Fifteen-minute consultation on excluding cardiac causes of chest pain

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ABSTRACT

Chest pain can be an extremely worrying symptom for children and parents, but is typically benign and rarely cardiac in origin. It can become problematic for paediatricians in acute care balancing parental expectations and not missing sinister causes. In addition, ordering unnecessary tests can be expensive, can lead to a prolonged hospital stay and unnecessary referrals to clinics. The aim of this review is to give an overview of the common causes of chest pain in children and how to identify cardiac causes using case vignettes.

INTRODUCTION

Chest pain can cause a huge amount of anxiety for parents and children. Unlike in adults, it is rarely caused by ischaemic heart disease and is typically benign. However, the presentation of a child in an emergency department (ED) can be a difficult task for the paediatrician.

NON-CARDIAC CHEST PAIN

There are a number of causes of non-cardiac chest pain in children (box 1), with the the most common being musculoskeletal.[1] Two large studies consisting of 8136 children found that only 0.6%–1.0% had a cardiac cause.[2 3] In a review of 103 children attending children's Accident and Emergency (A&E) with chest pain over a 3-year period, the most common examination finding was chest wall tenderness.[4] Clues in the history can help distinguish between non-cardiac from cardiac causes such as wheeze, pneumonia and gastro-oesophageal reflux. There is no gender predilection in regard to its causes.[5] Despite its benign nature, chest pain causes a great deal of anxiety. In a study of 100 children who had non-cardiac chest pain, 44% thought they were experiencing a heart attack and 40% did not attend school because of it.[6] This highlights that the focus should be on good history taking and appropriate counselling.

CARDIAC CHEST PAIN

Cardiac chest pain is rare. It is typically described as a heavy weight in the centre of the chest radiating to the jaw or left arm. Cardiac-related symptoms include pallor, sweating, presyncope/syncope and palpitations. Arrhythmias are an important feature to rule out, as children may confuse the unpleasant sensation of palpitations with chest pain.

HOW SHOULD YOU ASSESS THE CHILD WITH CHEST PAIN?

History

A thorough history along with an examination is key. It is important to ask about the frequency of chest pain and how many times they have presented to ED. How were these episodes resolved? Did analgesia have a good effect, or does it need optimising? Do they have a chest infection, wheeze or reflux? Ask about the original complaint of chest pain. What happened previously? Was there trauma? Have they experienced any of the red flag symptoms now or in their previous presentations? (box 2). Remember to explore the other systems in the body.

Investigations

Investigations are not a replacement to good history taking and examination.

Electrocardiogram

Any child presenting with red flag features or examination findings such as a murmur or features of cardiac failure should have an ECG.

How to evaluate an ECG is beyond the scope of this review. However, we will highlight some key points.

ST elevation is a key feature that should not be missed and if suspected should be discussed with your cardiology team. The most common cause of ST elevation is

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Box 1 Non-cardiac causes of chest pain in children[14]

- Musculoskeletal: costochondritis.
- Respiratory: cough, bronchospasm and pleuritic processes.
- Idiopathic.
- Psychogenic: anxiety.
- Gastrointestinal: acid reflux, oesophagitis and gastric ulceration.
- Miscellaneous: herpes zoster, sickle cell crisis and tumours.

benign early repolarisation (BER). This is commonly seen in Afro-Caribbean children and athletes. The diagnosis is likely if there are no concerning features in the history and the examination has no positive cardiac features. The ST segment should be compared with the PR segment to appreciate if it is elevated or depressed. ST depression is associated with strain and ischaemia and should be taken equally seriously. Pathological ST changes are typically associated with T-wave inversion, reciprocal changes and other evidence of strain such as ventricular hypertrophy and axis deviation. Whenever a general paediatrician is faced with a suspicion of ST changes, the three main concerns are whether these changes are benign early repolarisation, pericarditis or myocardial infarction, which is far less common. Table 1 summarises the key findings of these conditions. A treadmill test is indicated if there is evidence of exercise-related symptoms or ventricular ectopics on the ECG. Remember, any suspicion of pathological ST elevation should always be discussed with a paediatric cardiology specialist immediately.

