 3 episodes per week. Thirty-nine patients had no symptoms other than the chest pain. In 38 patients the pain subsided spontaneously without intervention. In 31 patients the pain was localized on the left precordium. There was no radiation from the original site in 43 patients.

Diagnostic Categories (Table 2)

Chest-wall pain (CW) was the most common diagnosis (67%). Other causes included pulmonary (17%), cardiac (14 %), traumatic (5%), gastrointestinal (4 %), and psychological problems (3%). Cardiac problems were identified in only 7 patients: 2 patients had supraventricular reentry tachycardia, 1 had mitral valve prolapse, and, 1 had



mitral regurgitation, two had atrial septal defect, 1 had patent ductus arteriosus,¹⁰

Table 1. Suggested protocol for history taking in a child presenting with chest pain.

1.	Onset , duration time and type of pain (ie, burning, stabbing, sharp)
2.	Variability with breathing.
3.	Location, character and radiation (eg, mid sternal, left anterior, diffuse or localised)
4.	Relation to exercise or activity
5.	Associated symptoms (eg, rapid heart beat, syncope, shortness of breath, dizziness)
6.	Recent illness (especially fever)?
7.	History of recent chest wall trauma
8.	Family history of:
	a. Heart disease ,
	b. Sudden or early death,
	c. Connective tissue disease (eg
	d. Marfan syndrome,
	e. Cardiomyopathy

Characteristics of Chest Pain

The recurrence of pain was not associated with a diagnostic category. Organic disease was not related to pain that awakened the child from sleep, exercise-induced pain, or location of pain. Subacute pain was more frequent in the respiratory category. Exacerbation of pain when eating was of value in distinguishing the digestive category from other categories.

Clinical Examination

The findings of the physical examination were within normal limits in 40 patients and abnormal in 10 cases. In 7 of these patients there were cardiac signs that were not thought to be associated with chest pain. One patient had gynecomastia and one had gastric ulcer. Pain reproducibility or exacerbation by palpation was understandably related to the CW and trauma categories. Pathologic cardiac auscultation and pallor were associated with the cardiac category. Finally, fever was associated with the respiratory and cardiac categories. Physical examination was found to be normal in all the children in the psychogenic and digestive categories.

Investigations

Most of the patients underwent unnecessary investigations. The most common diagnostic test was echocardiography in 43 patients, followed by chest radiography in 34 patients. Echocardiographic studies revealed organic pathology in 5 cases as follows: mitral valve prolapse (1), mitral

insufficiency (1), patent ductus arteriosus (1), atrial septal defect (2). Chest radiography was positive in 10 patients. Of the 10 positive results, 7 represented infiltrates or pneumonitis; 3 cardiomegaly. ECG was done in 23 cases, the result being interpreted as relevant to the diagnosis considered for the chest pain solely in the cardiac category. Of the 23 cases that had an ECG done, the ECG findings were abnormal in 9 cases, namely an abnormal axis for age in 4, arrhythmia in 4 cases, and left atrial dilatation in 1 case. Twenty patients had normal ECG findings. Determination of complete blood cell count and inflammatory parameters was done in 34 cases. Positive results were observed only in febrile patients. The serum cholesterol and total lipid levels and lipid electrophoresis were screened in 23 cases. Cardiac enzyme profiles were normal in all cases tested. Echocardiography, chest radiography, ECG and blood analysis were performed in 43, 34, 23, and 7 patients, respectively, with suspected chest pain by history and physical examination. Total lipid and cholesterol levels and lipid electrophoresis were normal in all cases. Two of these patients were even admitted to the hospital. In no case were organic diseases diagnosed by these ancillary studies. Seven patients were referred for evaluation by a child psychiatrist. None had pathologic symptomatology.

