

Evaluation of Fetal Heart Rhythm and Clinical Implications

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September 2024



No disclosures



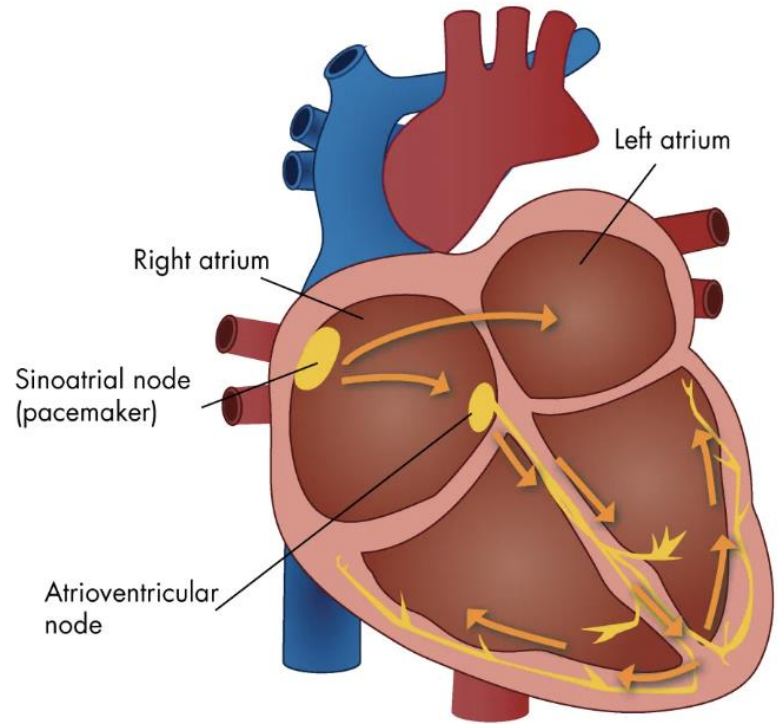
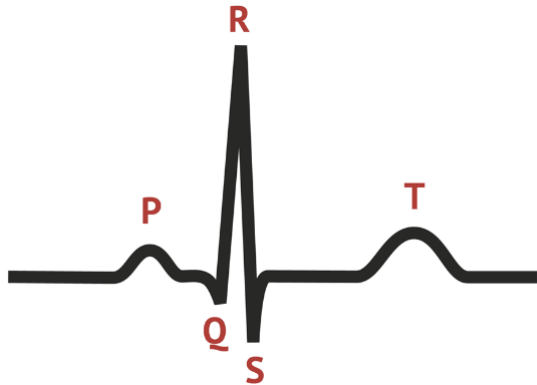
Objectives:

- Define normal fetal heart rate and rhythm
- Understand how to evaluate fetal heart rhythm by M-mode and doppler
- Differentiate between benign and pathologic fetal arrhythmias
 - Bradyarrhythmias
 - Tachyarrhythmias
- Understand when an emergent referral should be triggered
- Highlight options for transplacental therapy



What is normal

- 1:1 AV condition
- Normal PR interval
- Normal Rate
- Regular rhythm



M-Mode and Spectral Doppler

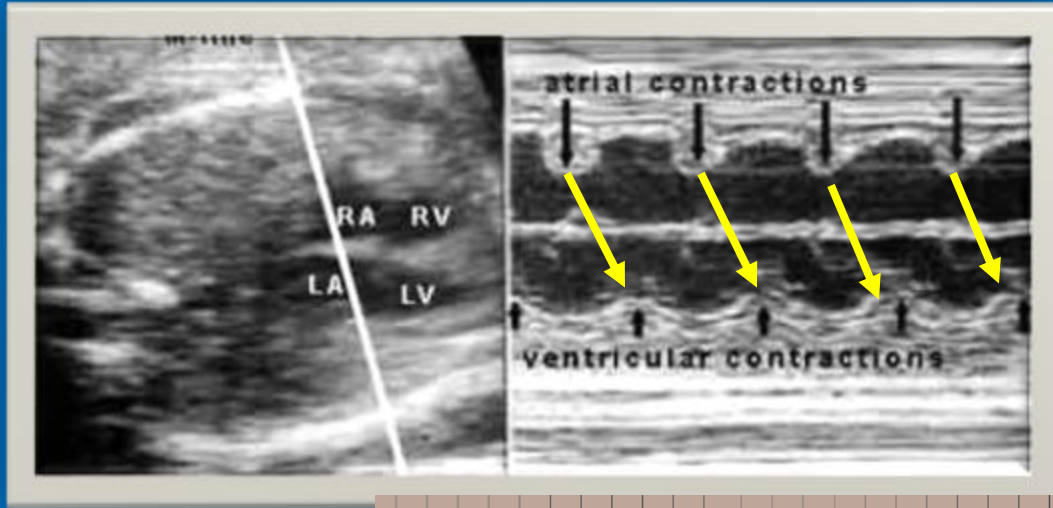
1. Relationship between atrial and ventricular rate
2. Measure PR intervals
3. View onset and termination of arrhythmias
4. Measure a-a' and VA and AV intervals to identify the specific type of arrhythmia
5. M-mode: Ultrasound line through atria and ventricle

Doppler:

1. LV inflow and outflow (mitral valve and aorta flow)
2. SVC and ascending aorta/innominate vein and transverse aorta
3. Pulmonary vein and pulmonary artery



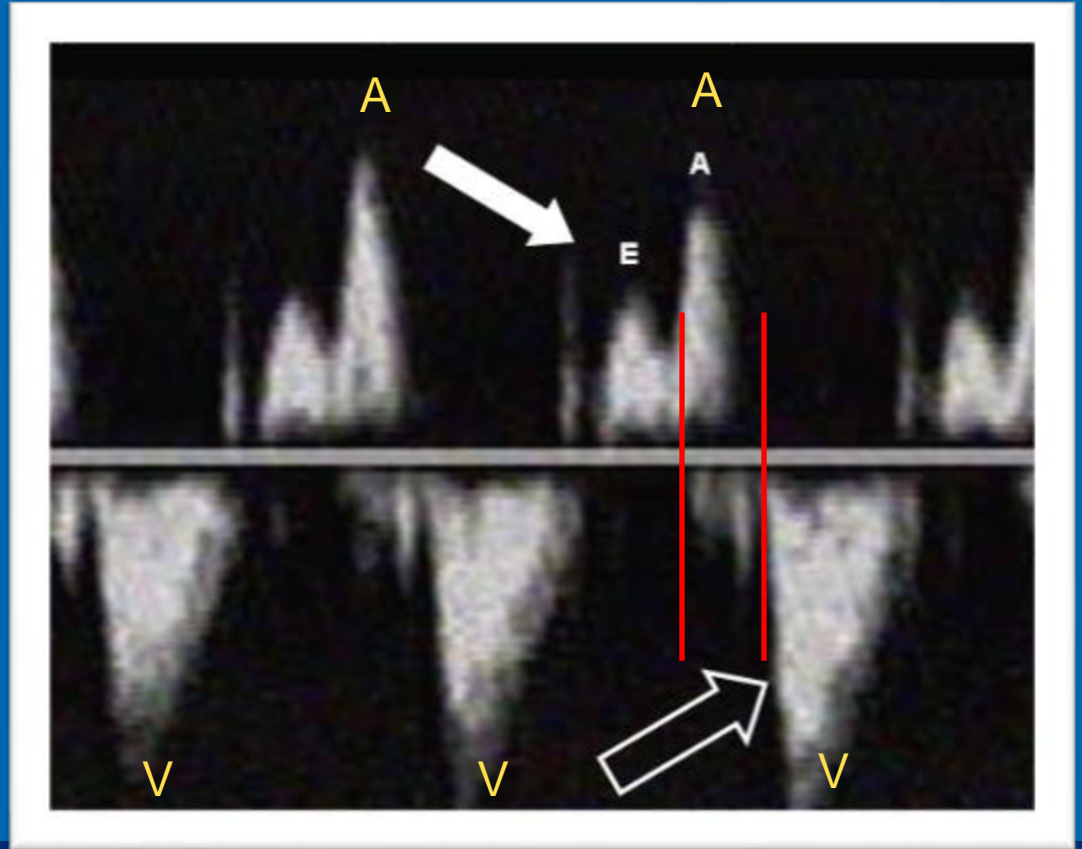
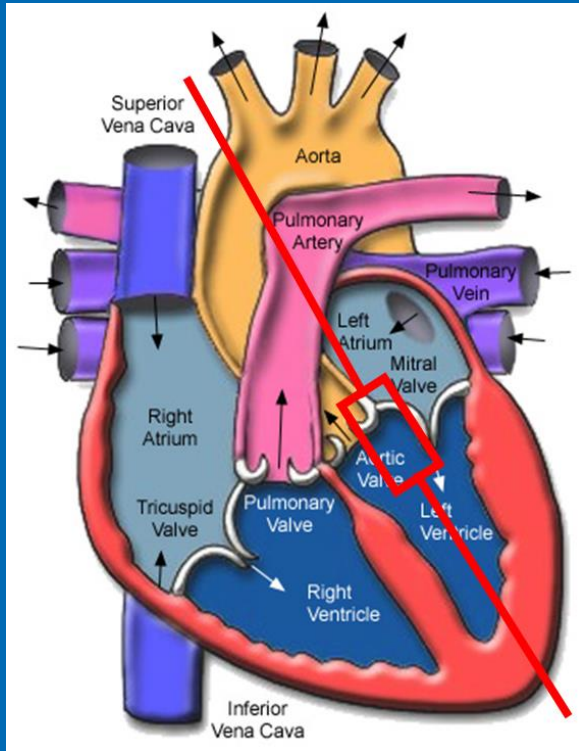
With mode through atrial and ventricle we identify **atrial contraction**, a surrogate of the **P** wave on EKG, and the **ventricular contraction**, a surrogate of the **QRS** on EKG.



