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ORIGINAL ARTICLE

Characteristics & outcomes of children presenting to an Emergency Department with chest pain

Janine Borg, Yana Dimech, Francesca Cassar Galea, Victor Grech, Ruth Farrugia

Background

Chest pain is a frequent presenting complaint to the paediatric emergency department. Although most cases are benign in aetiology, children are still extensively investigated. This study aims to assess whether cardiac risk factors in children with nontraumatic chest pain presenting to paediatric emergency department are appropriately identified and investigated, to review use of cardiac biomarkers and to audit documentation of cardiac risk factors.

Methods

Risk factors in history and examination were identified from international guidelines. Chi tests were used to compare rates of investigations in patients with red flags versus those without. Yield of investigations and documentation for risk factors were also assessed.

Results

A total of 130 children were included, median age 12 years. There were no significant differences in investigation rates between patients with cardiac risk factors (n = 92) and those without (n = 38). Yield from all investigations was minimal. Documentation was poor, with less than two thirds documentation rate for any cardiac risk factor.

Conclusion

Our study confirms that chest pain in children is usually due to benign causes. The yield of blanket laboratory investigations is limited. We suggest a clinical pathway to improve documentation and rationalise use of investigations in children presenting with chest pain to the emergency department.

Dr Janine Borg, MD, MRCPCH
Department of Child and Adolescent Health,
Mater Dei Hospital,
Msida, Malta

Dr Yana Marie Dimech, MD, MRCPCH
Department of Child and Adolescent Health,
Mater Dei Hospital,
Msida, Malta

Dr Francesca Cassar Galea, MD, MRCPCH
Department of Child and Adolescent Health,
Gozo General Hospital,
Victoria, Gozo

Prof Victor Grech
PhD (Lond), PhD (Melit), PhD (Portsmouth)
Department of Child and Adolescent Health,
Mater Dei Hospital,
Msida, Malta

Dr Ruth Farrugia, MD, MSc PEM, MRCPCH
Department of Child and Adolescent Health,
Mater Dei Hospital,
Msida, Malta
https://orcid.org/0000-0002-1553-2486

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Chest pain is a frequent presenting complaint to the paediatric emergency department (PED), with attendances increasing over time.[1] Children mostly have a benign underlying cause, with underlying cardiac pathology present in less than 1%.[2-4] Even though most patients with cardiac aetiology can be identified by a detailed clinical history and examination, an extensive work up is often done. Children with chest pain are also usually triaged as urgent and may take the place of more unwell patients who are triaged at lower urgency.

The primary aim of this study is to assess whether all children with cardiac risk factors are appropriately identified and investigated and to review the use of cardiac biomarkers in children presenting with chest pain to the paediatric emergency department. The secondary aim is to audit the documentation of cardiac risk factors in both history and examination. The ultimate outcome will be a management pathway for children with chest pain in the local setting.

MATERIALS AND METHODS

This is a retrospective observational study involving consecutive patients under the age of 16 years presenting with nontraumatic chest pain to the PED at Mater Dei Hospital in Malta over a period of 5 months between October 2019 to February 2020. The original aim had been to include patient attendance over the whole year, but this was halted because of the COVID pandemic and resultant marked drop in PED patient attendance.[5,6]

Relevant data was obtained from the emergency sheet for discharged patients or the medical file for patients who were admitted to hospital, and this coded data was input into an Excel spreadsheet. The following was included: demographic data including age and gender, time of attendance, clinical presentation, duration of symptoms, associated symptoms, risk factors for underlying cardiac cause, past medical history, investigations, final diagnosis and disposition. Documentation of 'no chronic health problems' was regarded as a negative history for any underlying cardiac or systemic conditions related to chest pain. Investigations included routine blood tests, cardiac biomarkers, electrocardiograms (ECG) and imaging performed at PED. All ECGs were reviewed by a paediatric cardiology trainee. Permission to access data was obtained from the data protection office at Mater Dei Hospital.

Red flags (essential points for identifying cardiac pathology) in the history and examination were identified from international guidelines on the management of children presenting with chest pain at the paediatric emergency department[7-9], as listed in Table 1.

Rate and yield of investigations were compared between the group of patients with red flags identified in history or examination to those without any red flags. Chi tests were used assess for significance. Documentation was also assessed for these relevant red flags in history and examination.

RESULTS

All patients presenting with nontraumatic chest pain (n = 130) were included; these accounted for 1.2% of total attendances to PED (n = 10,438) during the study period. There was slight male preponderance with 53% males (n = 69). Median age was 12 years (Interquartile range 9 –14).