Outcome

According to the results of the clinical and laboratory examinations, patients can be divided into two categories: (1) those with organic pathology (9 cases), of which 7 were cardiac in origin and 2 of noncardiac origin (1 case of gynecomastia and 1 with gastric ulcer); (2) those without organic pathology (41 cases). One patient with suspected organic disease and one patient with suspected nonorganic chest pain by history and physical examination were admitted to hospital; one patient had gastric ulcer. Both were discharged well. Forty-eight of the 50 patients presenting with chest pain had 6 months follow up in the pediatric cardiology clinic. No primarily unsuspected disease was diagnosed during the follow up except asthma in one case.

Discussion

Chest pain in children rarely results from heart disease.¹¹ Although the methodologies, descriptions



of the patient populations, and conclusions regarding etiologies differ significantly, many studies illustrate that most chest pain in children has a benign etiology. Cardiac disease was an uncommon underlying cause. Most chest pain is self-limiting and carries a good prognosis.^{2,5,8,9} Although our patient numbers are small, our study shows that, contrary to lay perception, but in agreement with other reports, chest pain is usually a benign symptom in children. Our results also indicate that chest pain in children is a relatively infrequent cause of presentation in a large pediatric emergency department or pediatric clinic in a busy teaching hospital.

Chest pain in children can result from a wide variety of causes. The most common cause of chest pain in pediatrics^{12-20,21,22} is CW pathology (12%–85%). It may also be secondary to respiratory (12%–21%) and less frequently to psychiatric (5%–17%), gastrointestinal (4%–7%), and cardiac problems (0%–6%).

Referral of pain from the upper respiratory tract and abdomen to the chest was common, which emphasizes the importance of a thorough extracardiovascular history-taking and physical examination. Traumatic and pulmonary causes of chest pain were usually quite readily apparent. However, in several cases the children needed to be carefully questioned before they remembered a specific injury. This may have been due to an unwillingness to reveal details in the presence of parents rather than to stimulation of a false cause-effect association.

As in other, large studies,^{8,9} chest pain due to pulmonary causes was commonly related to asthma or pneumonia, and the diagnosis was not difficult owing to the physical findings. According to our findings and to those of previous studies, it is possible to outline a practical approach in the evaluation of children with chest pain.

A thorough and complete history should always be performed, including questions about family and personal history, psychological state, medications, characteristics of pain, and associated symptoms. A thorough and complete physical examination is also fundamental, with special attention to vital signs, thorax palpation, and cardiac and respiratory signs. Chest wall pain is fairly common. It is classically stabbing and exaggerated with respiration, lasts seconds to minutes, is not associated with activity (or occurs after participation in sports activity) and,

sometimes may be reproduced by palpation. Children exhibiting solely these symptoms and having a normal history and physical examination require only an explanation of the diagnosis and reassurance.²¹ Psychogenic, traumatic, and digestive causes are usually easily recognizable.

Respiratory etiologies of chest pain are not infrequent. Asthma may be a diagnostic problem: spontaneous relief of attack is possible and auscultation may be normal in case of small airway hyperreactivity. Therefore, this diagnosis is probably underestimated. When history and physical examination are compatible with this diagnosis, children should be referred to the pulmonologist for a provocation test. If the child complains of chest pain in the emergency department, empiric treatment with a bronchodilator may be helpful to confirm the diagnosis if it relieves the chest discomfort.

Cardiovascular causes of chest pain are uncommon in the pediatric population, but they are potentially the most dangerous. They may be associated with myocardial ischemia, low cardiac output, or irritation of the pericardium. Obstructive lesions usually have a pathologic heart murmur present. The murmur of hypertrophic obstructive cardiomyopathy may be minimal at rest and becomes more impressive with maneuvers that impede left ventricular filling, such as standing or the Valsalva maneuver. Dilated cardiomyopathy and myocarditis should be suspected by a history of fatigue, dyspnea, and palpitations and by the auscultation of a gallop rhythm and a murmur of mitral regurgitation. Myocardial infarction is extremely rare and may be suspected by the description of a persistent crushing sternal chest pain and by signs of low cardiac output in children at risk (family history of early coronary artery disease, cocaine abuse, hypercholesterolemia, smoking and use of oral contraceptives,

Kawasaki syndrome). Pulmonary hypertension is associated with fatigue, exercise intolerance, palpitations, syncope, and a narrowed second heart sound. Children with arrhythmias complain of palpitations and may have signs of low cardiac output. Palpitations are not specific for arrhythmia, but it is important to perform a Holter recording when patients complain of chest pain with palpitations but are asymptomatic at the time of the visit.

