Original Article

Chest pain attendances to a Paediatric Emergency Department pre- and post-COVID-19 vaccination

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Background: Introduction of the mRNA vaccination for coronavirus disease 2019 (COVID-19) has been associated with an increase in cases of peri/myocarditis. In our retrospective cross-sectional study, we aim to (I) describe paediatric chest pain attendance, and (II) study resource utilisation in the Emergency Department (ED) of KK Women's and Children's Hospital (KKH), stratified by pre-pandemic, during the pandemic pre- and post-COVID vaccination introduction in adolescents.

Methods: We reviewed records of adolescents aged 12 to 18 years old who presented to our ED with the triage complaint of chest pain between 1 January 2019 to 31 January 2022, and determined the attendance rates, aetiologies and resource utilisation during the above time periods.

Results: There were 2,418 ED attendances for chest pain in our study population. Among 887 inpatient admissions for chest pain, 1.8% were attributed to a cardiac cause. Comparing the pre-pandemic period to the period after the mRNA COVID-19 vaccination was introduced, ED chest pain rates increased from a median of 0.5% of ED attendances [interquartile range (IQR), 0.3–0.5%] to 0.9% (IQR, 0.7–2.0%) (P<0.001), while admission rates increased from a median of 26.2% of ED attendances (IQR, 24.1–29.1%) to 40.9% (IQR, 37.6–56.6%) (P<0.001). Cardiac enzyme orders among ED visits for chest pain increased from a pre-pandemic median of 0% (IQR, 0.0–2.6%) to a post-vaccination median of 26.1% (IQR, 17.2–56.2%) (P<0.001) and were due to concerns for vaccine-related myocarditis. Seven cases of probable vaccine-related myocarditis presented with chest pain to our ED.

Conclusions: Paediatric chest pain is largely non-cardiac in origin. ED chest pain attendance rates and resource utilisation increased after the introduction of mRNA COVID-19 vaccination in adolescents.

Keywords: Chest pain; paediatric emergency; mRNA coronavirus disease 2019 vaccination (mRNA COVID-19 vaccination); myocarditis

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Introduction

Chest pain is a common reason for Emergency Department (ED) visits. Among adults presenting with chest pain, cardiac ischemia is an important differential, with the incidence of major adverse cardiac events ranging from 3.7% to 7.8% (1). In children, however, cardiac causes of chest pain are less common, and include arrhythmias, myocarditis and pericarditis, structural causes such as cardiomyopathies and valvular and coronary artery abnormalities. More commonly, chest pain in children is due to musculoskeletal, gastrointestinal, respiratory, or psychogenic causes, or may be idiopathic in nature (2,3). One important cardiac differential is myocarditis which can present with chest pain and mimic an acute coronary syndrome.

Following the coronavirus disease 2019 (COVID-19) pandemic, the mRNA vaccine was introduced in December 2020 and vaccination of adolescents aged 12 and above was initiated on 3rd June 2021 in Singapore. Only the Pfizer-BioNTech/Comirnaty mRNA vaccine was approved locally for use in adolescents at that time. A causal link of COVID-19 mRNA vaccines and myocarditis and pericarditis was soon reported across the world (4).

In Singapore, there were widespread health advisories regarding the potential development of myocarditis post-vaccination, and the need for medical attention in the presence of onset of symptoms, in particular chest pain. Data from the national registry in Singapore indicated an increased incidence of pericarditis and myocarditis in younger men after mRNA COVID-19 vaccination. By the end of July 2021, 34 cases of confirmed and probable myocarditis and/or pericarditis were reported with 7,183,889 doses of mRNA COVID-19 vaccine (5).

With the uptake of mRNA COVID-19 vaccination in adolescents, we noticed an increase in ED attendances for chest pain, with concerns for vaccine-related myocarditis. We aim to (I) describe chest pain attendances, and (II) study resource utilisation among children with chest pain in the ED, stratified by pre-pandemic, during the pandemic pre- and post-COVID vaccination introduction. We present this article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-23-230/rc).

Highlight box

Key findings

- Emergency Department (ED) attendances for chest pain increased significantly after the introduction of mRNA coronavirus disease 2019 (COVID-19) vaccination.
- Cardiac causes for ED chest pain admissions remained at less than 2% even after the introduction of the mRNA COVID-19 vaccination.
- Seven cases of vaccine related probable myocarditis presented with chest pain to our ED, and their acute clinical course was mild.

