

# Cardiology boot camp for the general pediatric clinic

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4/26/2018

Timely Topics in Pediatrics Conference 2018  
American Academy of Pediatrics – Hawaii Chapter

# Disclosure

- I have no relevant financial relationships with the manufacturers(s) of any commercial products(s) and/or provider of commercial services discussed in this CME activity
- I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.

# Overview

## Boot camp

Step 1: warm-up

Step 2: 7 drills

Step 3: burnout

Step 4: recovery at home

# The warm-up

Most common cardiac “complaints” in pediatricians office:

Heart murmur

Chest pain

Syncope

# Murmur

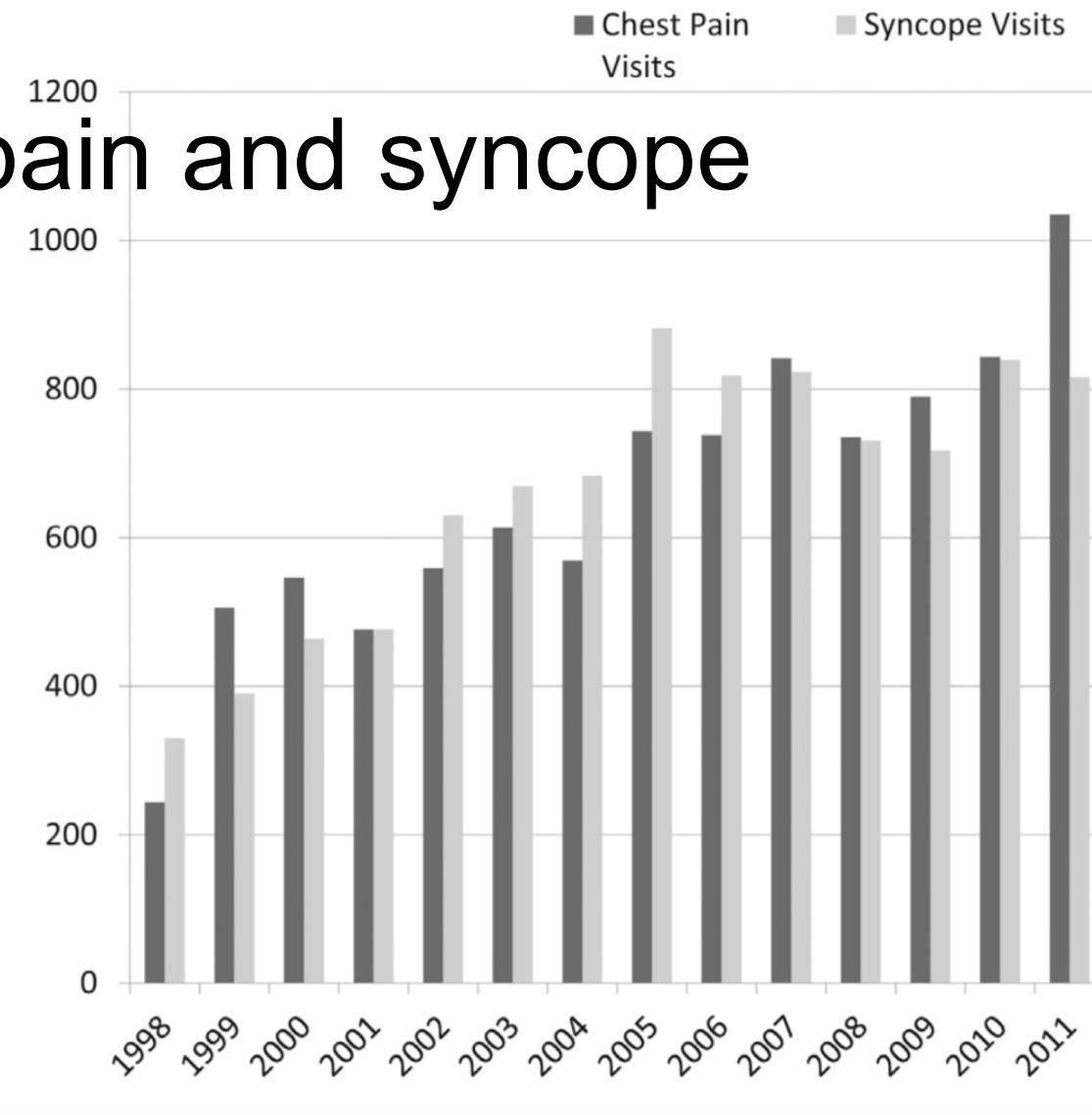
Cohort	Prevalence of innocent heart murmurs	Reference
2035, 1-15y	11.8%	Mainzer et al, Arch Dis Child, 1959
200, 2-12y	84%	Barlow and Pocock, Am Heart J, 1962
12050, 2-18y	72%	McLaren et al, Br Heart J, 1980
810, 5-14y	58% (41-9-4-4%)	Van Oort et al, Pediatr Cardiol, 1994

Prevalence of congenital heart disease is 0.8%

# Innocent heart murmurs

- Still's murmur
- Venous hum
- Pulmonary flow murmur
- Peripheral pulmonary stenosis in infants
- Carotid bruit

# Chest pain and syncope



Friedman and  
Alexander, J  
Pediatr, 2013

# Chest pain

## Frequency of cardiac etiology for chest pain

Study	Location	Total patients	Patients with cardiac chest pain, n (%)
Driscoll et al (1976) <sup>1</sup>	Ped	43	0 (0)
Pantell and Goodman (1983) <sup>13</sup>	PC	100	1 (1)
Selbst et al (1998) <sup>10</sup>	Ped ED	407	16 (4)
Gastesi et al (2003) <sup>33</sup>	Ped ED	161	1 (0.5)
Massin et al (2004) <sup>34</sup>	PC/Ped ED	69/168	3 (4)/8 (5)
Danduran et al (2008) <sup>2</sup>	PC	263	0 (0)
Friedman et al (2011) <sup>3</sup>	PC	406	5 (1.2)
Saleeb et al (2011) <sup>11</sup>	PC	3700	37 (1)

Friedman and  
Alexander, J  
Pediatr, 2013

# Causes of chest pain and syncope

- Non-cardiac chest pain ~99%
  - Cardiac origin of chest pain 1%
- 
- Neurocardiogenic syncope >99%
  - Cardiogenic syncope <1%



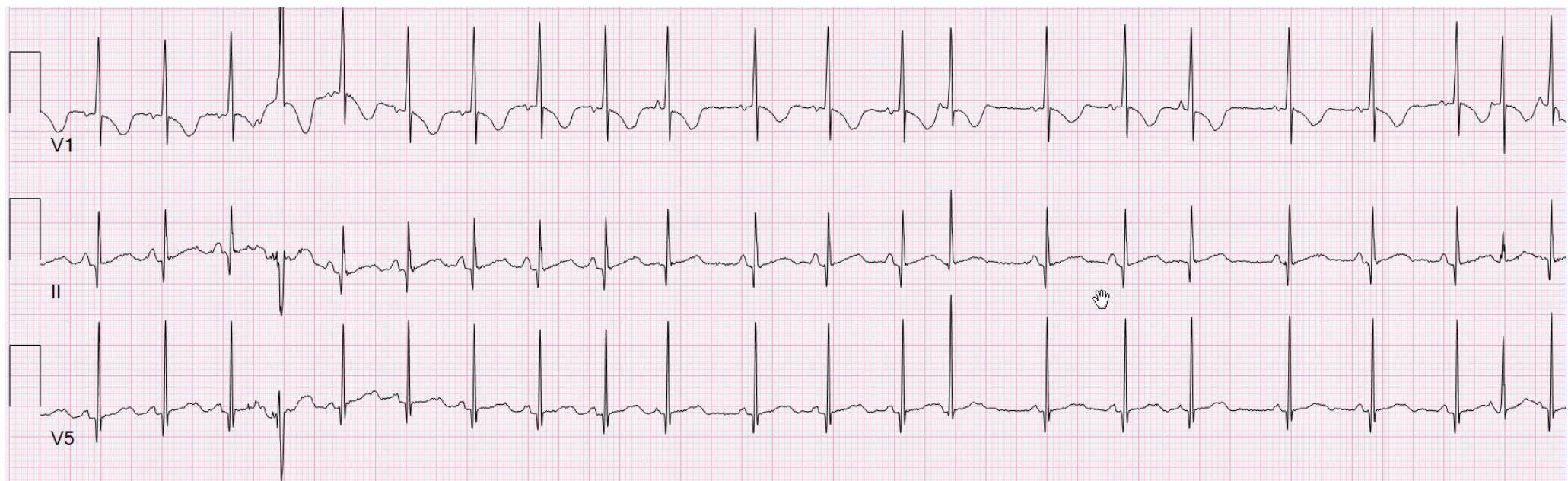
# Drills

- Newborn with arrhythmia
- Infant with murmur
- Young child with murmur
- Young teenager with chest pain
- Teenager with syncope
- Teenager with sports physical
- Teenager with murmur