Few of the patients were admitted to hospital, and only about one-quarter reported school



absenteeism. Specifically, no patients with myocardial infarction were identified. In 90% of the cases the pain was perceived to be moderate or severe. We concur with studies suggesting that children and parents fear that the pain may be arising from a "heart attack".^{2,5}

Careful documentation and analysis of cases revealed the importance of chest examination, vital signs and a clinical impression of the child's "wellness". More than half of the patients had a finding of chest-wall tenderness that generally reproduced the pain. This is in agreement with other studies.^{8,9}

Seven patients had a diagnosis of heart disease, but it was not likely to be the cause of their chest pain (except in one case with mitral valve prolapse).^{23,24} All cardiac lesions were of a mild degree of severity and not expected to be related to the chest pain. This result confirms those of Fyfe and Douglas.²⁵ They studied 67 patients referred to a cardiology clinic with chest pain and found only four (three with pericarditis and one with myocardial infarction) with cardiac disease that could have been the cause of their pain.

Twenty patients with cardiac disease reported by Fyfe and Douglas's did not have a diagnosis with which coexistence of chest pain is expected (obesity, hypertension, or smoking). Berezin et al.²⁶ performed a gastroenterologic evaluation in all patients with idiopathic chest pain and found gastrointestinal pathology in 21 of 27 cases. In our study one patient had gastric ulcer. Of 43 patients with chest pain who had an echocardiographic study, only 5 cases had relatively minor structural heart defect so echocardiography should preferably be ordered after consulting a pediatric cardiologist. Similarly, of 34 patients who had a chest radiography, only 10 cases were positive for lung pathology. Thus, chest radiography should only be indicated when respiratory problems are suspected. Serum cholesterol and total lipid levels and lipid electrophoresis were normal in all screened cases.

Our work and previous studies^{8,9} illustrate the low yield of laboratory investigations in children presenting with chest pain when a goal-directed approach is not considered the dilemma, therefore, is how to proceed in a goal directed, yet cost-effective approach to evaluate the child. Despite this consensus there are no guidelines available to assist the clinician in deciding how to eliminate

unnecessary testing while increasing the yield of tests that are needed.

Limitations

The number of patients in this study is relatively small to draw a definite conclusion. Because every child in the study did not receive an echocardiogram, some subtle structural abnormalities may have been overlooked, such as mild MVP, mild mitral regurgitation, or mild pulmonic stenosis. However, these trivial diagnoses generally do not produce or precipitate chest pain. In addition, children with complaints of associated rapid heartbeats with their chest pain may not have had a documented arrhythmia while participating in the study. Nevertheless, it is reassuring that at 6 months after evaluation, none of the children in the study has returned to the cardiology clinic with further complaints of chest pain. One limitation of our study was the inability to obtain chest radiographs and ECGs for all patients.

Conclusion

The data from this study supports those of previous reports that most chest pain in children has a benign etiology, is self-limiting, and carries a good prognosis. Nevertheless our data also support the contention that a thorough history and careful physical examination should guide practitioners in choosing the diagnostic tests that apply to a given patient. Laboratory testing is only helpful whenever indicated by history and physical examination. Allergic and exercise-induced asthma as well as cardiac arrhythmias should be carefully considered. Other tests may be indicated only in selected patients.