What is known and what is new?

- Chest pain in adolescents presenting to the ED is largely non-cardiac in origin.
- At the peak of mRNA COVID-19 vaccination, ED attendances and resource utilisation increased, although cardiac causes for chest pain still remained at less than 2%.

What is the implication, and what should change now?

- The risk of myo-pericarditis among adolescents with chest pain and recent mRNA COVID-19 vaccination is low.
- Adolescents with vaccine related probable myocarditis generally have a mild acute clinical course and close monitoring suffices in most cases.

Methods

Design

We performed a retrospective cross-sectional study in a single centre with chart review for the period dated 1 January 2019 to 31 January 2022. We defined the pre-pandemic period as January 2019 to February 2020, pandemic period prior to COVID-19 vaccination as March 2020 to May 2021, and pandemic period after the introduction of COVID-19 vaccination for adolescents as June 2021 to January 2022.

Setting

The ED of KK Women's and Children's Hospital has an annual attendance of about 150,000 patients per year. We received children sent via ambulances, walk-ins, as well as patients transferred from other hospitals. With reports of COVID-19 mRNA vaccine related myocarditis, we introduced a workflow from end June 2021 evaluating adolescents presenting with chest pain within 1 week from their last vaccine dose. Evaluation of suspected myocarditis included electrocardiogram (ECG), chest radiograph and cardiac biomarkers creatine kinase muscle-brain (CKMB) isoenzyme and high sensitivity troponin I in our ED. The ED in consultation with the hospital's cardiology department recommended hospitalising patients who presented with chest pain within 1 week of their

second vaccine dose, after considering risk of vaccine-related complications. The estimated myocarditis and/or pericarditis rate was highest among 12- to 17-year-old males at 66.7 cases per million doses with second dose mRNA vaccine, with myocarditis accounting for 40.3% of serious events reported in adolescents of the same age (6).

Selection of subjects

We included adolescents 12 to 18 years old who attended the ED with the triage complaint of "chest pain", "chest tightness", or "chest discomfort". We determined the total number attendances to the Children's Emergency per month and calculated the attendance rate of adolescents presenting with chest pain. We compared the attendance rates pre-COVID-19 pandemic, during the pandemic pre- and post-COVID-19 vaccination for adolescents. We determined the incidence of myocarditis/pericarditis in adolescents presenting with chest pain to our ED. Study team members who reviewed the case notes were not blinded to the patient outcomes. However, variables and variable definitions were determined apriori.

Data collection

We obtained information on patient demographics, ED triage category, primary ED diagnosis based on the SNOMED-Clinical Terms, investigations, disposition, level of inpatient care required, and the inpatient discharge diagnosis. Patients in the ED are triaged based on vital signs and clinical appearance based on the Singapore Paediatric Triage Scale (7). We categorised priority by resuscitation (most severe, attended to immediately) *vs.* non-resuscitation status.

We reviewed the frequency of investigations performed in the ED and compared these across the time periods of pre-pandemic and during the pandemic pre- and post-vaccination. These included the ECG, chest radiograph, and cardiac enzymes (CKMB, high sensitivity troponin I) which were performed in the ED. We compared the admission rates for chest pain pre-pandemic and during the pandemic pre- and post-vaccination and reviewed the maximum level of care required [general ward *vs.* higher acuity of high dependency or intensive care unit (ICU)].

We reviewed both the ED and inpatient primary discharge diagnoses, categorised them by systems. Cardiac causes included myocarditis, pericarditis, arrhythmias, heart failure, cardiomyopathy and hypertensive urgency. The diagnosis of probable myocarditis was based on the working case definition for acute myocarditis and acute pericarditis from the Centers for Disease Control and Prevention (CDC) (8). This was based on clinical presentation of chest pain with abnormal troponin I level and/or ECG abnormalities, and with no other identifiable cause. Respiratory causes included pneumothorax, pneumomediastinum, asthma exacerbations and respiratory infections. If the primary diagnosis description was gastritis, gastro-oesophageal reflux, abdominal pain, vomiting, gastroenteritis or dyspepsia, the cause of chest pain was deemed to be gastrointestinal. If the primary diagnosis description was costochondritis, chest trauma, chest contusion or chest abrasion, the cause of chest pain was deemed to be musculoskeletal. Cases with primary diagnoses of hyperventilation, panic attack, somatisation, drug overdose, depression and anxiety were categorised under psychogenic cause. We labelled those with non-specific primary diagnoses of "chest pain", or "palpitations" as "not otherwise specified". There were cases with primary diagnoses which appeared to be unrelated to chest pain, e.g., headache, seizures, giddiness, fever, viral illness—and these were categorised under other causes.