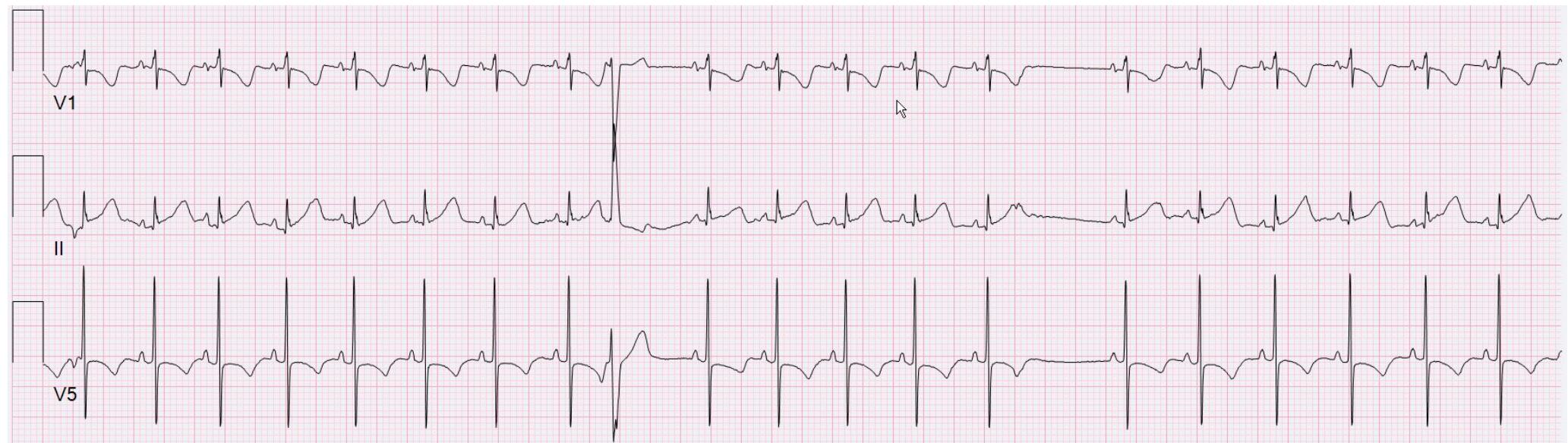
# 1. Newborn child with skipped beats

- 2 days old baby, Friday afternoon, nurse calls due to arrhythmia
- Frequent skipped beats
- ECG, rhythm strip

# 1. Newborn child with skipped beats



# 1. Newborn child with skipped beats



# 1. Newborn child with skipped beats

- PACs
- Conducted, aberrantly conducted, blocked
- Atrial contractions are benign
- Tend to resolve without treatment
- PVCs
- Ventricular contractions can be dangerous
- Could be associated with structural heart problems, cardiomyopathies, or inherited arrhythmia syndromes

## 2. Infant with a persistent murmur

- Well child visit, persistent murmur at 2 and 4 weeks
- What goes through your mind? The entire list of congenital heart defects (VSD, ASD, PDA, TOF, AVSD, DORV, IAA, COA, AS, PS, TGA, TAPVR, HLHS, DILV, TriA, TA, APW, PA/IVS, PA/VSD/MAPCAs)

## 2. Infant with a persistent murmur

- Step 1: CCHD screening

Critical congenital heart disease screening: cyanotic heart defects and critical aortic arch stenosis are out (TA, TGA, TriA, TOF, TAPVR, IAA, COA, HLHS, DILV, DORV, PA/IVS, PA/VSD/MAPCAs)

What's left: VSD, ASD, PDA, AVSD, AS, PS, TOF, COA and peripheral pulmonary stenosis

## 2. Infant with a persistent murmur

- Step 2: symptoms and PE

Symptoms of respiratory distress: lack of tachypnea and retractions rule out significant VSD, PDA, AVSD

Lack of hepatomegaly rules out significant PS, TOF

Normal femoral pulse and perfusion rule out severe COA, and critical AS

What's left: restrictive VSD, PDA, not too severe AS, PS, ASD, TOF, COA and PPS

## 2. Infant with a persistent murmur

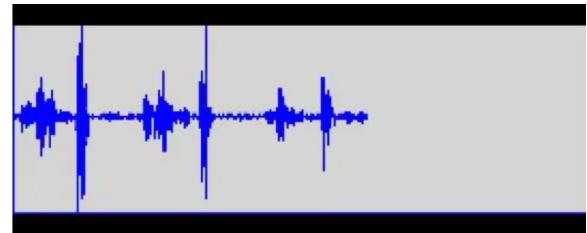
- Most common causes of murmurs in early infancy:

PPS

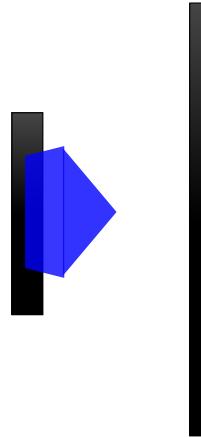
PDA

VSD

# Peripheral pulmonary stenosis



S1      S2



systole      diastole

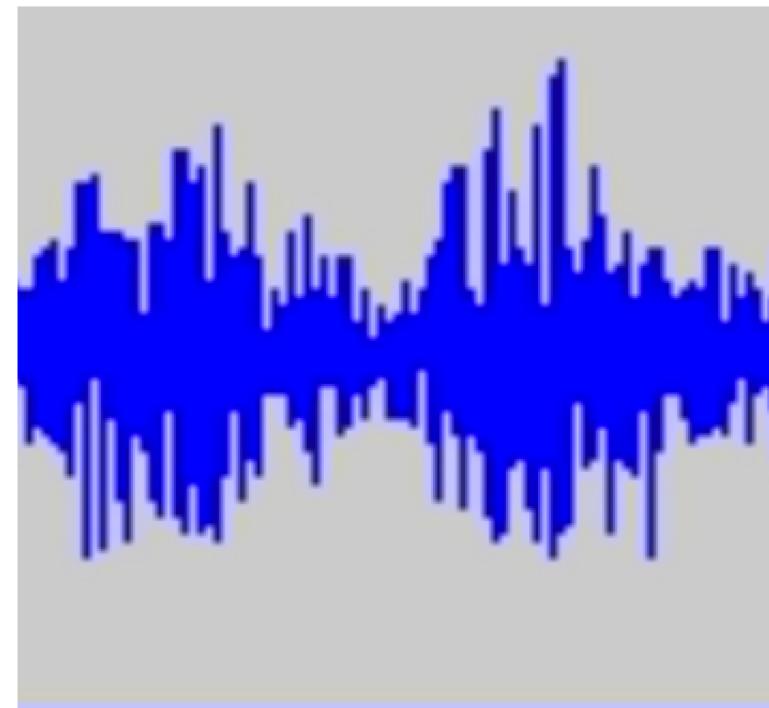
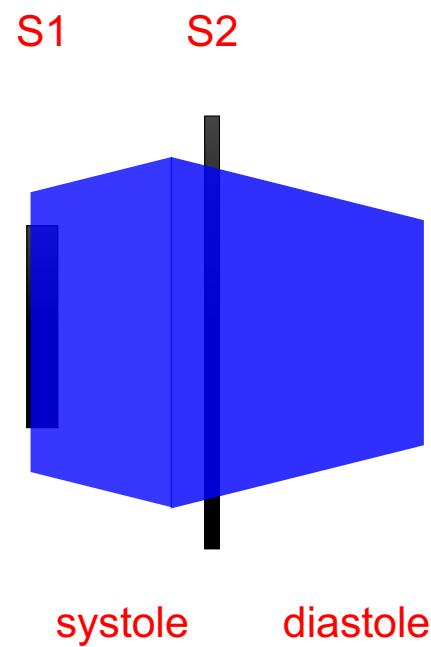