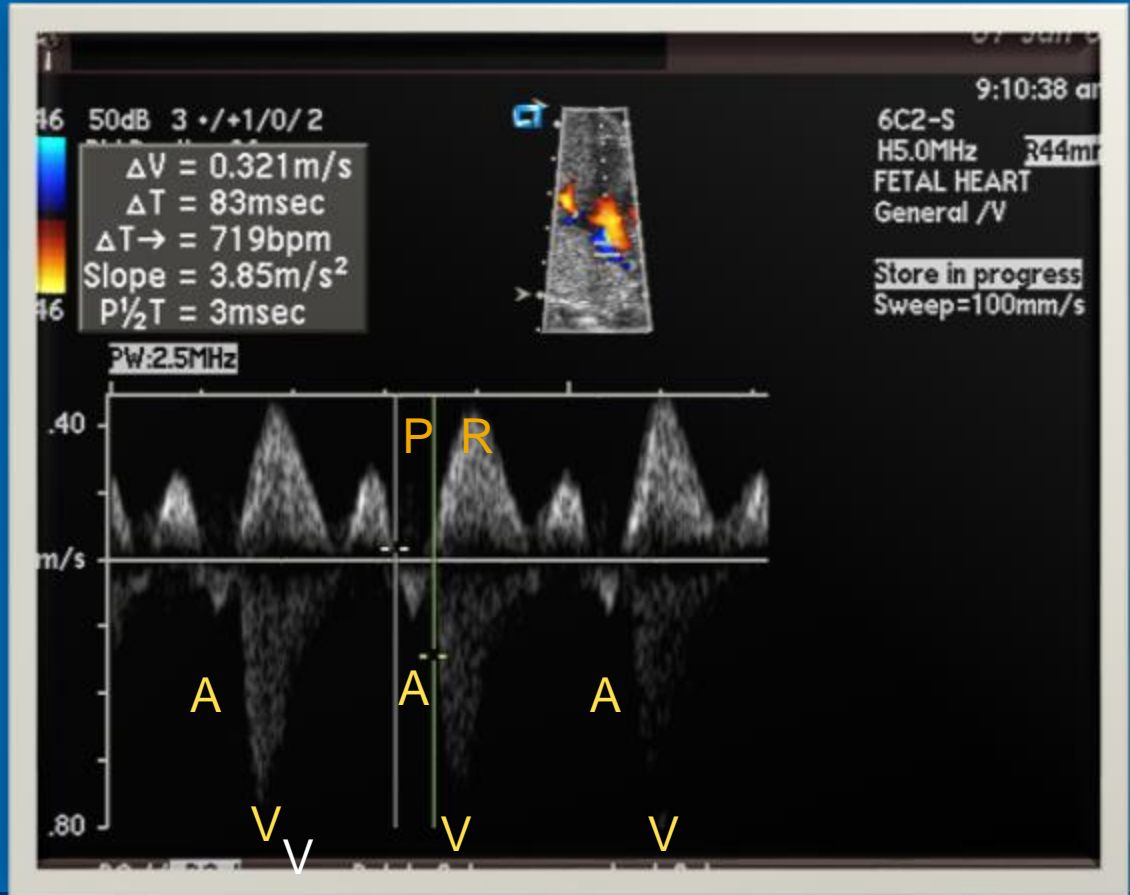
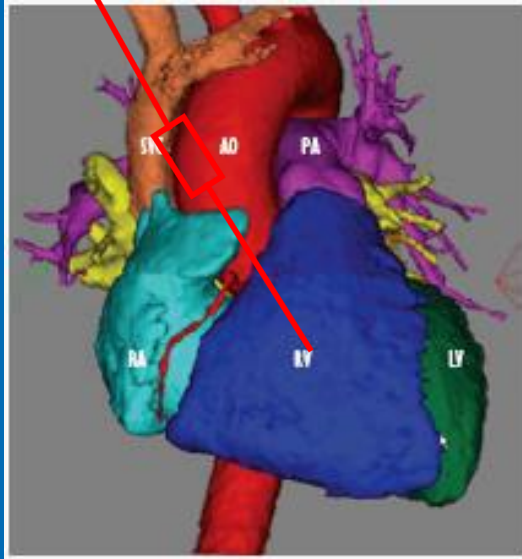
1:1 conduction
Normal Rate
Normal Rhythm



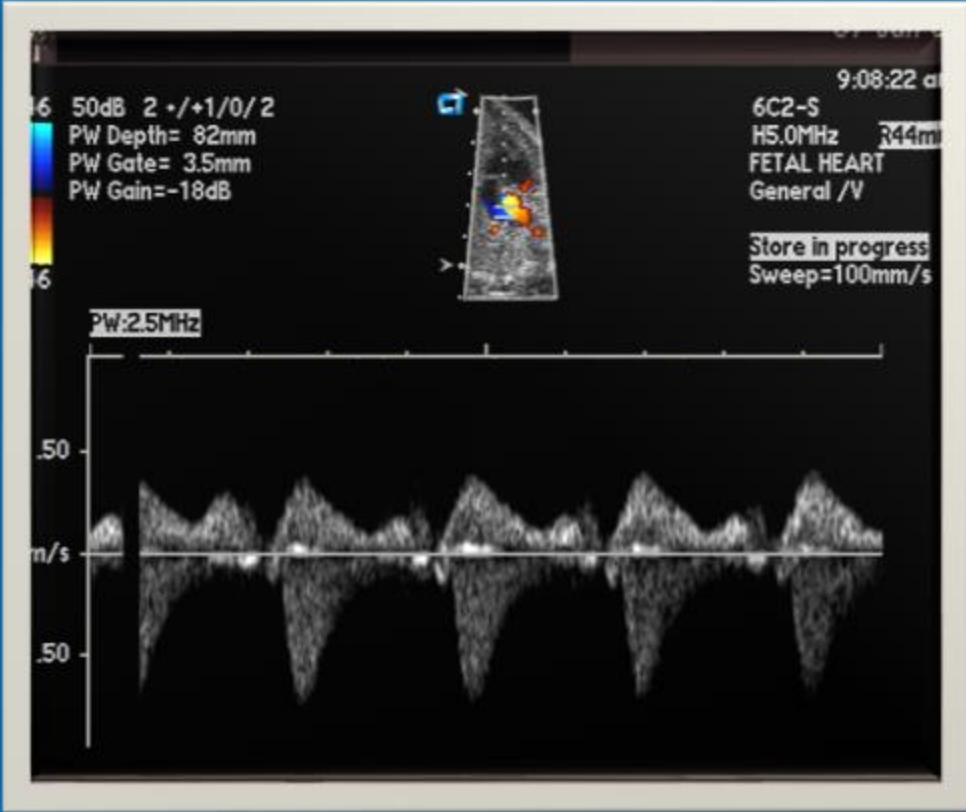
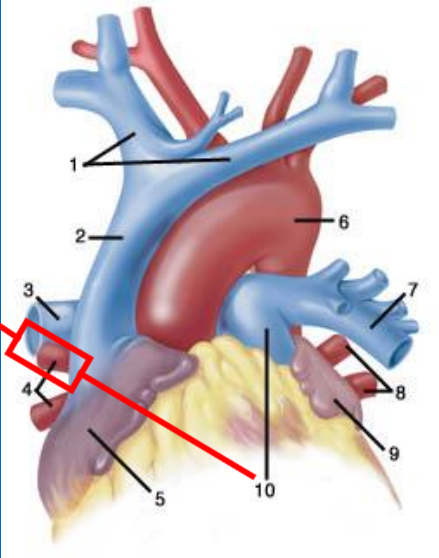
LV Inflow and Outflow