Statistical analysis

We compared the patient attendance, characteristics, management and disposition variables across the three time periods defined above. Categorical variables were described using frequencies and percentages, while continuous data were presented using mean [standard deviation (SD)] or median [interquartile range (IQR)], depending on normality. Since the monthly data for chest pain attendance rates, cardiac enzyme usage and admission rates were non-parametric, we presented median (IQR), and three-way comparisons were analysed using Kruskal-Wallis test. Categorical variables were analysed using the Chi-square test or Fisher's exact test, where appropriate. We used the SPSS statistical software v26 (Chicago) to perform the analysis. Statistical significance was taken at $P<0.05$.

Ethics

The study was conducted in accordance with the Helsinki Declaration (as revised in 2013). The study was approved by SingHealth Centralised Institutional Review Board, Singapore (CIRB Ref. No. 2022/2139) with waiver of informed consent due to the retrospective nature of the

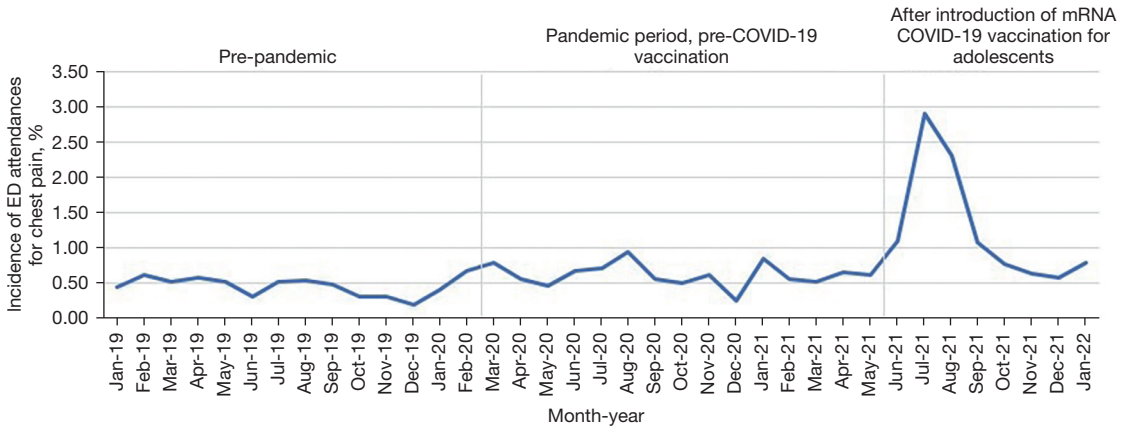

Figure 1 Monthly chest pain attendance among total ED attendances. ED, Emergency Department; COVID-19, coronavirus disease 2019.

study with de-identified data.

Results

There were 2,418 attendances to the ED with triage complaints including chest pain, chest tightness or chest discomfort, in adolescents aged 12 to 18 years old, during the study period of 1 January 2019 to 31 January 2022. Out of the 2,418 attendances, there were 2,079 unique patients and 31 were re-attendances within 72 hours. All 2,418 attendances were analysed. ED attendance rates for chest pain (out of total ED attendances) increased from a median of 0.5% (IQR, 0.3–0.5%) pre-pandemic, to 0.6% (IQR, 0.5–0.7%) during the pandemic from March 2020 to May 2021, to 0.9% (IQR, 0.7–2.0%) after mRNA COVID-19 vaccination in adolescents was introduced (P<0.001). Chest pain attendance rates reached a peak of 2.9% in July 2021 (*Figure 1*).