short systolic murmur



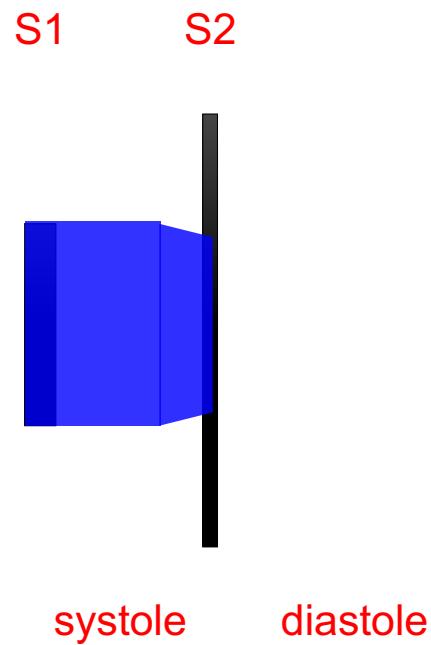
S1      S2

# Patent ductus arteriosus



continuous machinery murmur      S1      S2

# Ventricular septal defect



S1-coincident murmur



S1      S2

### 3. Young girl with “new” heart murmur

- Healthy 4 years old girl, first time murmur on WCC
- CCHD negative
- Normal development
- No respiratory distress
- Femoral pulses normal

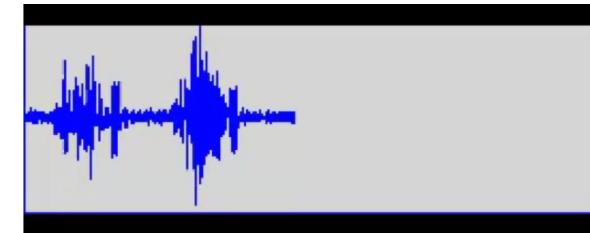
### 3. Young girl with “new” heart murmur

- What is left: ASD, PAPVR, mild to moderate PS or AS, MR (MVP), HOCM
- Innocent murmurs: Still's, venous hum

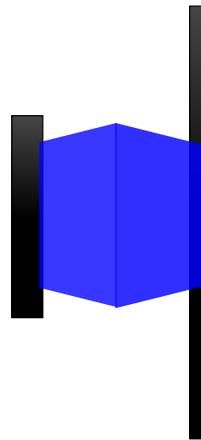
# Childhood murmurs

- Murmur in ASD, PAPVR, PS: systolic murmur at LUSB
- Murmur in MR: holosystolic murmur at apex and left axilla
- Murmur in AS, HOCM: systolic murmur at LMSB and RUSB
- Murmur in Still's: systolic murmur at LMSB and apex
- Venous hum: diastolic murmur at infraclavicular regions