SVC and AAao



PV and PA



Brady-arrhythmias

- Sinus bradycardia
- Channelopathies
- Blocked Premature atrial contraction
- Heart block, second vs third degree



Fetal Heart Rate < 3rd Percentile for Gestational Age Can Be a Marker of Inherited Arrhythmia Syndromes

Nadia Chaudhry-Waterman ^{1,*}, Bharat Dara ², Emily Bucholz ^{1,3}, Camila Londono Obregon ^{1,3}, Michelle Grenier ^{1,3}, Kristen Snyder ³ and Bettina F. Cuneo ^{1,3,4,*}

Mitchell et al Fetal Heart Rate Predictors of LQTS 2691

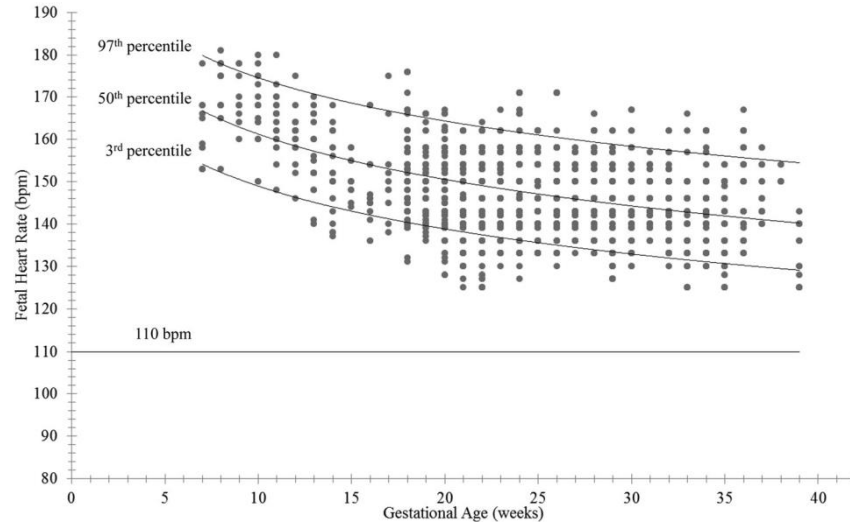
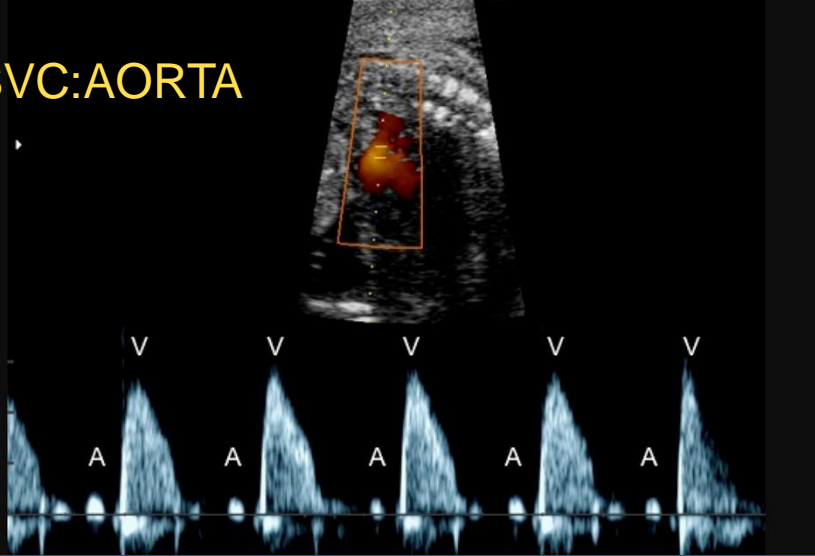


Figure 1. Individual FHR measurements (n=3264 data points) by gestational age of 547 normal fetuses. Curves representing the 3rd, 50th, and 97th percentiles of FHR are shown, as is a horizontal line at 110 bpm, which is the standard obstetric definition of bradycardia. FHR decreases with advancing gestational age. Some normal FHR measurements are <3rd percentile but none are <110 bpm. FHR indicates fetal heart rate; bpm, beats per minute.

