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**45th National Conference
on Pediatric Health Care**

**Pediatric Cardiology for Primary
Care Advanced Practice Providers**

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Experts in pediatrics, Advocates for children. 1

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Speaker Disclosure

- No disclosures


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Learning Objectives

- Identify features differentiating innocent and pathologic heart murmurs
- Identify features of Wolff-Parkinson-White
- Differentiate between the common causes of chest pain and suggestions for triage


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Bella

- 6 yo who presents to her primary care NP as a follow up for a new murmur heard on exam in the setting of fever, bilateral otitis media, + rapid strep
- Seemed to tire more rapidly than her teammates and her 3 siblings

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Murmur Statistics

- Newborns/infants; higher incidence of asymptomatic structural heart disease
- Older kids; < 1% of asymptomatic have structural heart disease
- 61% of kids referred to cardiology; innocent murmur

Key is determining when a murmur is considered innocent vs pathologic

Bloom, 2014; Frank, 2011

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PMH Red Flags

Murmur +

- Chest pain/palpitations/audible dysrhythmia
- Syncope/near syncope/dizziness
- Pallor/cyanosis
- SOB/tachypnea/increase in respiratory effort
- Asthma-like symptoms/chronic cough/DOE
- Developmental delay
- Easily fatigued/difficulty keeping up with peers
- Poor growth/failure to thrive
- Family history of sudden cardiac death in young family members

Frank, 2011; Ford, 2022

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Physical Exam

- Displaced point of max impulse (PMI): ventricular overload or cardiomegaly
- Hyperdynamic chest
 - Ventricular heave: volume overload (RVH) seen in left to right shunts (PDA, VSD)
- Thrill: vibratory sensation
 - LUSB: originate from PA or pulmonary valve; PS, PA stenosis
 - RUSB: originate from Ao or aortic valve
 - LLSB: VSD
 - Suprasternal notch: AS

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Heart Sounds

- Single S1 (LUSB)
- Physiologically split S2
- Normal variant in kids
 - Single S2; pHTN, AoV/PV pathology
 - Fixed split S2: ASD

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Seven S's of Innocent Murmurs

- *Sensitive*; changes with position or respiration
 - > 2yo completely disappears with standing
 - S2 physiologically split
- *Short duration*; not holosystolic
- *Single*; no associated clicks or gallops
- *Small*; does not radiate
- *Soft*; low amplitude, $\leq 3/6$
- *Sweet*; not harsh
- *Systolic*; never diastolic!

Bronckers, 2010

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Diagnosis of Innocent Murmur > 1yo

4 criteria

- Absence of abnormal PE findings
- Negative ROS
- History that's not suggestive of increased risk of structural heart disease
- Auscultatory features of an innocent heart murmur

Frank, 2011

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Pathologic Murmurs

- \geq grade 3/6
- Harsh
- Holosystolic
- Abnormal S2
- PMI at LUSB
- Systolic click
- Diastolic, except for venous hum
- No significant change in murmur intensity; supine to standing

👉 hypertrophic cardiomyopathy (HCM); increase in intensity \rightarrow decr venous return to the heart (decr LVEDV) leading to LVOTO

Frank, 2011

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Bella's Follow-up Appointment

- Afebrile, throat and ears are feeling better, has returned to school and playing on local soccer team
- PE; normal precordial activity, single S1 and physiologically split S2 with normal intensity of the pulmonic component (P2), grade 1-2/6 vibratory systolic murmur LLSB, no diastolic component
- Normal pulses and perfusion to her upper/lower extremities

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Murmur - When to Refer

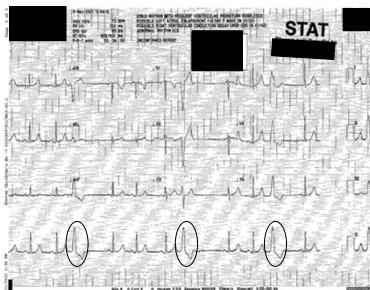
- **Newborns; within *hours***
 - Higher risk of having structural heart disease that presents as an asymptomatic murmur
- **Neonate; within *days***
 - Worry about closing of PDA in ductal dependent heart disease
- **Infant; within a *week***
 - Feeding difficulty may be 1st sign
- **Children/adolescents; within *months***
 - If asymptomatic, PE indicates a low probability of cardiac disease, neg. ROS & murmur has characteristics of an innocent murmur - may be followed by primary care provider