# Pulmonic stenosis



S1      S2



systole

diastole



crescendo-decrescendo murmur

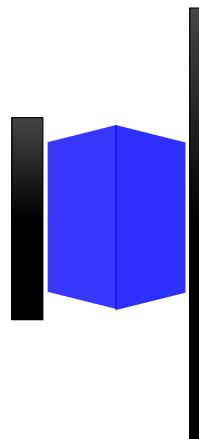
S1

S2



# Aortic stenosis

S1      S2



systole      diastole

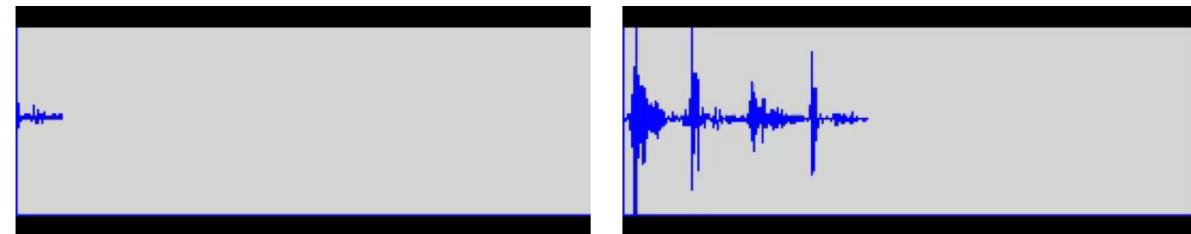


crescendo-decrescendo murmur

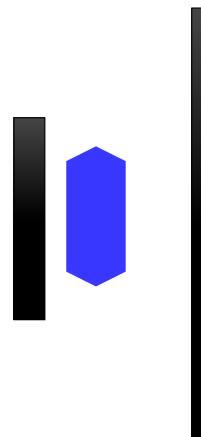
S1      S2



# Still's murmur

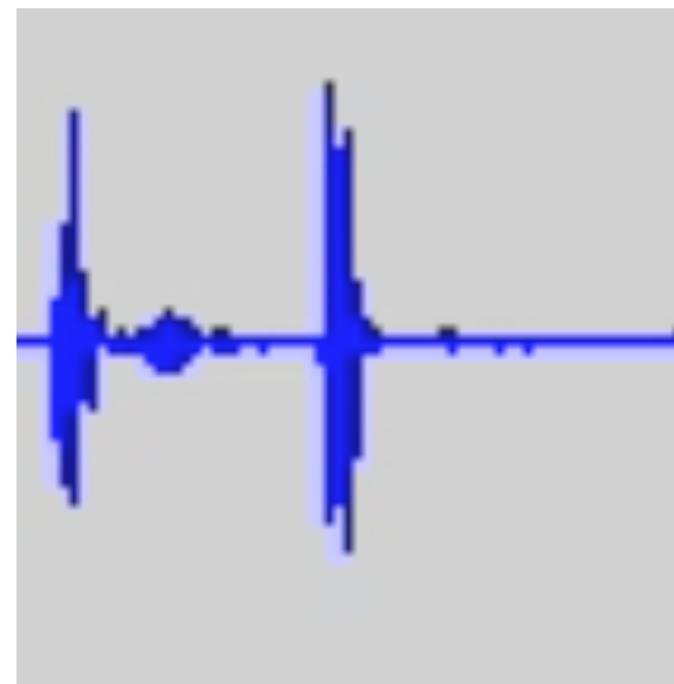


S1      S2



systole

diastole



short vibratory early systolic murmur

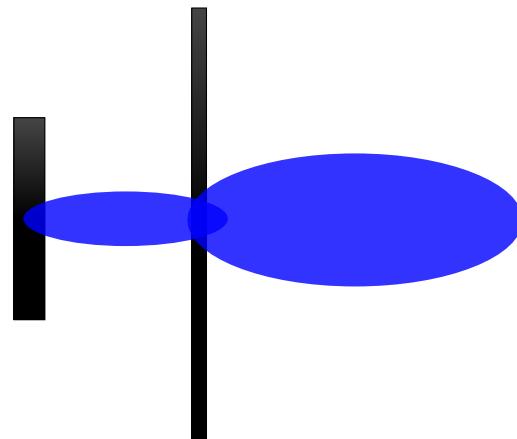
S1

S2



# Venous hum

S1      S2

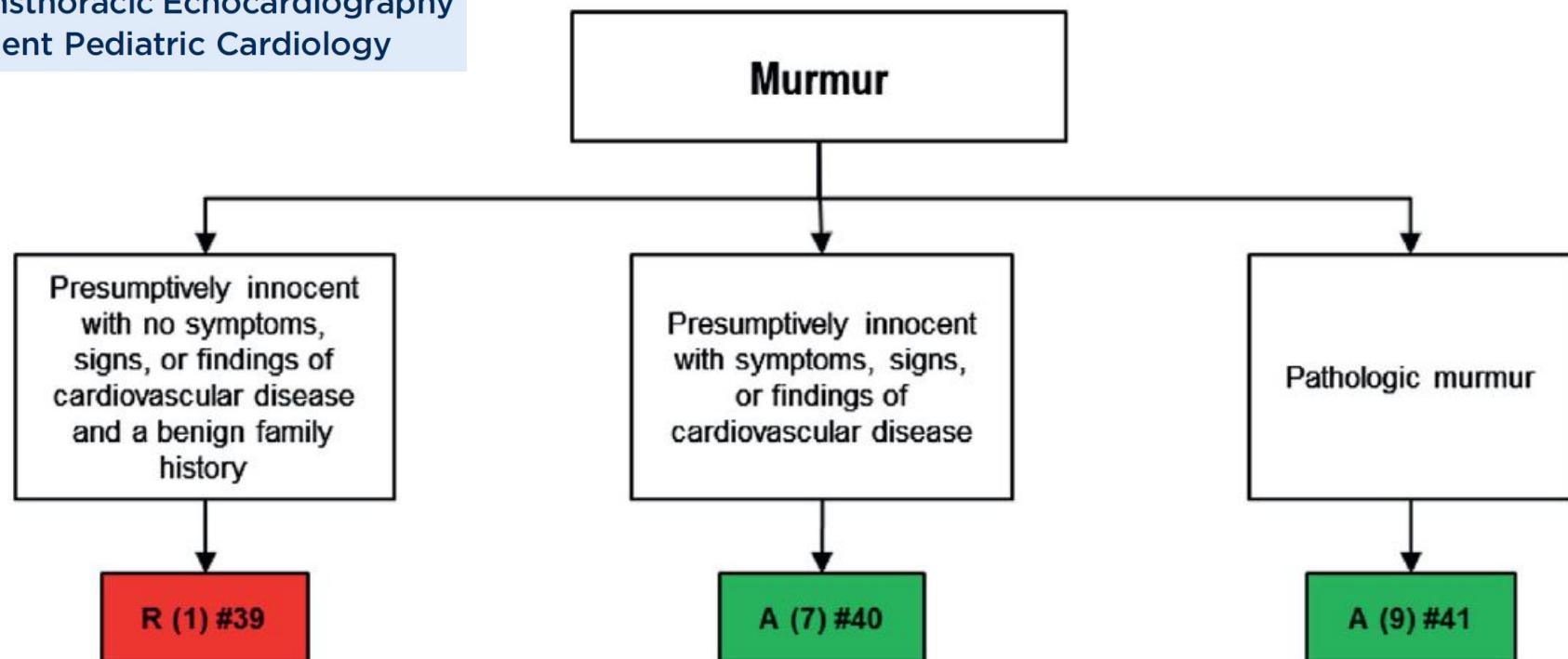


systole      diastole

Continuous murmur with louder diastolic component

**APPROPRIATE USE CRITERIA**

ACC/AAP/AHA/ASE/HRS/  
SCAI/SCCT/SCMR/SOPE  
2014 Appropriate Use Criteria for  
Initial Transthoracic Echocardiography  
in Outpatient Pediatric Cardiology



## 4. Pre-teen girl with chest pain

- 11 years old girl with precordial chest pain
- Occurs at random times
- Lasts 5 minutes
- No other symptoms
- No PMH besides asthma
- Rapid growth in the past 6 months

## 4. Pre-teen girl with chest pain

- What are we looking for besides musculoskeletal pain?
- SVT – arrhythmia may present as chest discomfort
- Ischemia – coronary artery anomaly
- Inflammation – pericarditis or myocarditis
- Vascular problems – aortic dissection, pulmonary embolism

# Prevalence of cardiac lesions

- 37 of the 3700 patients (1%) had a cardiac etiology
- SVT (n = 16)
- pericarditis (n = 10)
- myocarditis (n = 4)
- anomalous coronary origin from incorrect sinus (n = 3)

Saleb et al,  
Pediatrics, 2011

# Cardiac origins of chest pain

- pericarditis (n = 62)
- myocarditis (n = 46)
- coronary anomalies (n = 21)
- pulmonary embolus (n = 13)
- HCM (n = 3)
- pulmonary artery hypertension (n = 1)

Kane et al,  
Congen Heart  
Dis, 2010

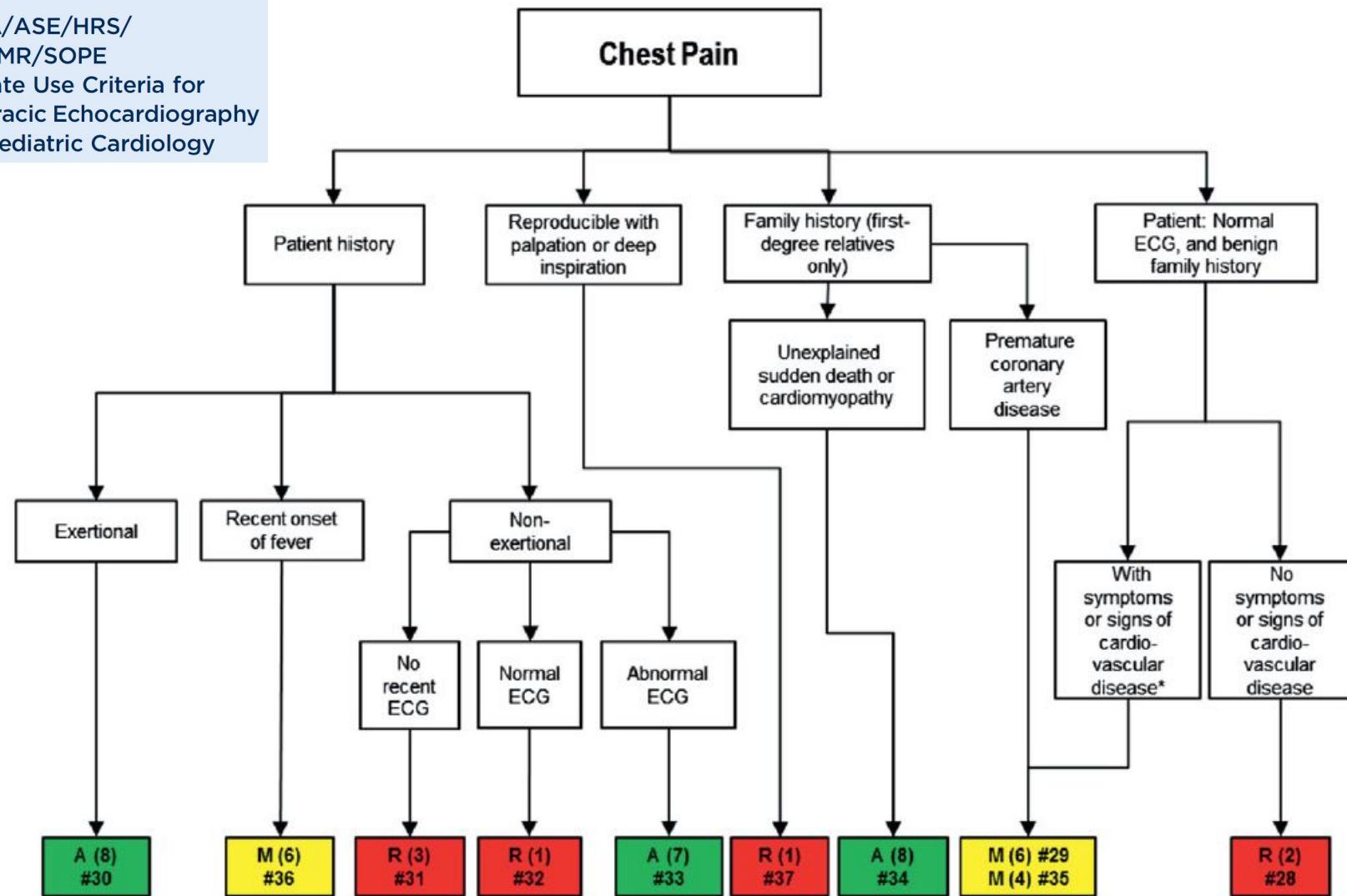
## 4. Pre-teen girl with chest pain

- Red flags: chest pain during exercise
- Red flags: chest pain lasting for more than a day
- Role of ECG: ST segment elevation



**APPROPRIATE USE CRITERIA**

ACC/AAP/AHA/ASE/HRS/  
SCAI/SCCT/SCMR/SOPE  
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## 5. Sophomore boy with syncope

- 15 years old boy, syncope associated with exercise
- During exertion
- No PMH
- Very active
- No symptoms
- No FH