Table 1 shows the characteristics and level of care for children presenting with chest pain across the three defined time periods. Although the mean age was similar, more adolescent males attended the ED for chest pain during the time period after mRNA COVID-19 vaccination was introduced, compared to pre-pandemic and pre-vaccination periods (52.9% *vs.* 46.0% and 44.1%, P=0.001). The percentage of resuscitation cases remained similar across the three time periods (2.6% *vs.* 2.4% *vs.* 2.9%, P=0.841). The largest proportion of ED primary diagnosis classification was not otherwise specified and a reflection of doctors indicating "chest pain" as a primary diagnosis, which did not indicate aetiology. Admission rates increased from median 26.2% (IQR, 24.1–29.1%) of chest pain attendances during pre-pandemic period, to 33.3% (IQR, 30.9–38.1%) during the pandemic and 40.9% (IQR, 37.6–56.6%) after the mRNA COVID-19 vaccination was introduced for adolescents (P<0.001).

The level of inpatient care required remained similar despite the increase in admission rates, with most patients requiring general ward care (general ward admissions 96.9% *vs.* 95.5% *vs.* 98.6% across the three time periods, P=0.56).

During the pre-pandemic phase studied, there were no adolescents with an ED or final inpatient diagnosis of myocarditis, among those who presented with chest pain. There was 1 case of pericarditis which presented in March 2020. Following the introduction of mRNA COVID-19 vaccination in adolescents in Singapore, seven cases (six males and one female) of vaccine-related probable myocarditis were diagnosed (*Figure 2*). All occurred after the second dose of mRNA COVID-19 vaccination. Six had onset of symptoms within 1 to 2 days from their second vaccine dose, while the remaining case developed symptoms 10 days after vaccination. Besides chest pain, other presenting complaints included palpitations, giddiness, near syncope and breathlessness. All seven patients had stable vital signs in the ED. Four out of the 7 had raised troponin I levels from the ED, and all had raised troponin I levels on repeat testing in the ward. At ED presentation, the troponin I levels ranged from less than 10 to 4,385 ng/L. Peak troponin I levels inpatient ranged from 124 to 18,341 ng/L (*Table 2*). Chest radiographs and ECGs done in the ED were normal for these patients. Four patients had subsequent ECG evidence of ST elevations in the ward. All tested negative for COVID-19, and none had documented COVID-19

Table 1 Characteristics of patients presenting with chest pain in each period

Variables	Jan 2019–Feb 2020[†] (n=837)	Mar 2020–May 2021[‡] (n=748)	Jun 2021–Jan 2022[§] (n=833)	P value
Age (years), mean (SD)	13.8 (1.3)	14.0 (1.4)	13.9 (1.4)	0.078
Males, n (%)	385 (46.0)	330 (44.1)	441 (52.9)	0.001
Triage category, n (%)				0.841
Resuscitation status	22 (2.6)	18 (2.4)	24 (2.9)	
Non-resuscitation status	815 (97.4)	730 (97.6)	809 (97.1)	
ED primary diagnosis classification, n (%)				<0.001
Cardiac	11 (1.3)	7 (0.9)	2 (0.2)	
Respiratory	168 (20.1)	107 (14.3)	55 (6.6)	
Gastrointestinal	68 (8.1)	59 (7.9)	37 (4.4)	
Musculoskeletal	121 (14.5)	103 (13.8)	43 (5.2)	
Not otherwise specified	349 (41.7)	357 (47.7)	605 (72.6)	
Psychogenic	31 (3.7)	47 (6.3)	22 (2.6)	
Others	89 (10.6)	68 (9.1)	69 (8.3)	
Disposition, n (%)				<0.001
Admitted	223 (26.6)	244 (32.6)	420 (50.4)	
Treated and discharged	343 (41.0)	299 (40.0)	222 (26.7)	
Referred to non-cardiology specialist outpatient clinic	126 (15.1)	97 (13.0)	100 (12.0)	
Referred to outpatient cardiology clinic	113 (13.5)	75 (10.0)	69 (8.3)	
Discharged against medical advice	15 (1.8)	17 (2.3)	12 (1.4)	
Referred to general practitioner	13 (1.6)	7 (0.9)	4 (0.5)	
Referred to other government hospital	4 (0.5)	9 (1.2)	6 (0.7)	
Level of care of hospitalisation[¶], n (%)				0.56
General ward	216 (96.9)	233 (95.5)	414 (98.6)	
HD/ICU	7 (3.1)	11 (4.5)	6 (1.4)	
Inpatient discharge diagnosis classification[¶], n (%)				<0.001
Cardiac	3 (1.3)	5 (2.0)	8 (1.9)	
Pericarditis	0 (0)	1 (0.4)	0 (0)	
Myocarditis	0 (0)	0 (0)	7 (1.7)	
Respiratory	36 (16.1)	33 (13.5)	22 (5.2)	
Gastrointestinal	17 (7.6)	27 (11.1)	20 (4.8)	
Musculoskeletal	129 (57.8)	128 (52.5)	307 (73.1)	
Not otherwise specified	7 (3.1)	5 (2.0)	34 (8.1)	
Psychogenic	16 (7.2)	29 (11.9)	13 (3.1)	
Others	15 (6.7)	17 (7.0)	16 (3.8)	