Julia

18 yo who had been in her USOH until she developed a 2 day history of fever, malaise, fatigue and cough

- ROS
 - Respiratory symptoms and new intermittent chest pain
- PE
 - Irregular heart rate, remainder of exam noncontributory
- 12 lead EKG; premature ventricular contractions (PVCs)
- PMH/fam hx
 - No meds, except for OCP
 - Negative for congenital heart disease/sudden cardiac death

Julia's EKG



Premature Ventricular Contractions

- Normal variant
- 50-70%; PVCs on 24h ambulatory EKGs
- Differential
 - Myocarditis
 - Myocardial injury or infarction
 - Cardiomyopathy
 - Cardiac tumors
 - Arrhythmogenic RV dysplasia
 - Long QT syndrome
 - Congenital or acquired heart disease
 - Drugs/medications

Julia's Cardiology Consult

ROS

- No activity intolerance, exertional dyspnea, CP with exertion
- No palpitations
- Reports feeling slightly lightheaded with position changes or standing for extended periods of time
- Reports her "heart go faster than usual at times, and "felt it speed up even more as she became nervous about feeling it", but never sudden in onset or associated with activity

Family hx

- Noncontributory

Julia's PE

- Well appearing, no syndromic features
- Respiratory
 - Breathing not labored or fast, lungs CTA bilaterally
- Cardiac
 - Normal precordial activity, no displacement of PMI
 - No palpable thrill, normal heart rate and regular rhythm, S1 with physiologically split S2, no loud murmur
 - No evidence of poor perfusion; good pulses
- GI
 - Benign, no enlarged liver
- Neuro
 - Grossly intact

Julia's EKG



When to Worry about PVCs/Ventricular Ectopy

- Occasional/single
 - Benign
- Significant
 - Associated with underlying congenital heart disease/cardiomyopathy
 - Family hx; syncope or sudden cardiac death
 - Occur with or become more frequent with activity
 - Multiform
 - Runs

Management

- Occasional/isolated uniform PVCs that are suppressed by exercise don't require extensive investigation or treatment
- Diagnostics
 - ETT
 - EKG
 - ECHO
 - Ambulatory 24h EKG monitor
- Symptomatic
 - Beta blockers
 - Cardiac MR; to eval RV dysplasia
- If multiform; refer to electrophysiologist for further investigation

Park, 2021

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Mia - Emergency Department

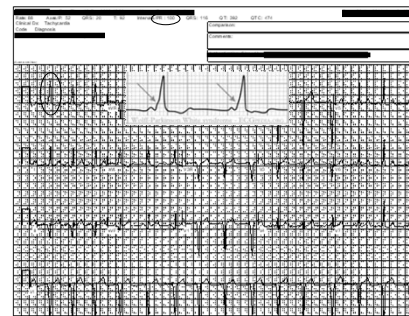
- 4 yo with 4 day hx of fever, malaise, fatigue, cough, intermittent abdominal pain, clear rhinorrhea and decreased appetite with subsequent decreased UO
 - Likely viral URI
- Acute onset of chest pain
- Pulse; 200 bpm
 - Vagal maneuvers
- Referred to the ED for further evaluation

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Mia's Inpatient Course

- Pneumonia treated with IV antibiotics
- 2 more episodes of tachycardia (230-240 bpm)
 - Each episode lasted about 2 min
 - 1st episode self resolved
 - 2nd required vagal maneuvers and ice
 - Unable to capture with 12 lead EKG, but on telemetry; likely SVT
- Echocardiogram
 - structurally normal heart, with good ventricular function

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Wolff-Parkinson-White (WPW)

- Accessory pathway that directly connects the atria to the ventricle
 - Bypasses AVN
 - Preexcitation
 - Can be rate dependent
- EKG
 - Short PR interval
 - Delta wave
- WPW *pattern*: short PR interval, delta wave on EKG and no other symptoms
- WPW *syndrome*: WPW pattern + arrhythmia (AVRT) involving an accessory pathway

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WPW Syndrome

- Echocardiogram
- Consider stress tests (> 7 yo) for asymptomatic kids
- Treatment
 - Beta blockers; infants/preschool
 - Catheter ablation or flecainide at 25 kgs/school age/young adolescent
- No activity restrictions
- Discussions with varsity level athletes

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What about Mia?