# Benign syncope

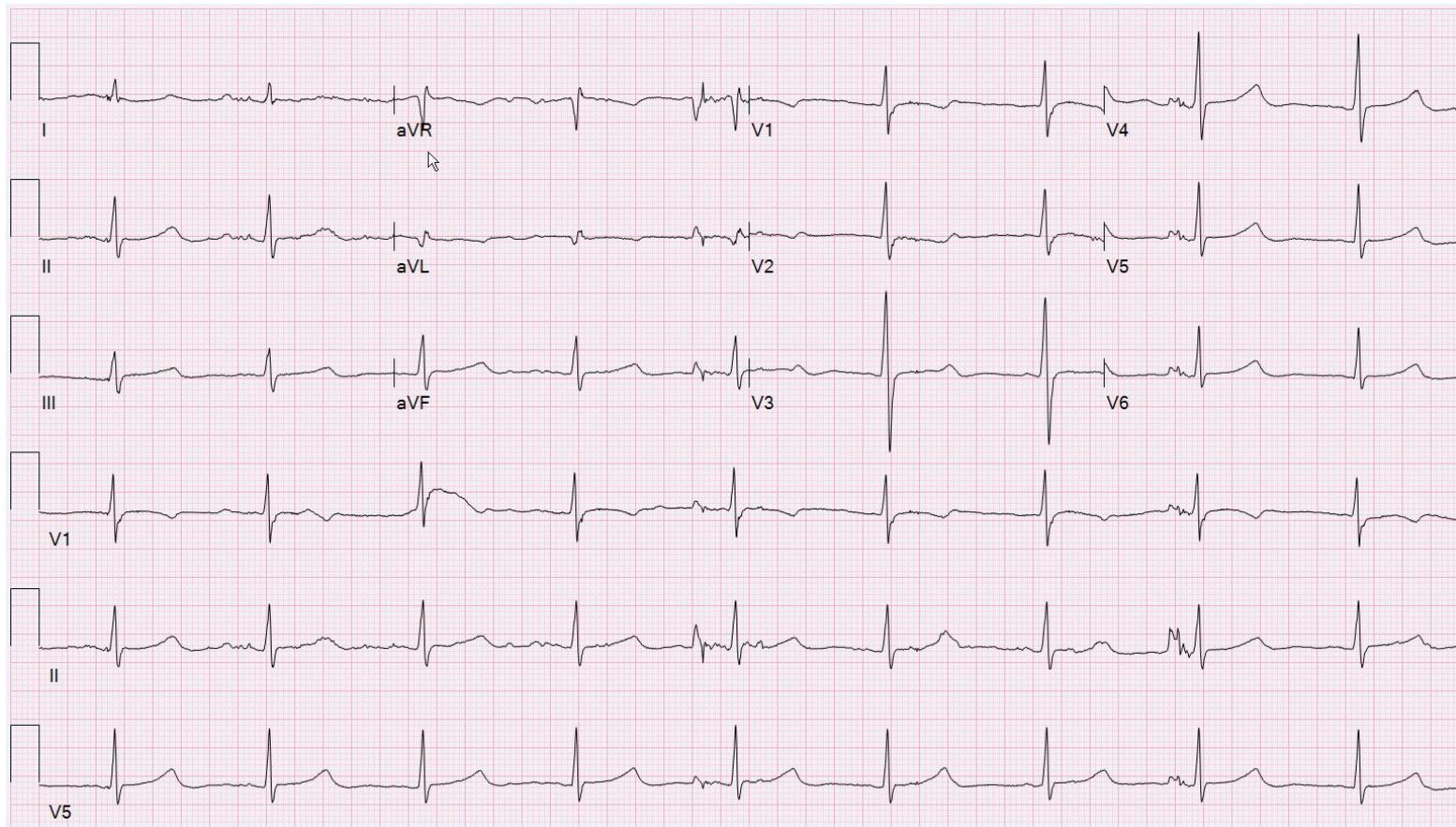
- Neuro-cardiogenic or benign syncope: after exercise in recovery, combing hair, hot shower, getting up from toilet, getting up from couch going to the kitchen
- Prodrome present, remembers event
- No CPR needed, regains consciousness in 1-2 minutes
- Convulsion possible, no post-ictal

# Cardiogenic syncope

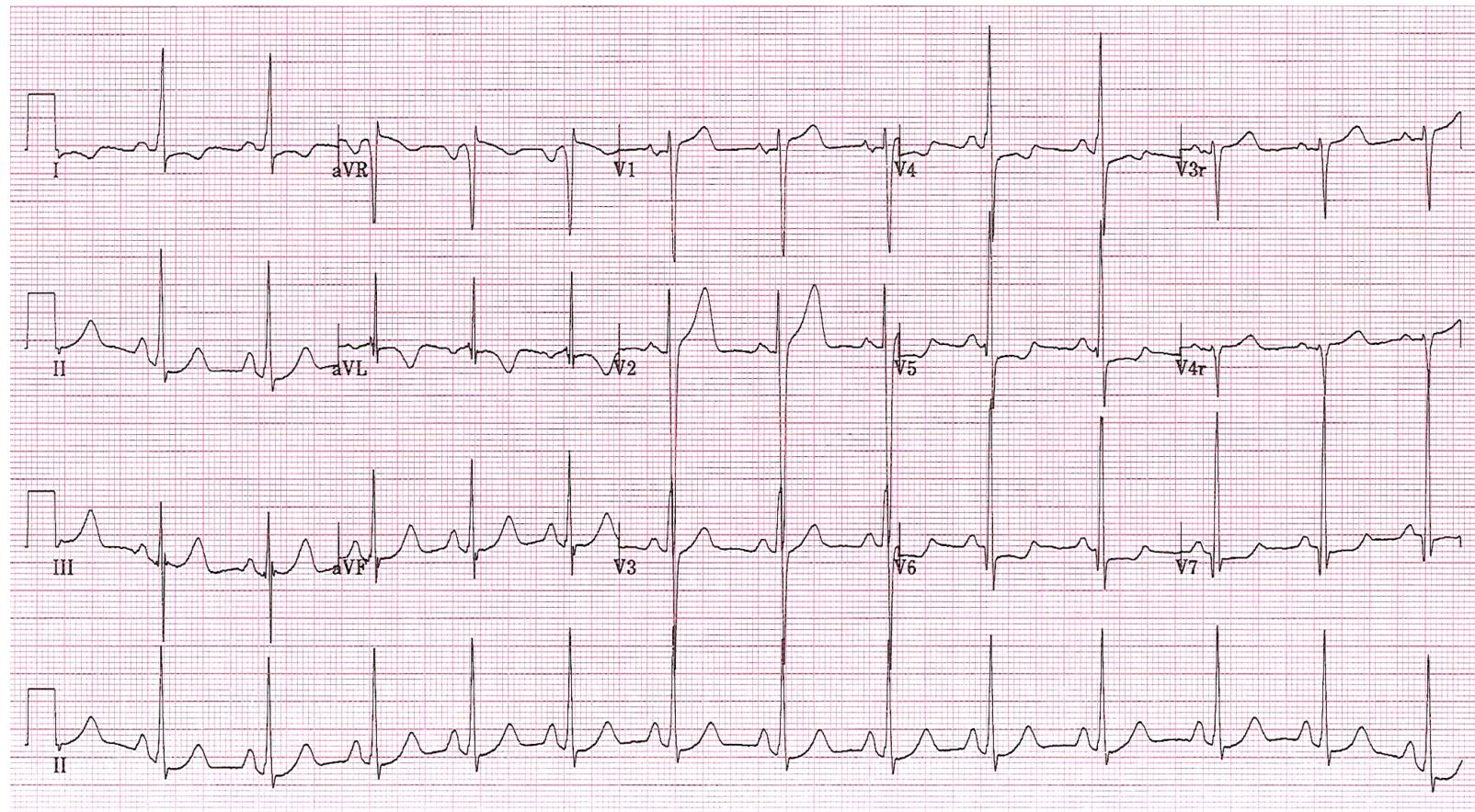
- During exercise
- Rarely remembers, no prodrome
- Induced by sudden noise, light
- CPR was performed
- SCD or IAS in family