[†], pre-pandemic period; [‡], pandemic period prior to introduction of COVID-19 mRNA vaccination for adolescents; [§], pandemic period after introduction of COVID-19 mRNA vaccination for adolescents; [¶], for admitted patients only. SD, standard deviation; ED, Emergency Department; n, number; HD, high dependency; ICU, intensive care unit; COVID-19, coronavirus disease 2019.

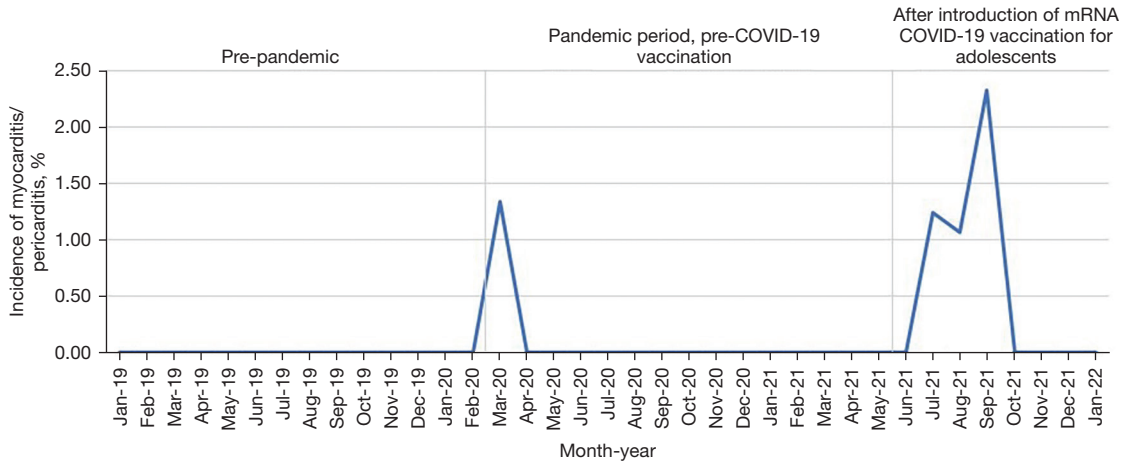

Figure 2 Incidence of myocarditis/pericarditis in adolescents presenting with chest pain. COVID-19, coronavirus disease 2019.

infection prior to presentation. Six of the 7 patients had severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) immunoglobulin G (IgG) (N-protein) antibody testing done, and all were negative. Microbiological workup for other infective causes of myocarditis in these seven children returned negative for influenza A and B, parvovirus, adenovirus, enterovirus and parechovirus. Three patients underwent cardiac magnetic resonance imaging (MRI) during their inpatient stay. Decision for cardiac MRI was based on individual physician's discretion. Out of the three patients, one had late gadolinium enhancement in the left ventricle compatible with myocarditis, while two had subtle or suspected late gadolinium enhancement. There was one ICU admission: A 15-year-old Chinese boy who presented with chest pain, breathlessness, diaphoresis and fever occurring 1 day after his second COVID-19 mRNA vaccine dose. He had raised troponin I level of 2,521 ng/L in the ED, which rose to a peak of 18,341 ng/L 6 days from his second vaccine dose. Inpatient echocardiogram showed normal cardiac function and serial ECGs showed stable T wave inversion in inferior leads. Inpatient cardiac MRI done on the 4th day of his admission (1 week from the start of his symptoms) showed reduced contractility and suspected late gadolinium enhancement in the mid-apical region of the right ventricle. He remained haemodynamically stable. All seven patients were managed with symptomatic treatment and none received intravenous immunoglobulin or steroids, or required extracorporeal life support. They were all discharged well after a median length of stay of 4 days (IQR, 3–4.5 days) with cardiology follow-up.