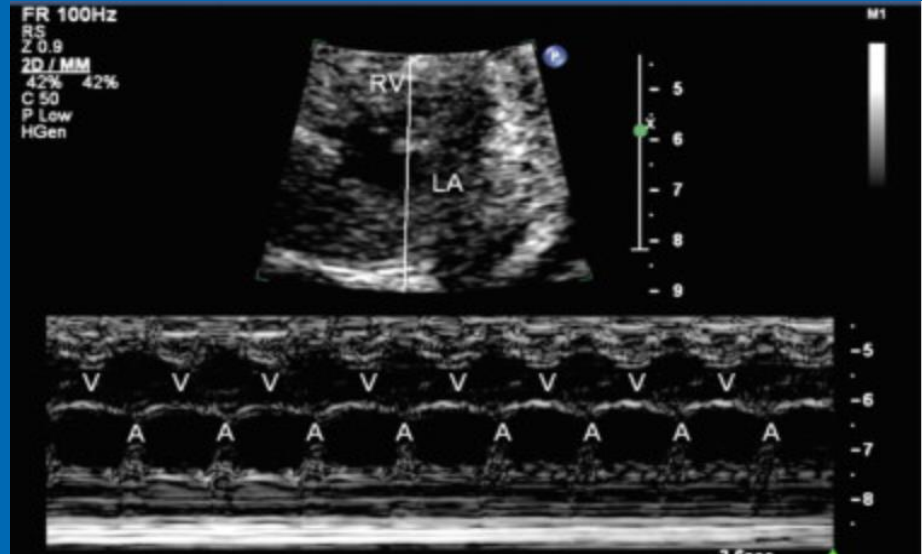


SVC:AORTA



Fetal HR < 3rd percentile
<110bpm
Consider channelopathies

1:1 AV conduction
Regular
HR 110-130 bpm
GA 20 weeks



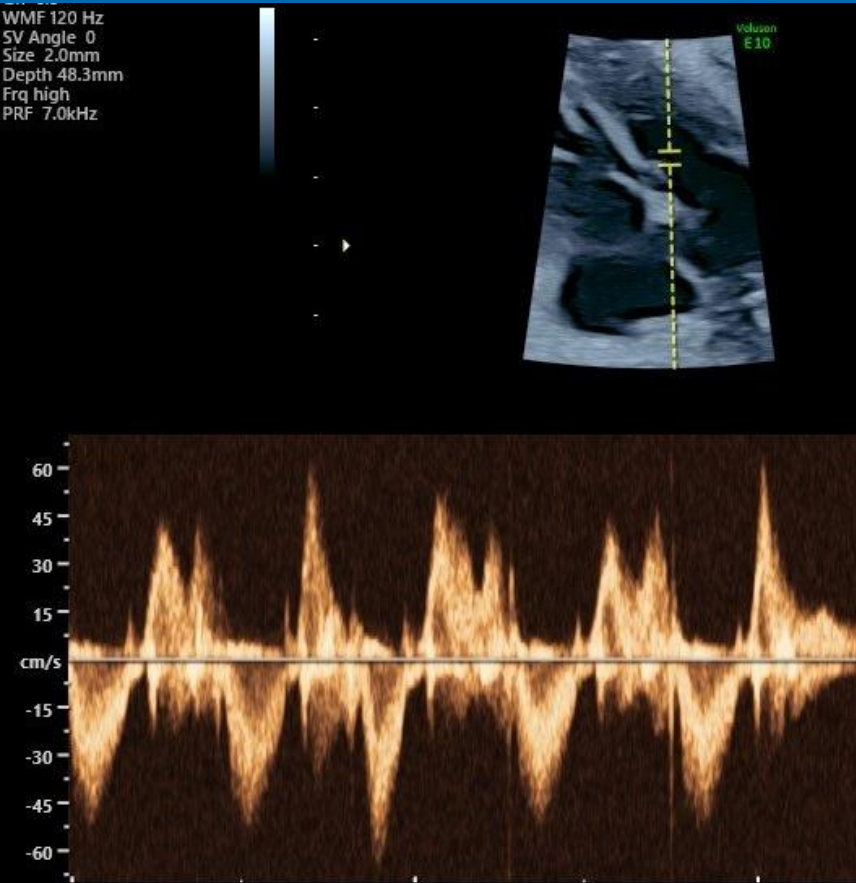
Consider referral to cardiology

Atrial ectopy

- Most common fetal arrhythmia found in 1-2% of all pregnancies
- Incidence increases as gestation progresses
- Isolated PACs are benign, usually no treatment is needed
- Complex PACs such as bigeminy, trigeminy or blocked PAC need a referral to cardiology for r/o secondary causes:
 - CHD
 - Myopathies
 - Tumors
 - Atrial septum aneurysms



Benign Isolated PACs are occasional and conducted



Complex PACs

- Can be mimickers of heart block as blocked atrial ectopy can cause ventricular bradycardia
- Differentiating heart block from blocked PAC is crucial as treatment is different
- Fetal heart block is an emergency, treatment may be recommended within 12 hrs
- Complex ectopy also needs cardiology evaluation, but it is less urgent and outcomes are better



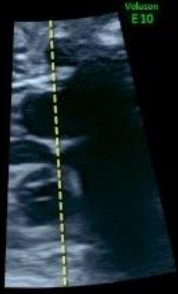
PACs

vs

Heart block

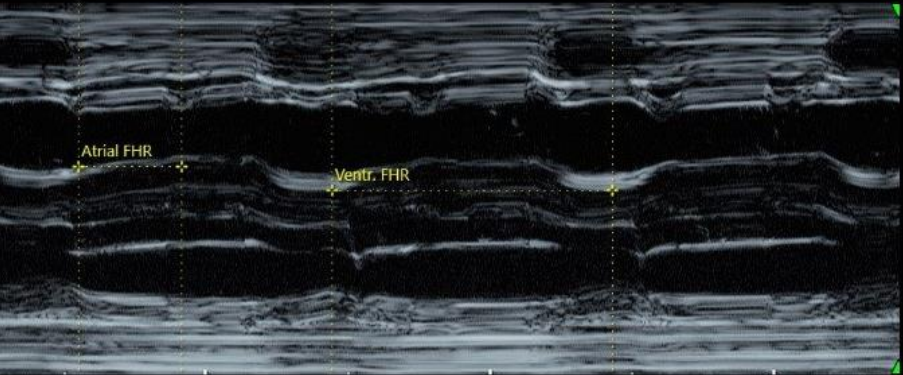


Atrial FHR 165bpm
Ventr. FHR 61bpm
Gn 4
CB/M7
P4/E2
SRI II 4



Heart block

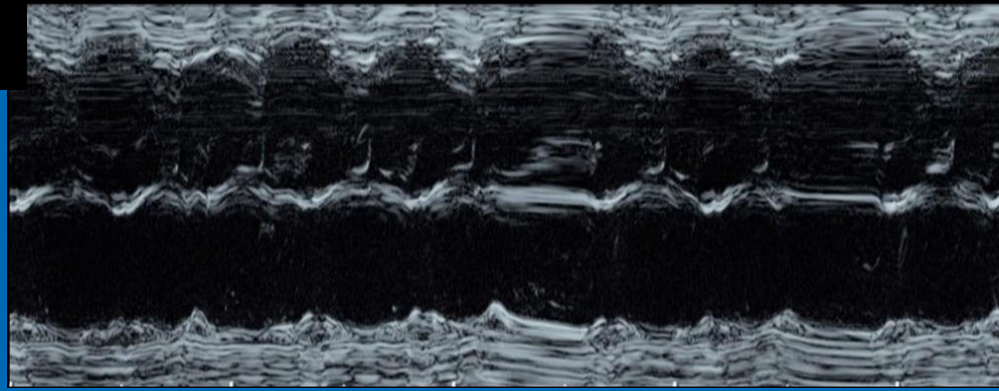
Atrial and ventricular rate vary
 $a-a'$ is shorter than $a':a$ (variability $>10\text{ms}$ is considered significant)
Rhythm is intermittently irregular
A:V conduction is not dissociated



Blocked PACs

2/3 Cardiac
HI L

Atrial rate is normal
 $a:a$ interval is constant
Ventricular rate slow
Both are regular
A:V dissociation



Treatment/Outcome

- For blocked PAC treatment is monitoring
- For heart block treatment we consider steroids, IVIG and Terbutaline
- Outcomes for PAC is great
- Outcomes for Heart block are guarded