# 5. Sophomore boy with syncope

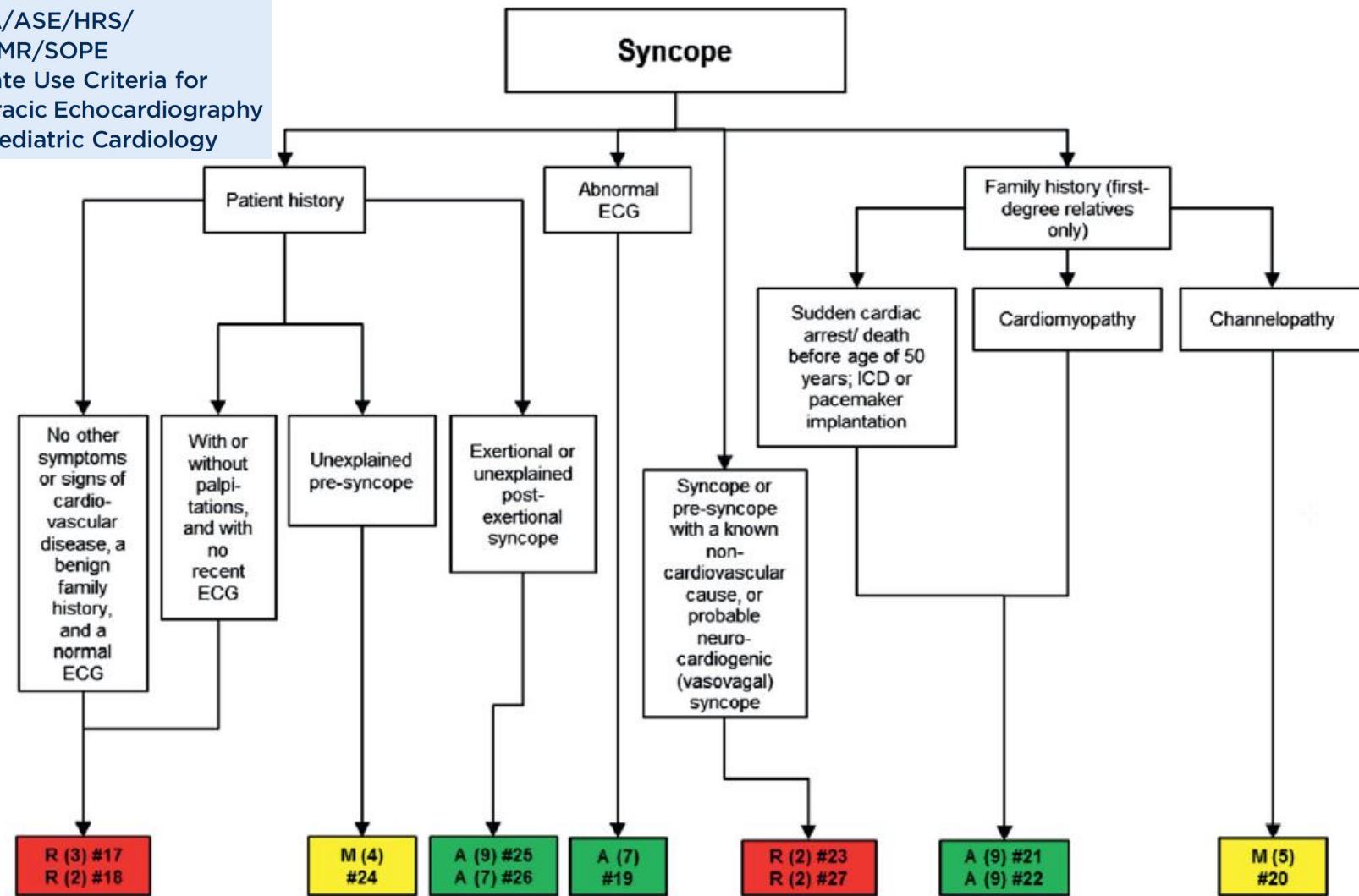


# 5. Sophomore boy with syncope



**APPROPRIATE USE CRITERIA**

ACC/AAP/AHA/ASE/HRS/  
SCAI/SCCT/SCMR/SOPE  
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## 6. Junior girl for sports physical

- 16 years old girl from Maunalani high soccer team
- Sports physical screening
- Asymptomatic teenager
- No FH of SCD or IAS
- Physical exam normal

# AAP/AHA recs for sports clearance

## Personal history

1. Chest pain related to exertion
2. Unexplained syncope/near-syncope
3. Excessive dyspnea with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Prior restriction from participation
7. Prior testing for the heart