The use of ECG and chest radiographs remained similar across the three time periods (*Figure 3*). Eighty-three-point-eight percent to 100% of adolescents presenting with chest pain symptoms to our ED had ECG performed, and 62.5% to 91.3% had chest radiographs performed. A median of 0% (IQR, 0.0–2.6%) of ED attendances for chest pain had cardiac enzymes performed in the pre-pandemic period, 1.8% (IQR, 0.0–4.8%) had cardiac enzyme tests during the pandemic prior to introduction of mRNA vaccination, and 26.2% (IQR, 17.2–56.2%) after mRNA vaccination was introduced (P<0.001). The use of cardiac enzymes rose to a peak of 66.9% of ED visits for chest pain during July 2021 after the introduction of mRNA vaccination.

Discussion

We report a baseline pre-pandemic median of 0.5% of monthly ED attendances for chest pain. This is similar to other EDs which report 0.5–1% attendance rates for paediatric chest pain (9,10). Our ED monthly attendance for chest pain rose to a peak of 2.9% after mRNA COVID-19 vaccination was introduced. This was accompanied by an increase in cardiac enzyme tests and chest pain hospitalisations. Chest pain attendances gradually decreased as most of the adolescent population completed their primary vaccination series. By December 2021, 91% of the eligible population aged 12 years and above had completed their primary vaccination series (11). Chest pain attendances decreased to 0.63% in November 2021.

Our study shows that chest pain in adolescents is largely non-cardiac in origin, with only 0.83% of cases deemed to be cardiac in origin based on ED primary diagnosis

Table 2 Clinical findings for post mRNA COVID-19 vaccination probable myocarditis using CDC criteria

No. of patient	Age (years)	Gender	Race	Presenting complaints	Onset of symptoms from 2nd vaccine dose (days)	Triage vital signs	Troponin I level in ED (ng/L)	Peak troponin I level in ward (ng/L)	Highest level of care	Length of stay (days)
1	12	Male	Chinese	Chest pain, fever, giddiness	2	Temp: 37.9 ℃; RR: 18 breaths/min; HR: 99 beats/min; BP: 120/87 mmHg	<10	357	GW	3
2	16	Male	Chinese	Palpitations, chest discomfort, shortness of breath, near syncope	10	Temp: 37.4 ℃; RR: 20 breaths/min; HR: 66 beats/min; BP: 109/67 mmHg	145	224	HD	2
3	15	Male	Chinese	Chest pain, fever, shortness of breath, diaphoresis	1	Temp: 36.5 ℃; RR: 16 breaths/min; HR: 75 beats/min; BP: 127/86 mmHg	2,521	18,341	ICU	5
4	12	Female	Malay	Chest pain, fever, vomiting, palpitations, giddiness	2	Temp: 37.8 ℃; RR: 20 breaths/min; HR: 107 beats/min; BP: 103/64 mmHg	<10	218	HD	4
5	13	Male	Chinese	Chest pain, lightheadedness	2	Temp: 37.6 ℃; RR: 18 breaths/min; HR: 103 beats/min; BP: 112/77 mmHg	<10	124	HD	3
6	16	Male	Chinese	Chest pain, shortness of breath, palpitations, diaphoresis	1	Temp: 36.6 ℃; RR: 16 breaths/min; HR: 76 beats/min; BP: 116/80 mmHg	4,385	6,192	HD	4
7	14	Male	Chinese	Chest pain, palpitations, giddiness	2	Temp: 37.7 ℃; RR: 20 breaths/min; HR: 86 beats/min; BP: 102/58 mmHg	20	11,685	HD	5