Troponin

Troponin is a protein that is released from myocardial cells when injured and can therefore be detected in the plasma. They are cardiac specific. Mild elevation can be seen in other conditions (Box 3).[7] It is a common test ordered when a child presents with chest pain or syncope.[8] It is not useful in diagnosing myocarditis[9] in the absence of other cardiac clinical features. Normal values for the paediatric population are not standardised which makes interpretation difficult. Mild elevation is a grey area but results in the thousands suggest myocardial injury, but may still reflect cardiac strain in the septic child.[10]

Box 2 Red flags for potential cardiac chest pain[14]

- Personal or current history of acquired or congenital cardiac disease.
- Exertional syncope.
- Exertional cardiac-type chest pain.
- Hypercoagulable or hypercholesterolaemic state.
- Family history of sudden death under 35 years of age inherited arrhythmias in first-degree relatives (such as long QT syndrome or Brugada syndrome).
- Implantable cardioverter defibrillators in situ (inappropriate firing of the defibrillator).
- Connective tissue disorders (e.g. Marfan's syndrome associated aortic dissection).
- History of cocaine/amphetamine use.

When to discuss with a tertiary centre

Any child who presents with positive red flag features (box 2), new cardiac examination findings or has a cardiac history past or present should always be discussed with your cardiac service.

CASES

Case 1

A 9-year-old girl presents with retrosternal burning chest pain associated with nausea. The pain can go on for long periods of time but is not associated with any cardiac-related symptoms. What is the likeliest diagnosis?

This girl has gastro-oesphageal reflux disease and her pain resolved with antacids. A thorough history and examination are all that is required. An ECG is not indicated.

Case 2

A 6 year-old boy presents with a 5 day history of short episodes of sharp central chest pain. There is no murmur. The pain is reproducible on palpation of the chest.

The key finding is that the pain is reproducible on palpation of the chest, and the rest of his

Table 1 ST elevation on ECG: BER versus pericarditis versus MI[15]

	Early repolarisation	Pericarditis	MI
Site	Precordial leads	All leads	Involved area leads
Clinical exam	No findings	Pericardial rub	Possible murmur
Q wave	Absent	Absent	Abnormal present
QRS morphology	Normal/slur at end of QRS	Low voltage	Descending limb of QRS merges halfway with convex raised ST segment
ST segment	Concave upward 2–5 mm	Convex (elevated in first stage)	Convex bowing upward
Reciprocal changes	Reciprocal depression	No changes	Reciprocal changes
T waves	Tall, peaked, high and asymmetrical	Positive initially become negative in later stages	Tall, peaked in earlier stages become negative late stages
Follow-up	Constant pattern	Changes in four stages	Serial changes of Q, ST, T

MI, myocardial infarction.

Box 3 Causes of elevated troponin[7 8]

- Cardiac: myocarditis, pericarditis and ischaemic heart disease.
- Non-cardiac: renal failure, sepsis, trauma, drug intoxication and carbon monoxide poisoning.

examination is normal. This suggests that the pain is most likely musculoskeletal. It is important to palpate the chest wall and watch the child's facial reaction rather than to assume it is muscular from history alone.

Case 3

A 16-year-old male adolescent presents in the evening with sudden-onset chest pain followed by syncope while being at a party. ECG was normal, but troponin was >7000 ng/L. What was the cause of his chest pain?

Syncope associated with chest pain is a red flag. His coronary angiogram was normal. This led to the suspicion that he had taken an illegal substance, cocaine, which later was found in his urine. Cocaine and amphetamines can cause coronary artery spasm, leading to myocardial injury. Recreational drug use is an important cause of chest pain in adolescents.

Case 4

A 15-year-old male Afro-Caribbean adolescent presents with left-sided chest pain. There are no associated symptoms. He has chest wall tenderness and you diagnosed a musculoskeletal cause. However, his ECG shows concave ST elevation with tall T waves (figure 1).[11] What is the diagnosis?

This boy has musculoskeletal chest pain with benign early repolarisation. This would be an appropriate case to discuss with cardiology in view of the ECG changes.