Tachyarrhythmias



26 weeks gestation on presentation



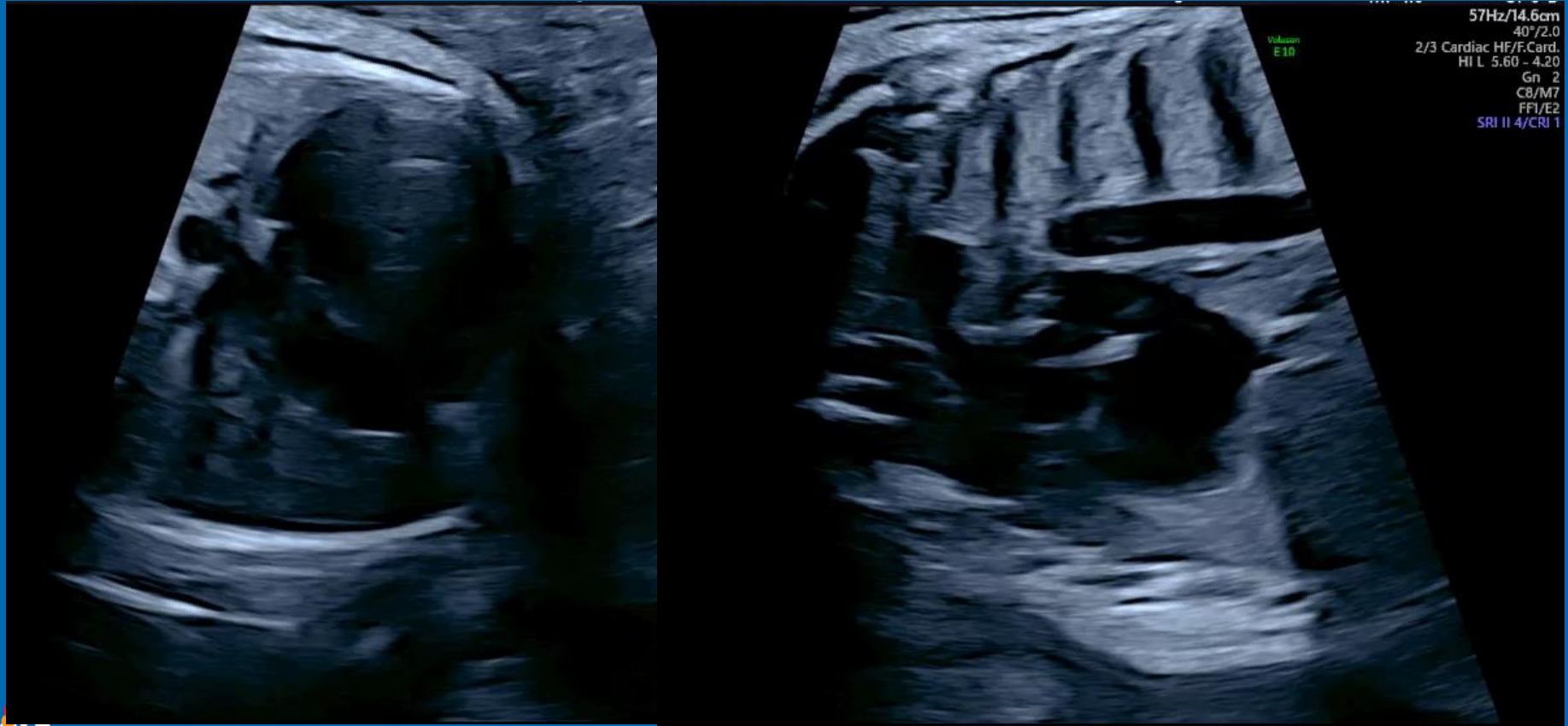
Pen
HI L
S



43Hz/16.3cm
35°/1.0
Penetration/OB
HI L 6.60 - 3.90
Gn -1
C7.0/M16
FF3/E2
SR II 2/CR1 3



36 weeks gestation on Flecainide



Tachyarrhythmias: Defined as persistent fetal heart rate >170 bpm

- SVT represents 10% of fetal arrhythmias
- 5-10 % of cases SVT will be associated to CHD
- Fetal echocardiography is required
- Associated CHD has a negative impact of prognosis
- The subtype of arrhythmia is defined by a combination of the VA interval, GA at presentation, the rate, AV relationship and onset/termination and determines the treatment of choice
- Short VA (AVRT) is the most common followed by flutter they both have a great outcome when appropriately treated
- **THEY COME TO OB OR MFM SCANS OR DOPPLERS!! Thank you**



Sinus tachycardia

Typically, 160-200 beats/minute

Brief bursts, typically with increased fetal activity

1:1 atrioventricular conduction

Normal duration of the atrioventricular interval

Marker of fetal distress

- Hypoxia

- Increased maternal catecholamines

- Intraamniotic infection

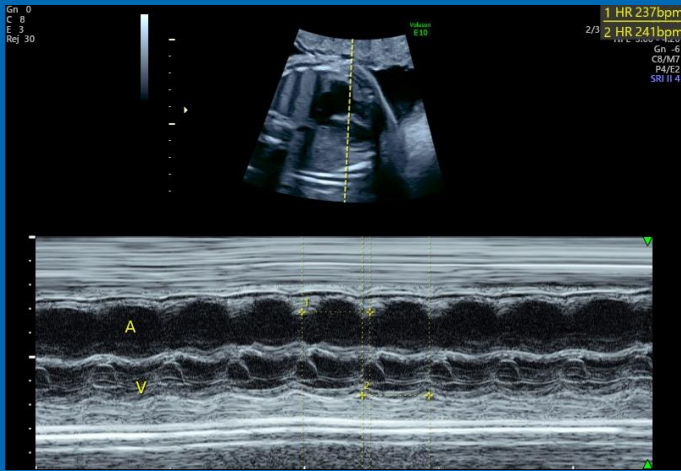
- Maternal medications

- Fetal anemia



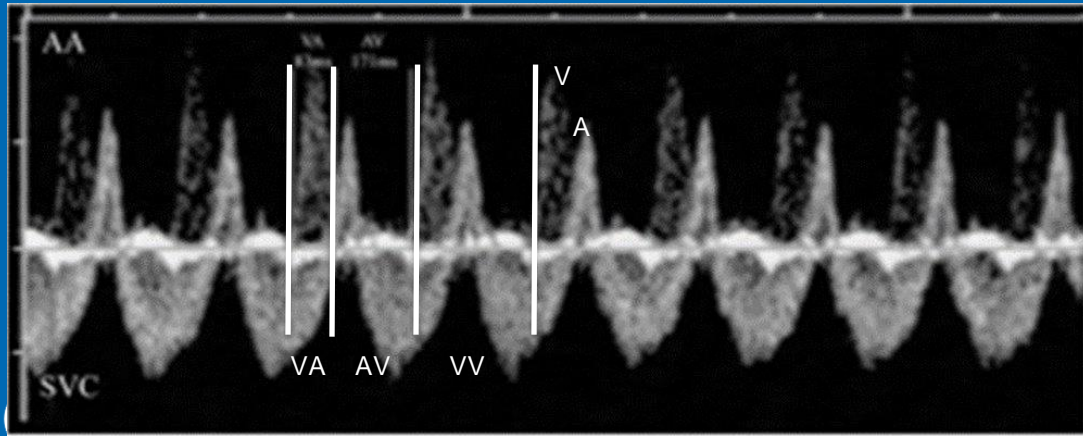
Characteristics of SVT

SVT type	GA	Typical Rates	AV Relationship	Onset/ Termination
Short VA AVRT AVNRT	>18 weeks	>180 bpm (200-320)	1:1	Sudden Terminates with conducted PAC
Long VA EAT PJRT	>12 weeks	170-220 bpm	Variable, but may be 1:1	AET gradual PJRT sudden
Atrial flutter	>28 weeks	Atrial: 300-550 bpm Ventricular: 180-240 bpm	Variable but most commonly 2:1 or 3:1	

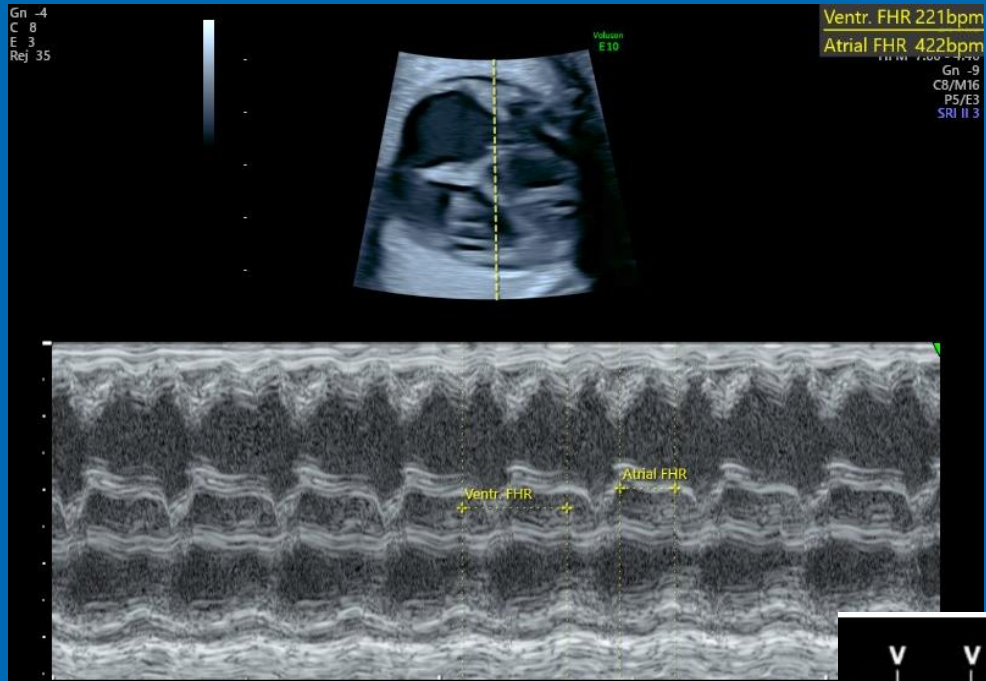


AVRT:

1. Fixed rate > 180 bpm, most commonly 200-320.
2. 1:1 AV conduction shown by M mode pr doppler
3. Short VA tachycardia.

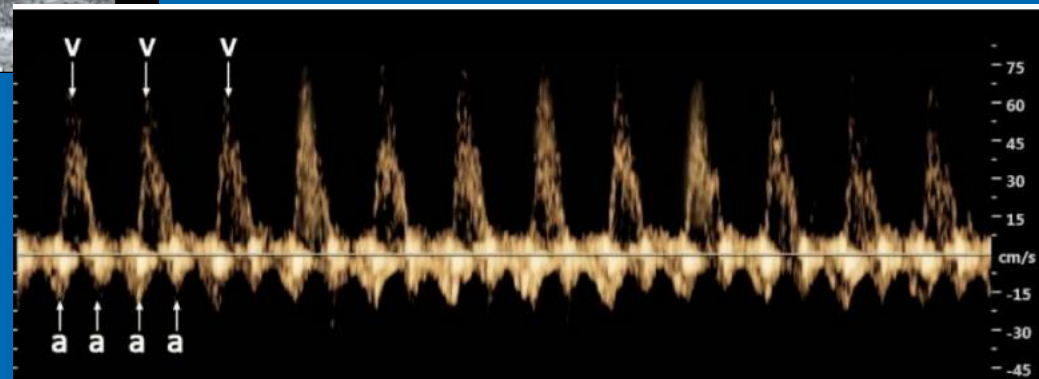


Doppler of SVC and aorta
 Atrial systole is shown by retrograde flow in the SVC and ventricular by aortic outflow in this case both are above the baseline.
 In short VA VA interval $< \frac{1}{2}$ of VV and VA/AV ratio < 1



Flutter

1. Fixed atrial rate 300-500 bpm
2. Variable ventricular rate 180-240
3. Variable ventricular conduction 2:1 AV conduction most common



Flutter

vs

AVRT

Gn -4
C 8
E 3
Rej 35



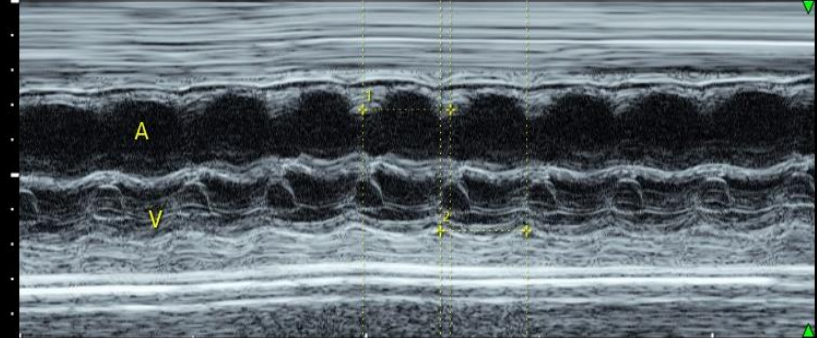
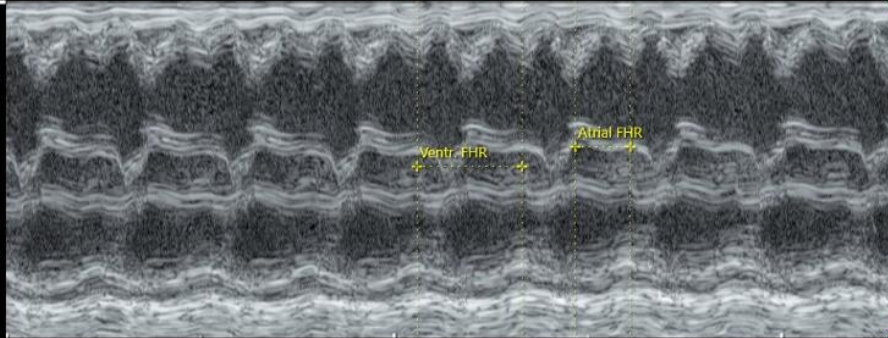
Volume
E10

Ventr. FHR 221bpm
Atrial FHR 422bpm
Gn 0
C 8
E 3
Rej 30
Gn -9
C8/M16
P5/E3
SRI II 3



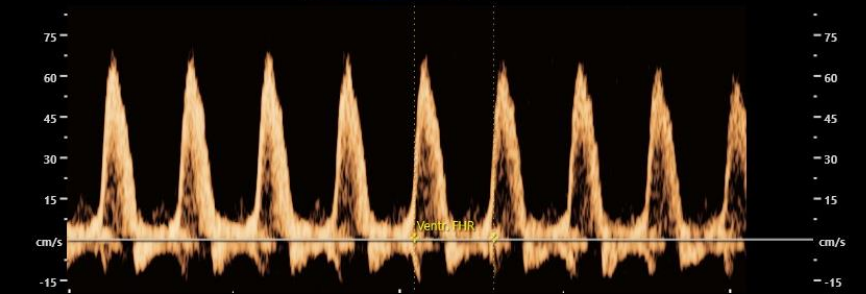
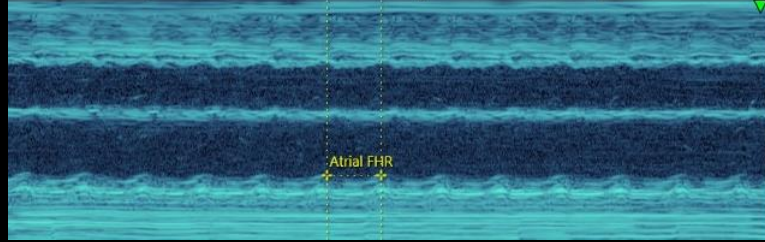
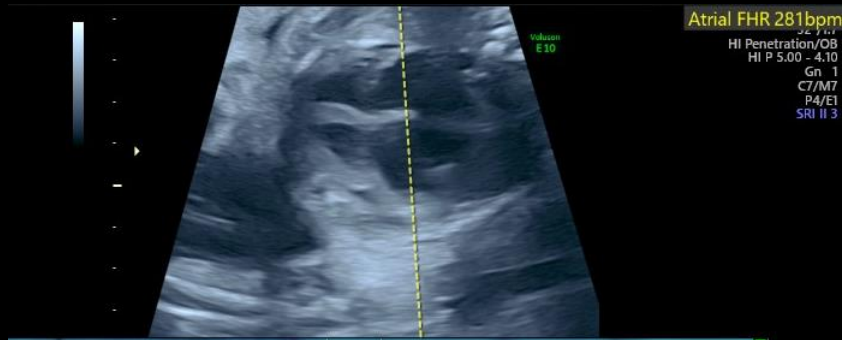
Volume
E10

1 HR 237bpm
2/3 2 HR 241bpm
Gn -6
C8/M7
P4/E2
SRI II 4



Different approaches to evaluating AVRT





Treatment

- AVRT responds better to Flecainide
- Atrial flutter responds better to Sotalol
- Digoxin is most useful as adjunct therapy consider IM dosing in Hydrops
- Amiodarone is rarely used but works for everything



Maternal Monitoring on Sotalol

ECG Criteria

ECG Value	Target Range
Heart Rate	>50 bpm
PR interval	<200 msec
QRS duration	<100 msec
QTc	<450 msec