COVID-19, coronavirus disease 2019; CDC, Centers for Disease Control and Prevention; ED, Emergency Department; Temp, temperature; RR, respiratory rate; HR, heart rate; BP, blood pressure; GW, general ward; HD, high dependency; ICU, intensive care unit.

classification. Among the 887 patients admitted during the study period, 1.8% were attributed to a cardiac cause. Ten-point-three percent of admissions were due to respiratory causes, 7.2% gastrointestinal causes, and 63.6% were attributed to musculoskeletal causes. Similarly, among 4,288 patients aged younger than 19 years old who presented with chest pain to two tertiary care paediatric EDs in the United States, only 0.6% were of cardiac origin (12). This is despite parental and patient's perception that chest pain is due to a cardiac cause. In a study of 663 children aged 3 to 18 years presenting with chest pain to a Turkish cardiology outpatient clinic, 90.2% of patients and 70.8% of parents thought the chest pain was due to a cardiac cause (2).

A retrospective cohort study of 111 children under 16 years old presenting with chest pain to an Italian paediatric ED pre-COVID-19 era and during the COVID-19 period till May 2021 showed increased presentations during the COVID-19 era (0.74% *vs.* 1.6%, P<0.001) with no differences in the causes for chest pain between the two periods. Cardiac causes were identified in 4.5% of their cases (13). The increase in chest pain presentations was postulated to stem from mental health issues giving rise to functional symptoms. While our ED did see an increase in chest pain attendances and inpatient admissions during the COVID-19 era pre-vaccination (0.6% and 32.6% respectively, *vs.* 0.5% and 26.6% pre-pandemic),

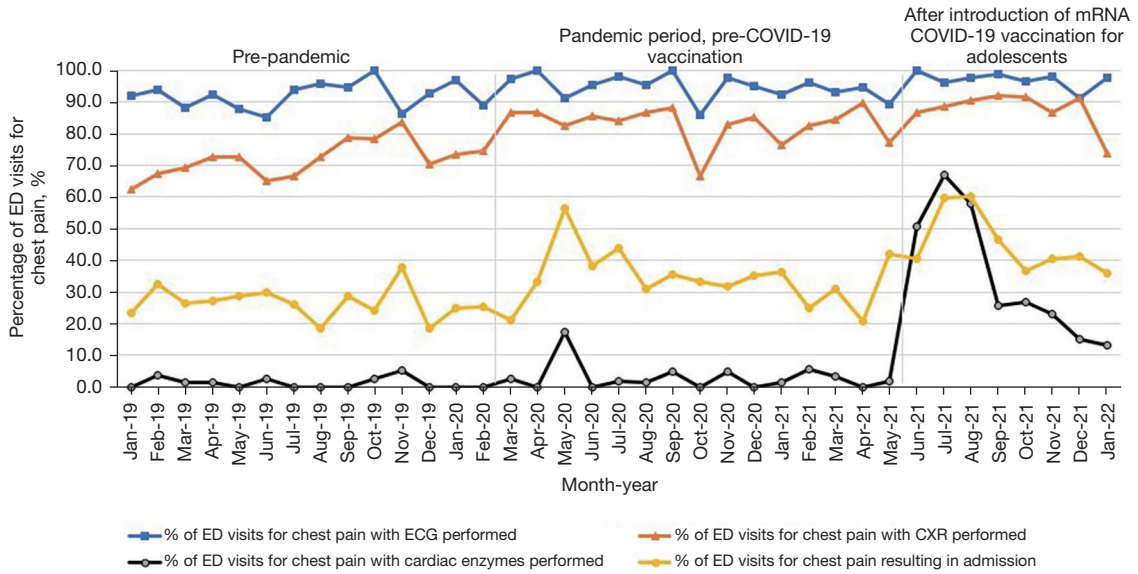

Figure 3 Resource utilization. COVID-19, coronavirus disease 2019; ED, Emergency Department; ECG, electrocardiogram; CXR, chest X-ray.

the increase in chest pain attendances and admissions post-vaccination was more marked at 0.9% and 50.4% respectively.