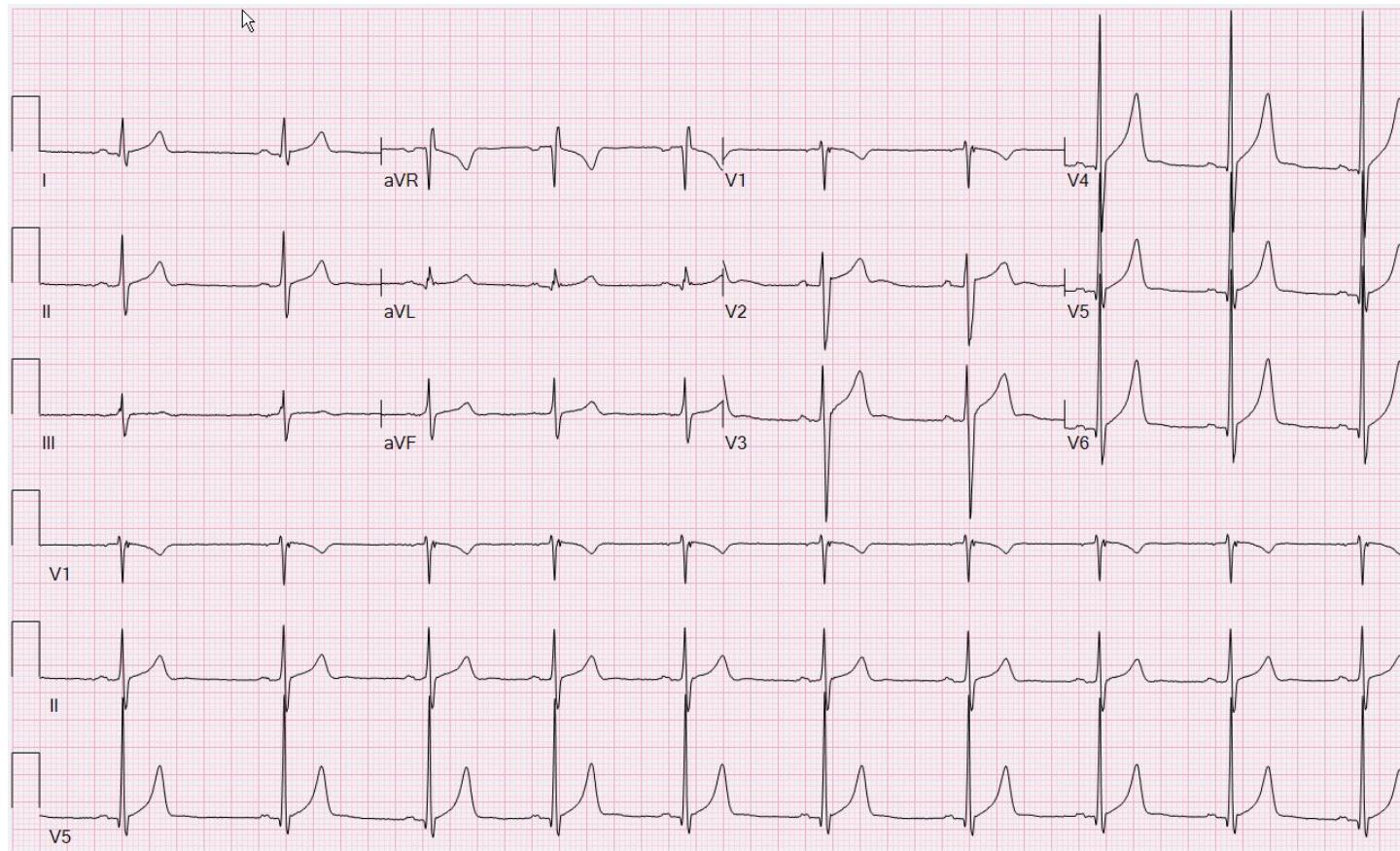
## Family history

8. Sudden death before 50 y of age
9. Disability from heart disease in <50 y
10. IAS in a relative (HCM, LQTS, MS)

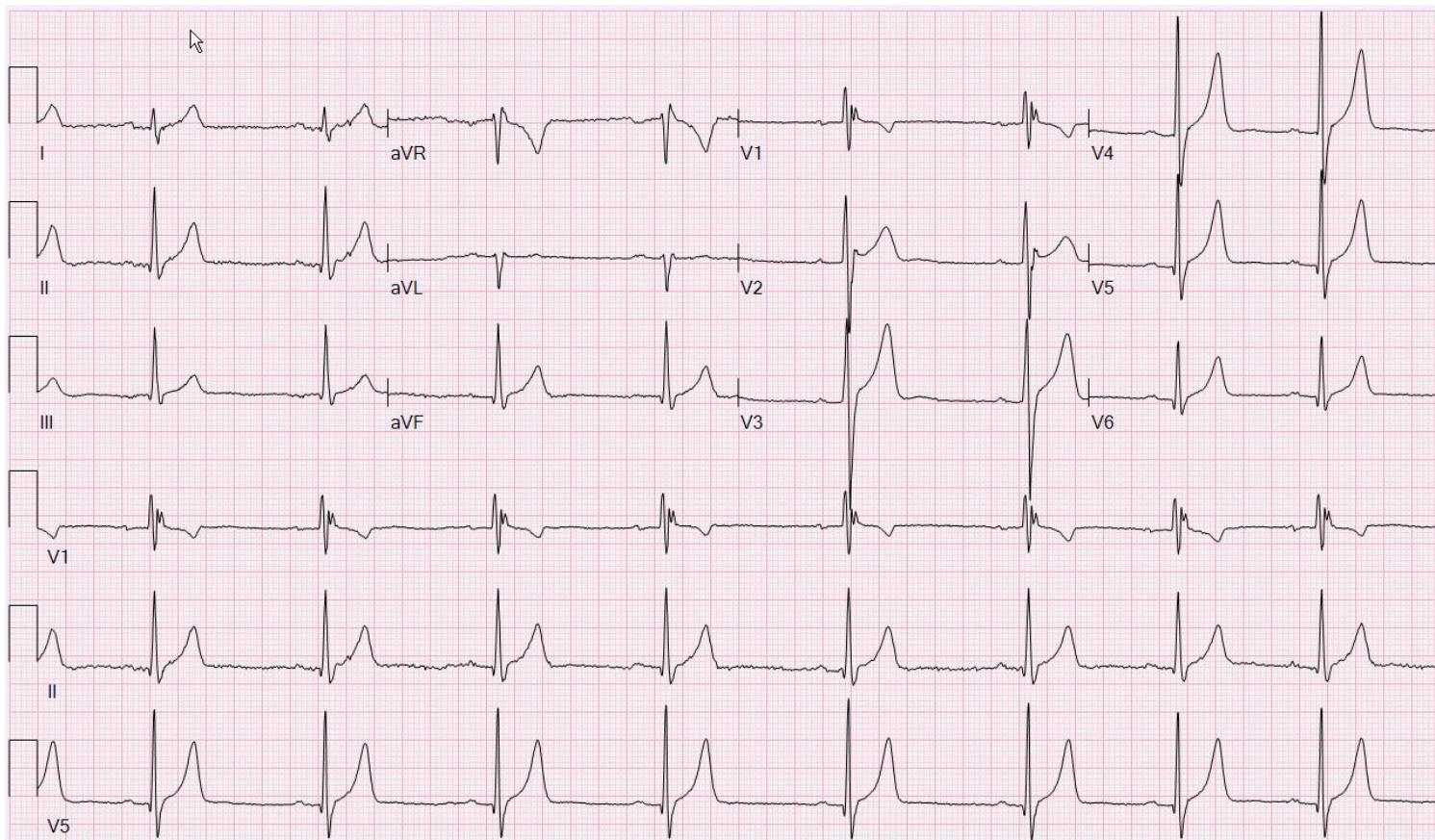
## Physical examination

11. Heart murmur
12. Femoral pulses
13. Physical stigmata of Marfan syndrome
14. Blood pressure

# 6. Junior girl for sports physical



# 6. Junior girl for sports physical



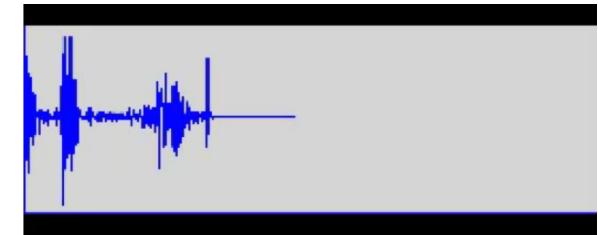
## 7. Senior boy with murmur

- 17 years old boy, tall, athletic, new murmur
- Asymptomatic
- Normal exercise tolerance
- Thin, but no chest deformity
- Family history is negative
- PMH relevant for recurrent OM

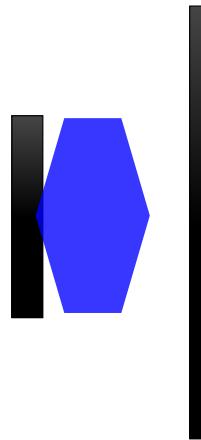
## 7. Senior boy with murmur

- What's left: ASD, PAPVR, BAV, MVP/MR
- Innocent pulmonary flow murmur
- Difficult to differentiate benign pulmonary flow murmur from increased flow due to ASD
- Echo is appropriate

# Pulmonary flow murmur



S1      S2

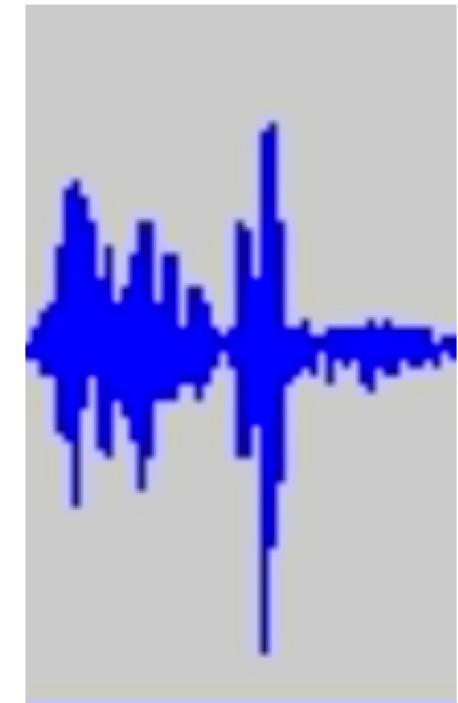


systole

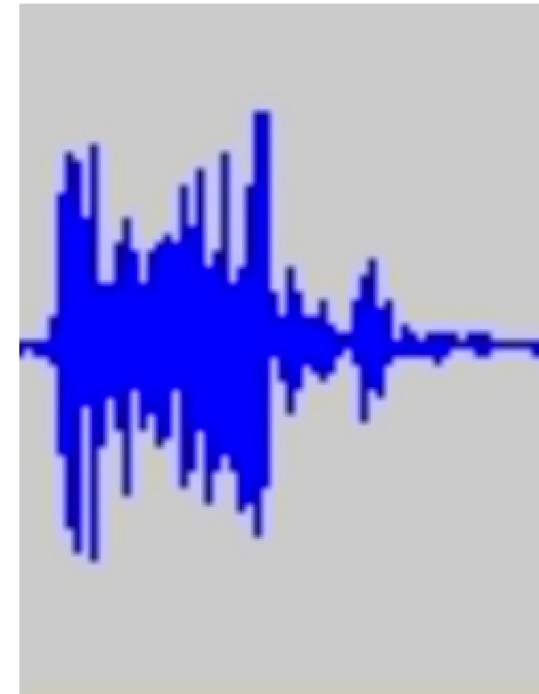
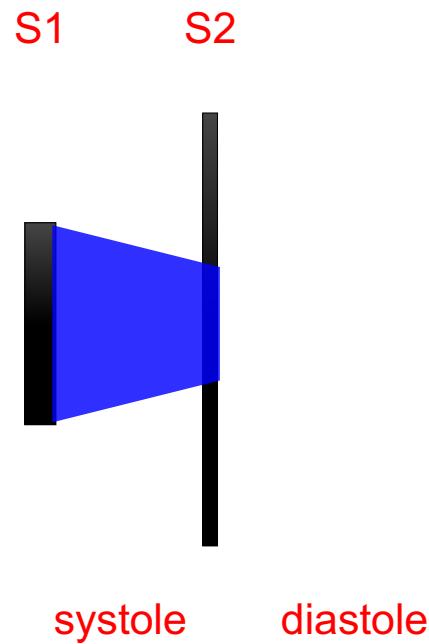
diastole