- Inpatient EKGs; evidence of Wolff-Parkinson-White Syndrome
- Beta blocker started and discharged home
- 28kg; successful RFA & beta blocker stopped

No evidence of WPW on EKG in the ED

- Sinus tachycardia
- WPW can be intermittent; antegrade conduction at slower heart rates
- ? heart rate related

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John

- 15 yo male with chest pain
- Experiencing chest pain over the last 24h
- Started while playing hockey
- 8/10 stabbing pain along the whole left side of his chest while playing

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John's ROS/ PMH

- He's never had this before; stopping peak exertion helps
- Plays varsity hockey and soccer
- Denies shortness of breath, palpitations, dizziness, or syncope
- PMH; asthma, had viral URI 3 weeks prior
- Family history; negative for sudden death, CHD, cardiomyopathies
- Recent injuries; none
- Medications; azithromycin, prn albuterol

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Physical Exam

- Well appearing, Dad was anxious
- VS; afebrile, HR 64 bpm, RR 16/min, BP 110/70, O2 sats 100% RA
- Normal Cardiac Exam; S1 with S2 split, no increase in P2, no murmur
- Lungs; clear
- Abdomen; soft, no HSM, + bowel sounds
- Extremities; warm and well perfused, no edema

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Pediatric Chest Pain

- Common problem that causes anxiety in patients, families and providers
- History and physical examination can determine the cause and identify patients who require referral/ further workup
- A cardiac cause is *RARE*

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Past Medical History

- Congenital or acquired heart disease
- Receipt of an mRNA COVID-19 vaccine within the preceding 30 days
- Risk factors for pulmonary embolism
- Risk factors for aortic dissection

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Family Medical History

- Hypertrophic cardiomyopathy or sudden death in first-degree relatives (eg, parents or siblings) younger than 50 yo
- History of connective tissue disease
- History of inherited hypercoagulable state

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ROS Concerning Findings

- Chest pain with exertion, dizziness, syncope, palpitations, or breathing problems
- Chest pain that radiates to the back, jaw, left arm/ shoulder
- Severe, tearing type pain
- Chest pain worse in supine position
- Associated with fever

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Physical Exam

Fever, tachypnea, tachycardia, gallop, rub, distant heart sounds	Non-innocent murmur	Painful swollen extremity, loud S2, peripheral edema
<ul style="list-style-type: none"> • Myocarditis • Pericarditis 	<ul style="list-style-type: none"> • Mitral regurgitation • Outflow tract obstruction 	<ul style="list-style-type: none"> • DVT • pHTN • Heart failure

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Chest Pain Differential

Non-Cardiac	Cardiac
<ul style="list-style-type: none"> • Musculoskeletal • Respiratory • GI/ GERD • Breast • Unsure/ idiopathic 	<ul style="list-style-type: none"> • Coronary artery abnormality • Myocarditis/ pericarditis • Pulmonary hypertension • Cardiomyopathy; dilated, hypertrophic • Aortic dissection/ Takayasu arteritis • Arrhythmia

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John

- Labs; CBC, inflammatory markers, troponin - all within normal range
- CXR; normal heart size, clear lung fields
- EKG; normal sinus rhythm with nonspecific ST/T wave changes
- Echo; normal

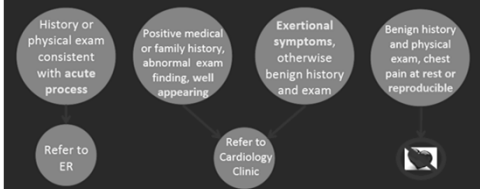
Diagnosis

- Non-cardiac CP
- Cleared to play in his hockey game

Chest Pain

- Non-concerning history, PE; no further testing indicated
- PE/ ROS concerning findings; consider referral to cardiology

Chest Pain in Kids: Suggestions for Triage



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