There are well-validated protocols for adult patients with chest pain, such as the HEART Pathway (history, ECG, age, risk factors, and troponin pathway), and the Emergency Department Assessment of Chest Pain Score Accelerated Diagnostic Protocol (EDACS-ADP) that provide standardised evaluation for chest pain (1). In children however, there is no standardised evaluation pathway or algorithm for exclusion of cardiac causes (10). The Children's Hospital of Philadelphia implemented a clinical pathway for evaluation of paediatric chest pain based on history and physical examination (14). Post implementation, 3.9% of paediatric chest pain visits had troponin levels performed, 35.6% had chest radiographs, 47.7% had ECGs and 1.2% had echocardiograms performed in the ED (15). In contrast, ECG and chest radiographs were used more frequently in our ED at baseline. On average, 94.2% of adolescents presenting with chest pain symptoms to our ED had ECG performed, and 79.9% had chest radiographs performed during our study period (*Figure 3*). This is likely due to our department's current guidelines which recommends routine ECG and chest radiograph for paediatric chest pain.

The increased incidence of myocarditis in our study population after the introduction of mRNA COVID-19 vaccination is in keeping with other local data and international studies (4–6,16). A case series of 15 adolescents between 12 to 18 years old showed that males were mainly affected (93%), and symptom onset within 1 to 6 days after vaccination (16). Chest pain occurred in all of these patients. In their short-term follow-up, patients were mildly affected, with 73% having resolution of symptoms. Likewise, all the cases of probable vaccine related myocarditis in our study were discharged stable.

We noted an increase in resource utilisation post-COVID-19 vaccination. Increased cardiac enzyme investigations rates and admission rates resulted from our protocol evaluating chest pain presentations in adolescents presenting within 1 week of their last COVID-19 mRNA vaccine dose. Similarly, another local paediatric ED noted an increase in COVID-19 vaccine related attendances of up to daily incidence of 15.4%, with chest pain accounting for their most common presentation (58.8%) (17). Eighty-five-point-five percent of their attendances had ECG performed, and 64.3% had blood investigations performed, with only 6.4% cases having clinically significant abnormalities.

Parental anxiety and physician concerns regarding the new mRNA vaccine and unknown side effects most likely contributed to the increased chest pain presentations to our ED and increased resource utilisation. Heightened anxiety is likely to have resulted especially after media reports in early July 2021 over a 16-year-old male who suffered cardiac arrest 6 days after his first COVID-19 mRNA vaccine dose (18).

We recognise the limitations of our retrospective chart

review study. We recognise that these findings reflect the experience of a single tertiary paediatric institution, and further study is required to understand if other paediatric centres had similar observations. Our findings reflected local practices, and physician decisions were guided by our institution's COVID-19 protocols. While we were able to review a large number of chest pain attendances to our ED retrospectively, we were limited by the non-specific SNOMED-Clinical Terms ED diagnosis of "chest pain" which did not indicate aetiology. We had ethics approval to obtain de-identified data and could not follow up on discharged patients. Hence, it is possible that we may have missed significant cardiac diagnoses. However, we believe that the risk is low, since children with recurrent symptoms would likely have re-attended our ED. Also, while we reported primarily on the index ED visit and hospitalisation (where admitted), we did not have information on subsequent outpatient cardiology investigations such as echocardiography or treadmill stress testing. This would have added greater clarity on the further resource utilisation in managing paediatric chest pain. Future research should look into determining the risk factors for clinically significant causes of paediatric chest pain, so as to implement and validate paediatric chest pain evaluation algorithms.

Conclusions

In conclusion, we reported an increase in chest pain attendances, with increased resource utilisation following reports of myocarditis and pericarditis with the introduction of the COVID-19 mRNA vaccination. However, there was no increase in cases requiring resuscitation or higher acuity inpatient care. Cardiac causes for ED chest pain admissions remained at less than 2% even after the introduction of mRNA COVID-19 vaccination. High vigilance ensured that children with raised cardiac enzymes were monitored carefully and none deteriorated. Although paediatric chest pain is largely non-cardiac in origin, red flags in the history and physical examination should prompt the physician for further evaluation. This includes recent mRNA COVID-19 vaccination which is a risk factor for development of myocarditis/pericarditis.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-23-230/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Helsinki Declaration (as revised in 2013). The study was approved by SingHealth Centralised Institutional Review Board, Singapore (CIRB Ref. No. 2022/2139) with waiver of informed consent due to the retrospective nature of the study with de-identified data.

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