Laboratory Criteria

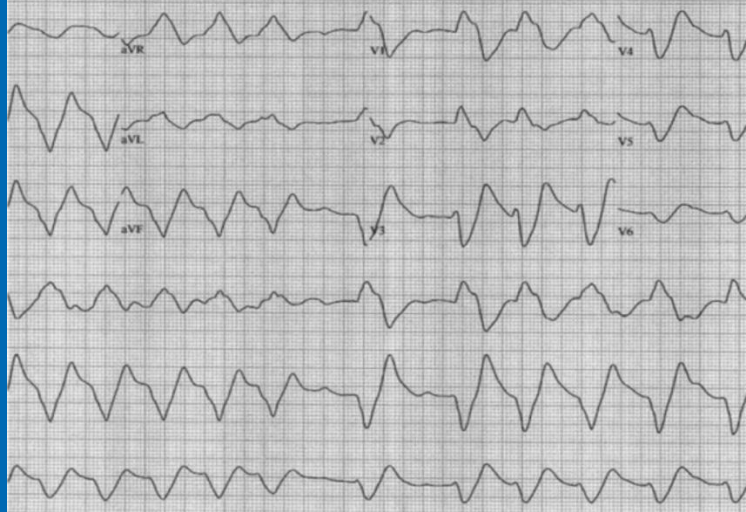
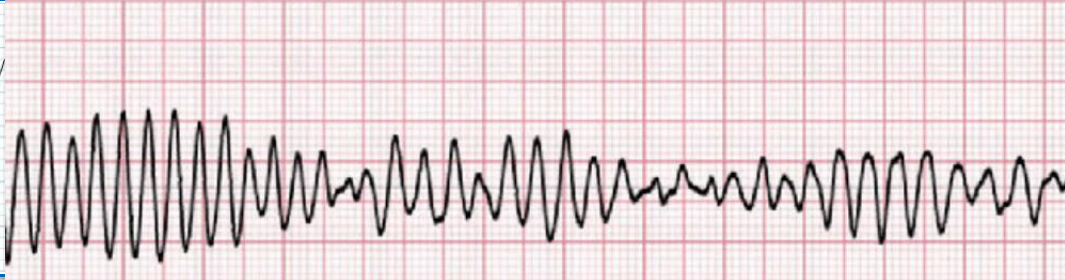
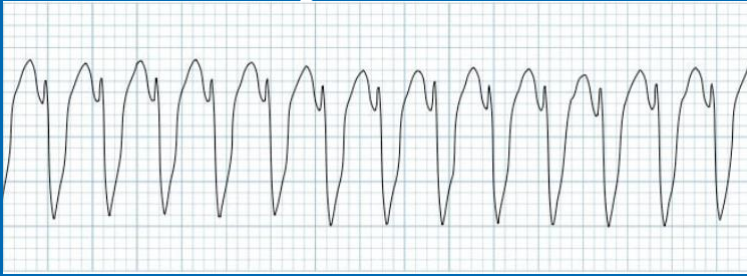
Laboratory Value	Target Range
Serum K	3.5 - 5mmol/L
Serum Ca	8.5 - 10 mg/dL
Serum Mg	1.8 - 2.1 mg/dL
Serum Cr	<1.5 mg/dL



	<u>Digoxin</u>	<u>Flecainide</u>	<u>Sotalol</u>	<u>Amiodarone</u>
Dose	<p>Start: 0.25 mg Q8H x4-6 doses for total of 1–2 mg over 24–48 hours.</p> <p>Fetal IM Dose (if indicated: 88 mcg/kg estimated fetal weight (EFW))</p> <p>Maintenance by serum concentration (dose divided BID or TID):</p> <ul style="list-style-type: none"> ≥2.3 ng/mL: hold doses until level <2 2 to 2.2 ng/mL: 0.25 mg/day 1.5 to 1.9 ng/mL: 0.375 mg/day 1.2 to 1.4 ng/mL: 0.5 mg/day 0.8 to 1.1 ng/mL: 0.75 mg/day <0.8 ng/mL: 1 mg/day 	<p>Start: 100 mg/dose BID or TID (200-300 mg/day)</p> <p>Maintenance: can be increased every 2-3 days to max of 450 mg/day if no response.</p>	<p>Start: 80 mg TID or 120 mg BID Maintenance: can be increased every 2-3 days to max of 480 mg/day.</p>	<p>Start: loading dose 1600–2400 mg/day in divided doses 2–4 times daily, usually halved every 24 h. Maintenance dose 200–400 mg/day BID.</p>
Goal Therapeutic Range	1-2.5 ng/mL	0.2-1 mcg/mL	n/a	n/a
Route	PO	PO	PO	PO



Toxicity is an issue



Delivery Planning

1. We aim for term delivery at 39 weeks gestation
2. In a fetus with well controlled tachyarrhythmia and no maternal contraindications, we aim for vaginal delivery
3. As in all our other patients we do planned inductions
4. None of the discussed tachyarrhythmias need to be weaned, these can all be stopped after delivery



Pediatric care

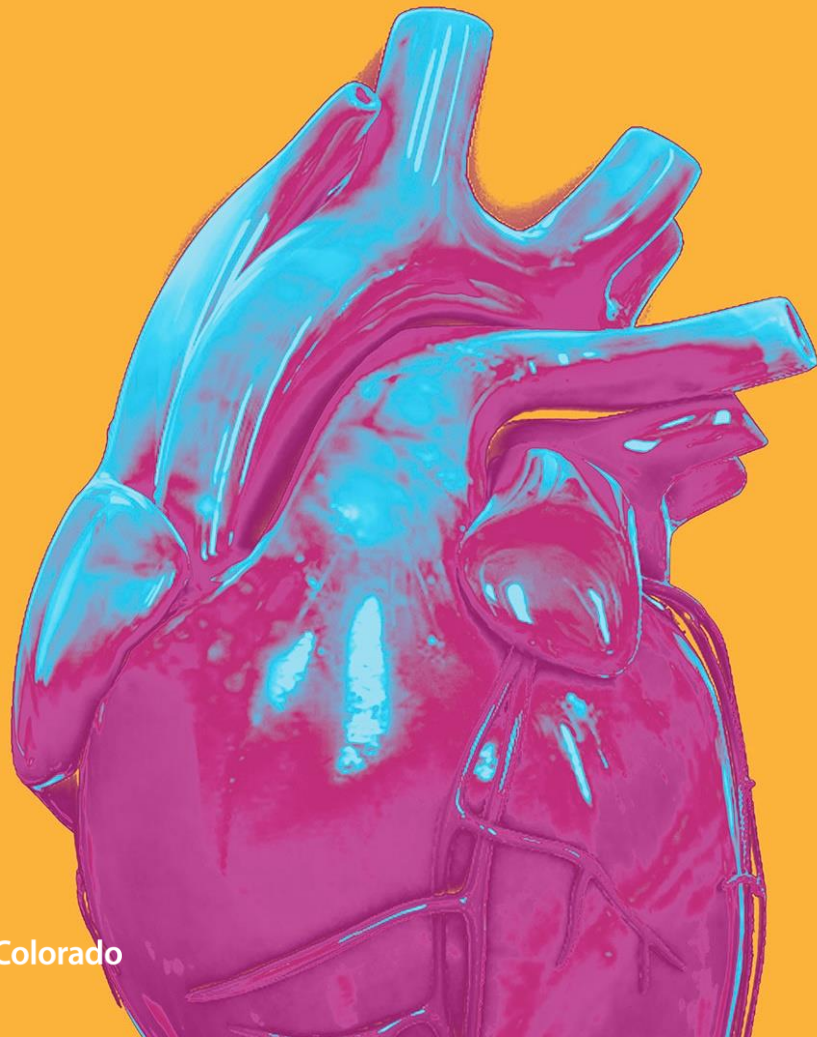
- If baby is born and remains in sinus rhythm, they will be candidates to enter the couplet care protocol
- This protocol includes baby staying in room with parents, no IV, feeds at lib, post natal EKG, echo, cardiology consult and a ZIO AT monitor discharge home with mom with 28 hrs
- We are prioritizing this protocol as it facilitates bonding of baby with parents, decreases pressure to start antiarrhythmic medications, decreases potentially unnecessary interventions and it also decreases cost of care