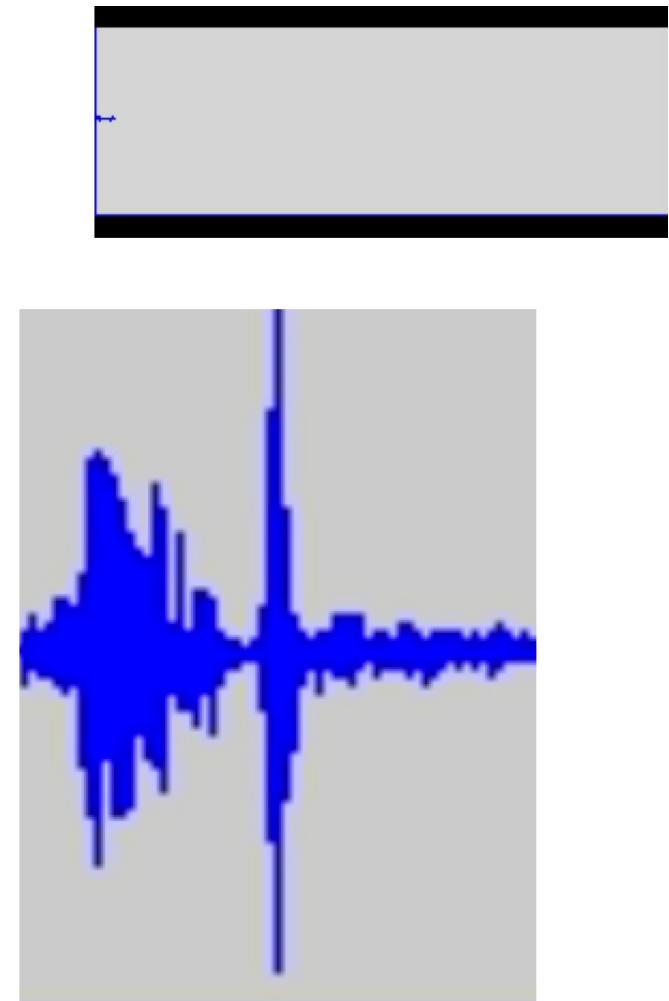
short crescendo-decrescendo murmur    S1      S2



# Mitral regurgitation



regurgitant holosystolic murmur



S1      S2

# Burnout

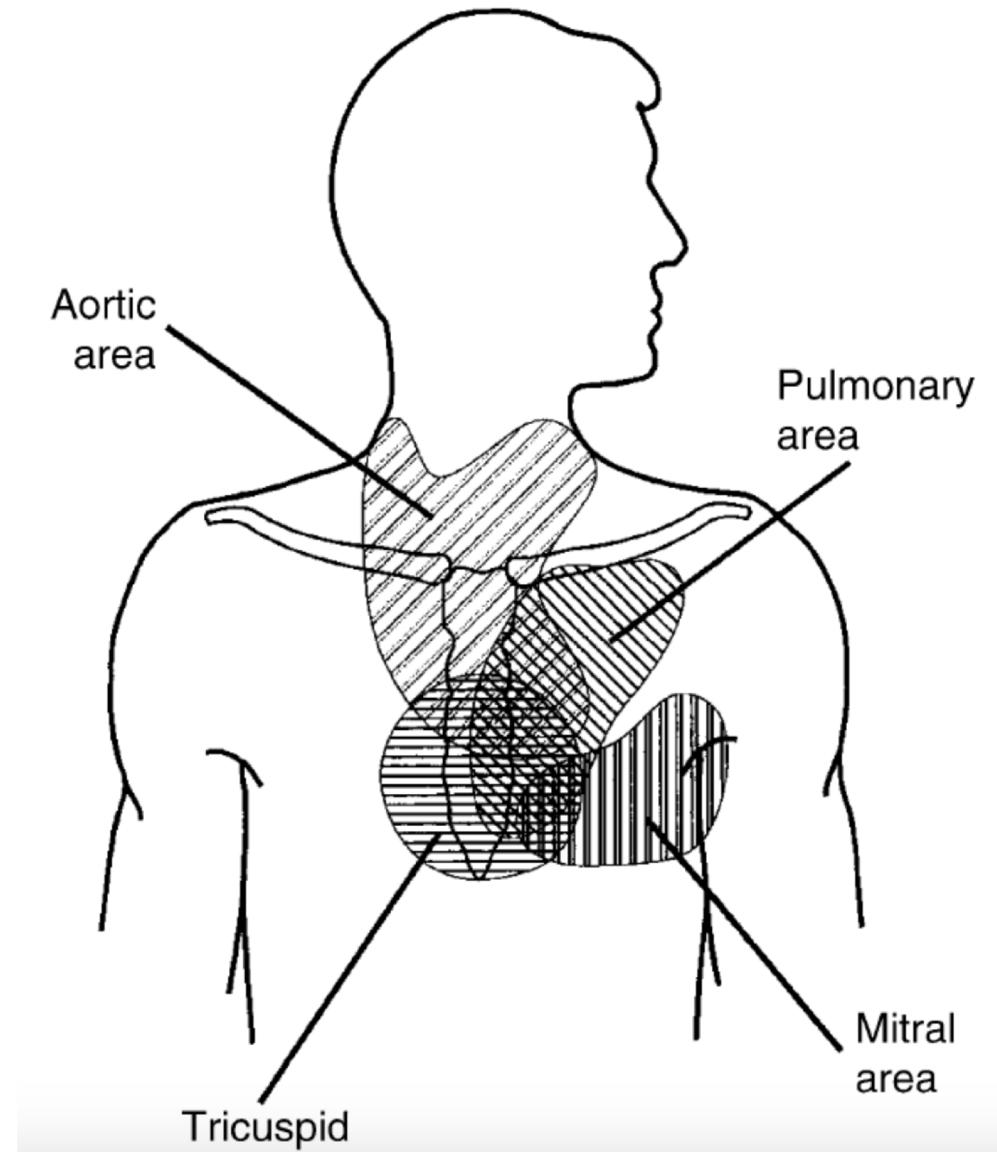
- Murmurs
- Chest pain
- Syncope
- ECGs

# Burnout – murmurs

- Odds are it is innocent (99%)
- Type of innocent murmur depends on age
- Red flags: FTT, cyanosis, respiratory distress, hepatomegaly, poor femoral pulses, poor perfusion
- Innocent heart murmurs are very common (75% have a murmur during their childhood): PPS, Still's, venous hum, pulmonary flow murmur

# Auscultation

- Active, not passive
- Location
- Timing
- S1-S2
- Length, pitch



# Burnout – chest pain

- History, history, history
- Red flags: exertional, KD, heart surgery, prolonged
- Most common is growing pain (musculoskeletal)
- Possible cardiac: pericarditis, myocarditis, coronaries
- Get echo if: exertional, abnormal ECG, positive FH

# Burnout – syncope

- History, history, history
- Red flags: exertional, heart surgery, family history
- Most common is neurocardiogenic
- Possible cardiac: LQTS, HCM, DCM, coronaries
- Get echo if: exertional, abnormal ECG, positive FH

# Burnout – ECGs

- Always look at QTc and T waves
- Let them be read by pediatric cardiology (not ER, not adult cardiology)
- Sports physical: questions and physical exam is more important than ECG

# Summary workflow

- History and physical exam is most important
- ECG is easy and sometimes helpful
- If in doubt, cardiology consult \$150, with outpatient echo \$750
- Echocardiogram (\$1000 in hospital) did not add any value of syncope evaluation after history, physical exam, and ECG  
(Ritter et al, Pediatrics, 2000)