Table 1 *Red flags in the history and examination*

Red flags in history taking
Crushing/compressive pain
Exertional symptoms
Radiation to back or arm
Associated symptoms; dizziness, syncope, palpitations, haemoptysis
PMH of cardiac disease, CTD, clotting abnormalities, Kawasaki disease, ICD
Previous cardiac arrest
FH of cardiac disease, sudden death at a young age, inherited arrhythmias
Hypercoagulable state
Recent surgery
Cocaine or amphetamine use
Red flags for examination findings
Murmur
Signs of heart failure: limb oedema or hepatomegaly or pulmonary oedema
Pericardial rub
Decreased/muffled heart sounds
Fever >38.5°C with no obvious source
Haemodynamic instability: hypotension
ECG changes suggestive of acute cardiac pathology

Abbreviations: PMH - *Past Medical History;* CTD - *Connective Tissue Disorder;* ICD - *Implantable Cardiac Defibrillator;* FH - *Family History*

This was the first episode of chest pain for nearly half of the patients (n = 60) with the majority (n = 100) having pain duration of less than 6 hours and 17 patients being symptomatic for over 24 hours. The pain was localised to the left or mid chest in nearly all patients (n = 120). Twelve patients had underlying medical conditions relevant for cardiac aetiology, namely cardiac disease, congenital heart disease, CTD or previous history of Kawasaki disease. None had Marfan's syndrome or an ICD.

Eighty seven patients (67%) had red flags identified on history taking, with the most common being crushing chest pain, followed by fainting (n = 34), as documented in Table 2. Of these, nearly half (n = 40) had 1 red flag, with a maximum of 4 red flags identified in 2 patients. The majority of patients (92%; n = 120) had no relevant findings on clinical examination.

Overall, two thirds of patients had blood tests, with the most common being full blood count, renal profile (n= 86) and troponin (n = 85). Patients having cardiac risk factors (n = 92) had a similar rate of investigations as patients without risk factors (n = 38), as detailed in Table 3.

The yield from all investigations was minimal. Cardiac markers were requested in 85 patients; there was 1 deranged troponin result (Troponin T >14 ng/L) and 2 deranged CK results (CK >192 U/L), in separate patients. All 3 were referred for cardiology follow up and none of them had evidence of cardiac pathology. Full blood count was only significant for 1 patient who was diagnosed with microcytic anaemia and one patient had raised creatinine on renal profile. Of note, for the 45 patients without cardiac biomarkers, 36 (80%) had red flags in history or examination.

ECG was performed for 121 patients; of these 86 (71%) had red flag findings in history or examination.

Table 2 *Frequency of red flag findings in history and examination (total of 92 patients)*

Red Flags History	Positive findings n	(%)
Crushing/Compressive pain	37	(40)
Exertional symptoms	22	(24)
Radiation to back or arm	17	(18)
Associated symptoms: dizziness, syncope, palpitations, haemoptysis	44	(48)
PMH of cardiac disease, CTD, clotting anomalies, Kawasaki, ICD	12	(13)
Previous cardiac arrest	0	
FH of cardiac disease or sudden death	7	(8)
Hypercoagulable state	0	
Recent Surgery	0	
Drug abuse	1	(1)
Red Flags Examination findings	**Positive findings n**	**(%)**
Murmur	3	(3)
Signs of cardiac failure: hepatomegaly or limb or pulmonary oedema	0	
Pericardial rub	0	
Decreased/muffled heart sounds	0	
Fever >38.5°C (with no obvious source)	8	(9)
Haemodynamic instability: hypotension	0	
ECG changes suggestive of acute cardiac pathology	0	

Table 3 *Investigation frequency and outcome by group*

	Patients with Red Flags n	(%)	Patient without Red Flags n	(%)	Chi	p value
Investigations						
ECG	85	(91)	36	(95)	3.84	0.45
CXR	51	(55)	19	(50)	0.32	0.57
Echo	4	(4)	1	(3)	0.21	0.64
Holter	0		0		-	-
Cardiac MRI	0		0		-	-
Troponin	56	(61)	29	(76)	2.83	0.09
CK	45	(49)	25	(66)	3.08	0.08
Full blood count	57	(62)	29	(76)	2.47	0.11
Renal profile	56	(61)	29	(76)	2.83	0.09
CRP	51	(55)	27	(71)	2.73	0.10
VBG	2	(2)	1	(3)	0.02	0.87
Amylase	9	(10)	4	(11)	0.01	0.89
Outcome						
Admission	12	(13)	3	(8)	0.70	0.40
Repeat presentation	1	(1)	1	(3)	0.42	0.51

Of the 9 patients not having an ECG, 6 (67%) also had red flags in the history or examination. There were no acute ECG changes suggestive of ischaemia, arrhythmias or new cardiac pathology, but 6 ECGs were abnormal (4.9%). All abnormalities were minor or previously known and consisted of one case each of ectopics, junctional rhythm, sinus arrhythmia, sinus bradycardia and known changes in one patient with hypertrophic obstructive cardiomyopathy and another with pre-excitation.

Chest X rays were performed in 54% of patients (n = 70). There was 1 diagnostic finding of pleural effusion - this patient had suggestive findings on clinical examination.

Underlying diagnosis for chest pain was documented for 124 patients (95%), with musculoskeletal origin being the most common (40%). Table 4 shows the range of diagnosis for all patients presenting with chest pain. Children under 12 years of age were more frequently diagnosed with gastrointestinal origin for chest pain (12/60 vs 4/64).