Summary

- 1) Brady arrhythmias are a FHR $< 3^{\text{rd}}$ percentile for gestation age
 - 1) Heart block has a regular atrial and ventricular rate but they are dissociated constant a:a interval
 - 2) Blocked PAC are irregular variable a:a' and a':a interval
 - 3) Channelopathies
 - 4) Differentiation is important to prognosis and treatment
- 2) Tachyarrhythmias are a FHR > 170 bpm which is persistent
 - 1) If untreated they can cause fetal demise
 - 2) If treated and controlled outcome is great
 - 3) The most common tachyarrhythmias are AVRT and flutter
 - 4) AVRT 1:1. Flutter variable A:V conduction





Thank you



Children's Hospital Colorado
Here, it's different.™

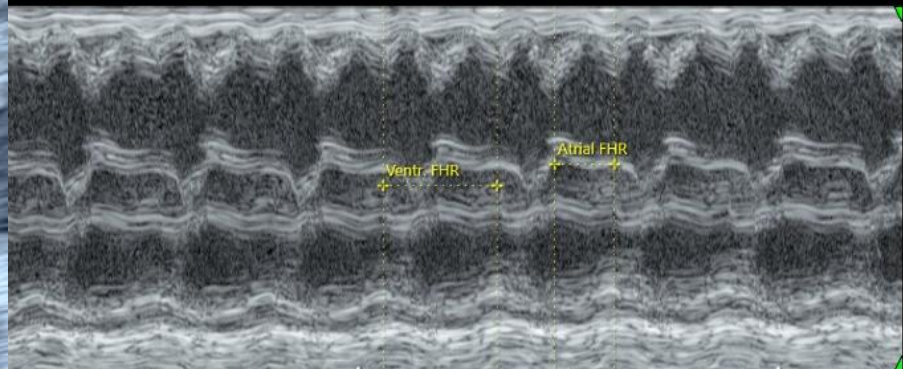


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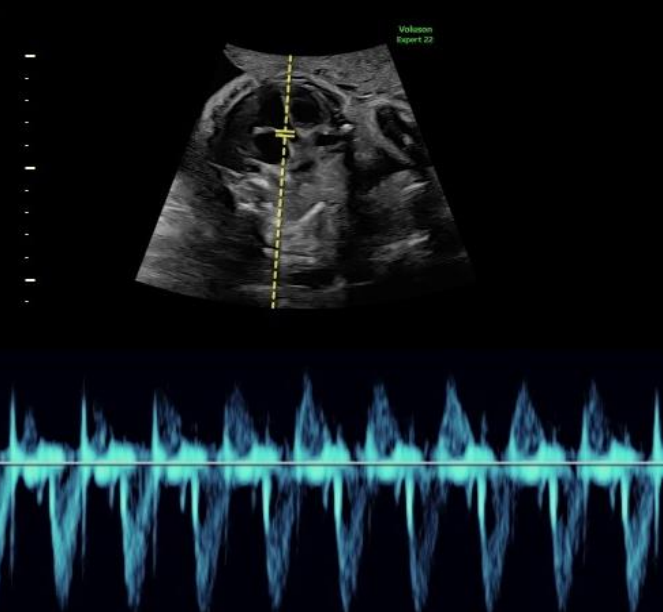
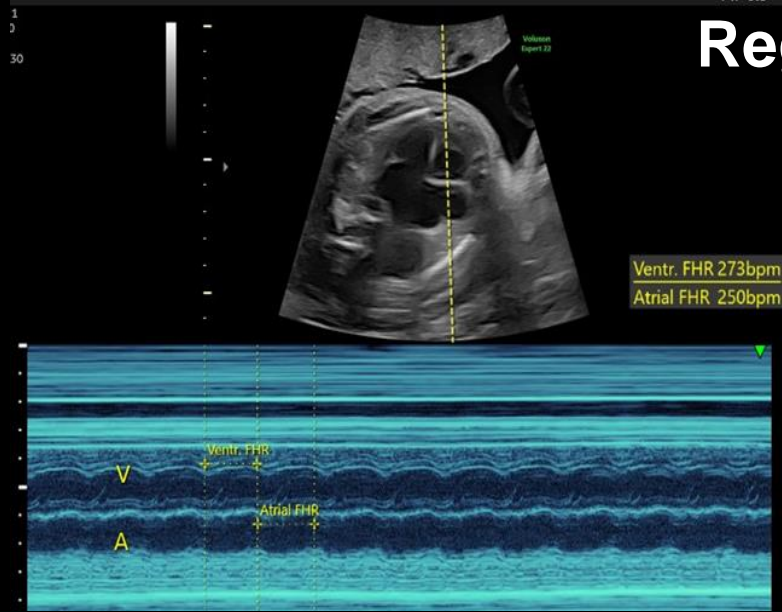
GA 30 wks
Atrial Rate 422
Ventricular 221
Regular



Ventr. FHR 221bpm
Atrial FHR 422bpm
Gn -9
C8/M16
P5/E3
SRJ II 3



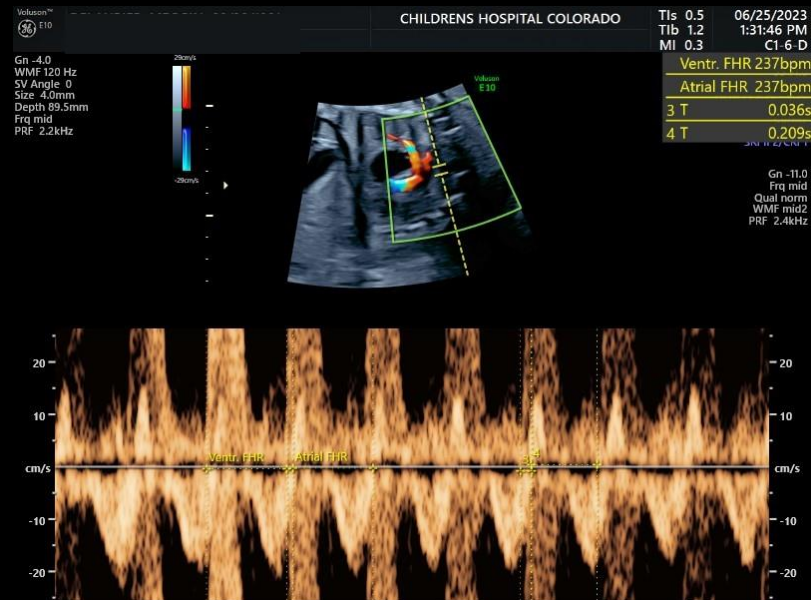
GA 20 wks
Atrial rate is 273
Ventricular rate 273
Regular



M mode



SVC: Aortic doppler

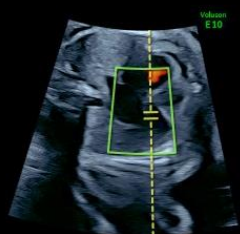
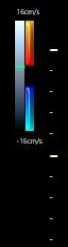


Gn 0
C 8
E 3
Ref 30



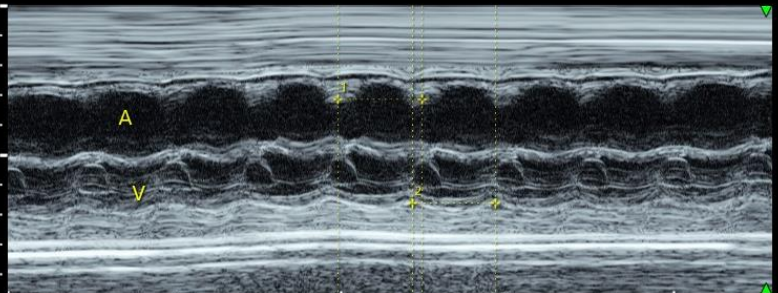
1 HR 237bpm
2/3 2 HR 241bpm
Gn -6
C8/M7
P4/E2
SRI II 4

Gn 0.0
WMF 120 Hz
SV Angle 0
Size 3.0mm
Depth 105.6mm
Frq mid
PRF 5.5kHz



1 HR 229bpm
2/3 Cardiac HF/E Card.
HI L 5.60 - 4.20
Gn -1
C8/M7
FRJ/E2
SRI II 4/CRI 1

Gn -11.0
Frq mid
Qual norm
WMF mid2
PRF 1.3kHz



MV