Case 5

A 14-year-old female adolescent presents with fever and an acute history of central crushing chest pain which radiates to the left arm and complains of palpitations. On examination, she is tachycardiac and tachypnoeic. There appears to be a gallop rhythm. An ECG was performed, which demonstrated sinus tachycardia and non-specific ST segment changes (figure 2).[12] Her chest X-ray

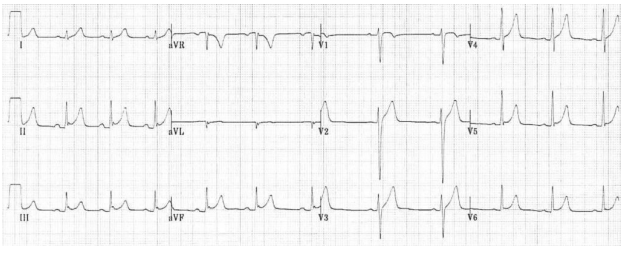

Figure 1 Case 4.

Figure 2 Case 5.

revealed cardiomegaly. Her troponin was elevated. What is the diagnosis?

This girl has viral myocarditis. Myocarditis can present with chest pain and commonly features heart failure and/or electrical disturbances secondary to a viral infection.

Case 6

A 14-year-old adolescent with pulmonary atresia who has undergone a number of surgeries in the past presents with central chest pain that radiates to the back and jaw and is associated with shortness of breath and reduced exercise tolerance. What would you do next?

Any child who presents with chest pain and has had cardiac surgery in the past warrants a discussion with a paediatric cardiologist. This child has poor function and ventricular strain secondary to his conduit being narrowed.

Case 7

A 12-year-old boy who recently had a viral upper respiratory tract infection presents with a sharp, substernal chest pain which is relieved by leaning forward but worse on deep inspiration. Examination reveals a pericardial friction rub. There is no murmur and breath sounds were normal. His ECG shows the following changes (figure 3).[13]

The history of a recent viral infection with a normal respiratory examination makes an infective cardiac cause more likely. The child does not show signs of failure and his ECG does not show any arrhythmias. This makes a diagnosis of myocarditis unlikely. The ECG changes are consistent with pericarditis (table). This child should be treated with ibuprofen and discussed with the cardiology team.

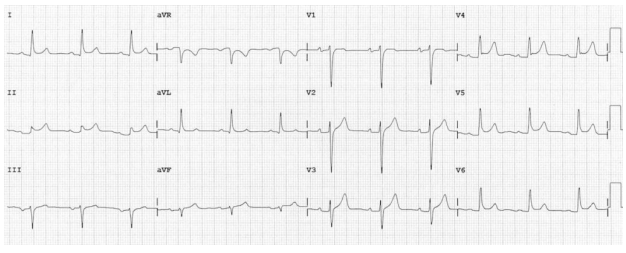

Figure 3 Case 7.

This review presents a number of cases that highlight the key aspects of assessing a child who presents with chest pain. We hope that you now feel more confident in distinguishing the different causes of chest pain in children.

Test your knowledge

1. What is the most common cause of chest pain in children?
   A. Asthma.
   B. Musculoskeletal.
   C. Cardiac.
   D. Gastro-oesophageal reflux.
   E. Pulmonary embolism.
2. What is the most important investigation when seeing a child with chest pain?
   A. Chest X-ray.
   B. Troponin.
   C. ECG.
   D. History.
   E. CT pulmonary angiogram.
3. Which two features are indicative of benign early repolarisation?
   A. Changes involving only the precordial leads.
   B. Changes occurring in four stages.
   C. Common in athletes and children of Afro-Caribbean origin.
   D. Associated with a pericardial rub.
   E. Occurs above the age of 50.
4. Which two are red flags for cardiac chest pain?
   A. The presence of ST elevation (<2 mm) in the precordial leads.
   B. History of congenital heart disease.
   C. Associated with chest wall tenderness on palpation.
   D. Exertional syncope.
   E. Improves with ibuprofen.
5. Which scenarios would you discuss with cardiology?
   A. A 7-year-old child who had a syncopal episode while swimming.
   B. A 13-year-old adolescent who complains of chest pain with chest wall tenderness.
   C. A 6-year-old child who previously had an arterial switch operation as a baby complaining of chest pain.
   D. A 15-year-old adolescent who presents with a 5-month history of right-sided chest pain.
   E. A 14-year-old adolescent who presents with a 3-hour history of chest tightness associated with palpitations and nausea.

Answers to the quiz are at the end of the references.

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Answers to the multiple choice questions

1. B;
2. D;
3. A and C;
4. B and D;
5. A, C and E.