References

1. Diehl AM: Chest pain in children; tip-offs to cause. *Postgrad Med* 1983; 73: 335-342
2. Driscoll DJ, Glicklich LB, Gallen WJ: Chest pain in children: a prospective study. *Pediatrics* 1976; 57: 648-651
3. Fyfe DA, Moodie DS: Chest pain in pediatric patients presenting to a cardiac clinic. *Clin Pediatr (Phila)* 1984; 23: 321-324
4. Asnes RS, Santulli R, Bemporad JR: Psychogenic chest pain in children. *Clin Pediatr (Phila)* 1981; 20: 788-791
5. Pantell RH, Goodman BW: Adolescent chest pain: a prospective study. *Pediatrics* 1983; 71: 881-887



6. Brown RT: Costochondritis in adolescents. *J Adolesc Health Care* 1981; 1: 198-201
7. Brenner JI, Berman MA Chest pain in childhood and adolescence. *J Adolesc Health Care* 1983; 3: 271-276
8. Selbst SM: Chest pain in children. *Pediatrics* 1985; 75: 1068-1070
9. Selbst SM, Ruddy RM, Clark BJ et al: Pediatric chest pain: a prospective study. *Pediatrics* 1988; 82: 319-323
10. Sackett DL, Haynes RB, Tugwell P: *Clinical Epidemiology: a Basic Science for Clinical Medicine*, 2nd ed, Little, Toronto, 1985: 59-138
11. Brenner JI, Ringel RE, Berman MA (1984) Cardiologic perspectives of chest pain in childhood: a referral problem. *Pediatr Clin North Am* 31:1241-1258
12. Bergman AB, Stamm SJ: The morbidity of cardiac nondisease in school children. *NEnglJMed* 1967; 276: 1008-1013
13. Brenner JI, Berman MA Chest pain in childhood and adolescence. *J Adolesc Health Care* 1983; 3: 271-276
14. Diehl AM: Chest pain in children; tip-offs to cause. *Postgrad Med* 1983; 73: 335-342
15. Driscoll DJ, Glicklich LB, Gallen WJ: Chest pain in children: a prospective study. *Pediatrics* 1976; 57: 648-651
16. Fyfe DA, Moodie DS: Chest pain in pediatric patients presenting to a cardiac clinic. *Clin Pediatr (Phila)* 1984; 23: 321-324
17. Asnes RS, Santulli R, Bemporad JR: Psychogenic chest pain in children. *Clin Pediatr (Phila)* 1981; 20: 788-791
18. Pantell RH, Goodman BW: Adolescent chest pain: a prospective study. *Pediatrics* 1983; 71: 881-887
19. Brown RT: Costochondritis in adolescents. *J Adolesc Health Care* 1981; 1: 198-201
20. Dixon WJ, Brown MB, Engleman L et al: *BMDP Statistical Software*, U of Cal Pr, Berkeley, Calif, 1985: 157-158
21. Brenner JI, Ringel RE, Berman MA: Cardiologic perspectives of chest pain in childhood: A referral problem? To whom? *Pediatr Clin North Am* 1984; 31: 1241-1258
22. Keith J, Rowe RD, Vlad P: *Heart Disease in Infancy and Childhood*, 3rd ed, Macmillan, New York, 1978: 1023-1039
23. Bisset GS III, Schwartz DC, Meyer RA (1980) Clinical spectrum and long-term follow-up of isolated mitral valve prolapse in 119 children. *Circulation* 62:423-429.
24. Lane JR, Ben-Shachar G. Myocardial infarction in healthy adolescents. *Pediatrics*. 2007 Oct;120(4):e938-43.
25. Fyfe DA, Douglas SM (1984) Chest pain in pediatric patient presenting to a cardiac clinic. *Clin Pediatr* 23:321-324.
26. Berezin S, Medow MS, Glassman MS, Newman LJ (1988) Chest pain of gastrointestinal origin. *Arch Dis Child* 63:457-460.