Fifteen patients (11%) were admitted for further investigation and management and another 35 patients (27%) were referred for general or cardiology follow up. No new cardiac pathology was diagnosed in any patients.

Our secondary aim, was assessment of documentation of red flags in history taking and on examination. Table 5 shows these results. There was rather poor documentation overall, with less than two thirds documentation rate for any cardiac risk factor.

DISCUSSION

Parents and carers associate chest pain with serious underlying cardiovascular pathology.[4] However, chest pain of cardiac origin is rare in children.[10,11] In fact, the majority of our patients were diagnosed with musculoskeletal chest pain (35%), in keeping with other international studies.[2] In general, younger children are more likely to have organic cardiorespiratory pathology with older children having more psychogenic chest pain.[11] This was not evident in our population, possibly due to the high rate of diagnosis for non-specific chest pain, of whom a proportion may have underlying psychiatric conditions, most commonly panic disorders.[12]

Despite cardiac chest pain being a rare occasion, it is of utmost importance that these patients are identified and managed appropriately. A retrospective analysis of 484 children with cardiac conditions[13] showed that 76% had originally presented to PED with chest pain; the most common diagnoses for these patients were pericarditis (45%), myocarditis (35%) and pulmonary embolism (10%).

The use of appropriate red flag criteria has been shown to have high sensitivity approaching 100% (but low specificity) for ruling out cardiac origin of chest pain.[14] In fact, a positive or suspicious family history is present for most patients with cardiac conditions predisposing to sudden cardiac arrest but may not always be identified during their first

Table 4 *Underlying diagnosis for patients presenting with chest pain*

Underlying diagnosis	Number	(%)
Musculoskeletal	50	(40)
Nonspecific	36	(29)
Gastrointestinal	17	(14)
Respiratory	11	(9)
Psychogenic	10	(8)

Table 5 *Documentation of risk factors for underlying cardiac disease*

	Documentation n	(%)
Red Flags – History		
Crushing or Compressive pain	66	(51)
Radiation	67	(52)
Palpitations	81	(63)
Dizziness	66	(51)
Syncope	83	(64)
Drug abuse	5	(4)
Recent surgery	6	(5)
Young onset ischaemic heart disease	1	(1)
Implantable cardiac defibrillator	50	(39)
Connective tissue disorder	4	(3)
FH sudden unexplained death <35 years old	50	(39)
FH cardiomyopathy	22	(17)
Hypercoagulable state	50	(39)
Red Flags – Examination		
Fever without source	50	(39)
Liver edge	50	(39)
Peripheral oedema	66	(51)

presentation.[15] Good history taking and examination are imperative in identifying red flags for patients at increased risk of having chest pain of cardiac or life threatening origin. These patients should then have further investigations, with the first line investigation being an ECG.[16] Judicious use of ECG in these patients is still associated with a low yield, with up to 3% contributing to the acute presentation[11,17], mainly myocarditis, pericarditis, Wolff-Parkinson-White and other arrhythmias. In our study, the majority of patients had an ECG, even though they did not have a history and examination suggestive of cardiac disease, with no contributory ECG findings identified. Of note, 6/9 patients without ECG had red flags identified on history taking or examination.

Certain studies suggest that cardiac biomarkers could be beneficial in identifying cardiac conditions such as myocarditis and heart failure and may also be a helpful prognostic indicator.[18] In fact, elevated troponin was the strongest predictor of cardiac diagnosis in a retrospective study analysing value of troponin as a marker for heart disease in previously healthy children.[19] However, the approach of 'screening' patients without underlying risk factors by taking cardiac biomarkers provides limited benefits whilst increasing cost and resource utilisation.[20] More than half of the patients included in our study had cardiac biomarkers, with no significant difference in investigation rate for children with no red flags when compared to those with red flags. Only one patient had an abnormal troponin level; this patient had hypertrophic obstructive cardiomyopathy, was admitted for further observation, and remained well.

It is evident that a thorough history and physical examination will exclude most underlying serious causes for children presenting with chest pain[21] and these should be documented appropriately. Medical notes which are unclear, lack completeness and specificity may result in poor patient outcome[10] and unnecessary investigations.[22] Medical professionals may have taken a comprehensive history and carried out a complete examination, but then fail to communicate this clearly and specifically in the notes. Unfortunately, only one of our patients had full documentation for all the red flags in history and examination, and our results could have been affected by lack of adequate documentation. Further investigations are then not needed in patients for whom a clear etiology, other than cardiac disease, can be established.[23-25]

CONCLUSION

Our study provides an overview of children presenting with chest pain to the PED, and confirms that this is usually due to benign causes. The yield of blanket laboratory investigations is limited. We suggest a clinical pathway to improve documentation and rationalise the use of investigations in children presenting with chest pain to the PED.

This paper is dedicated to the memory of Dr Victor Calvagna

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