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# Arrhythmias in Pregnancy: An Approach to Management of Both Patients

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Disclosures: None



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## Overview

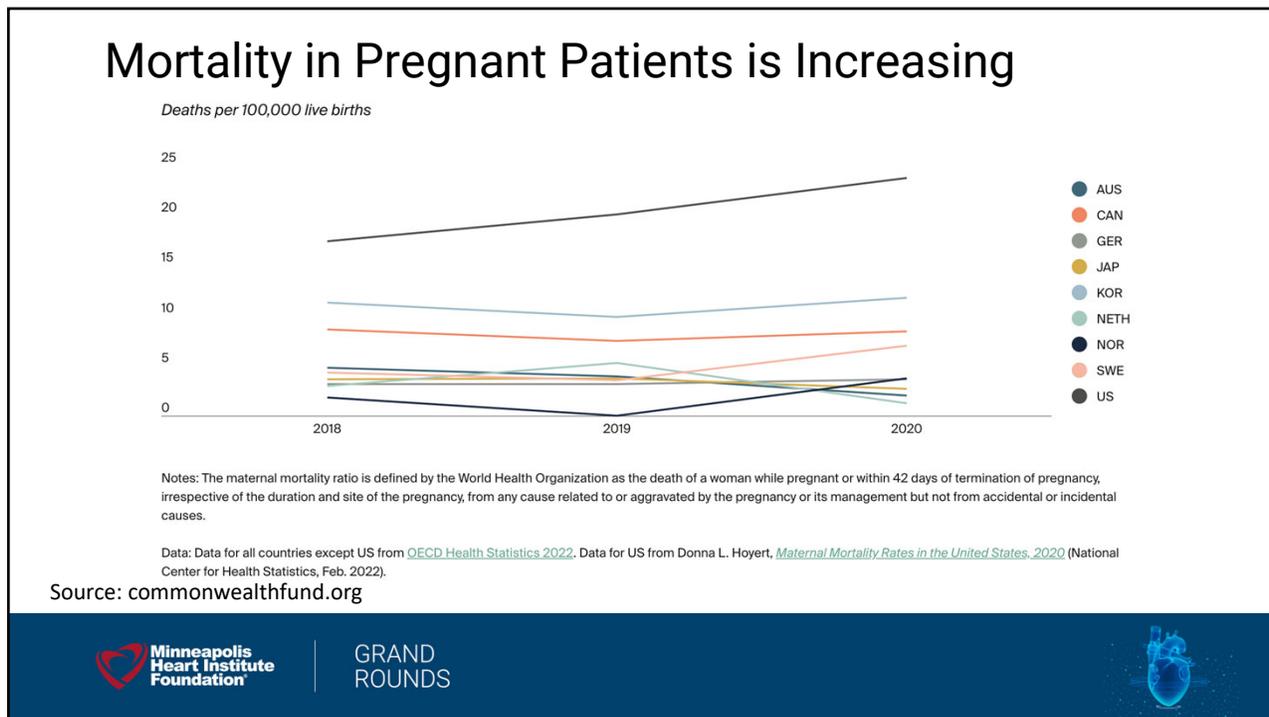
- Morbidity and Mortality
- Hemodynamic changes during pregnancy
- Management of the most common arrhythmias
- Device management
- Special populations
- Anticoagulation
- Cardiopregnancy Team



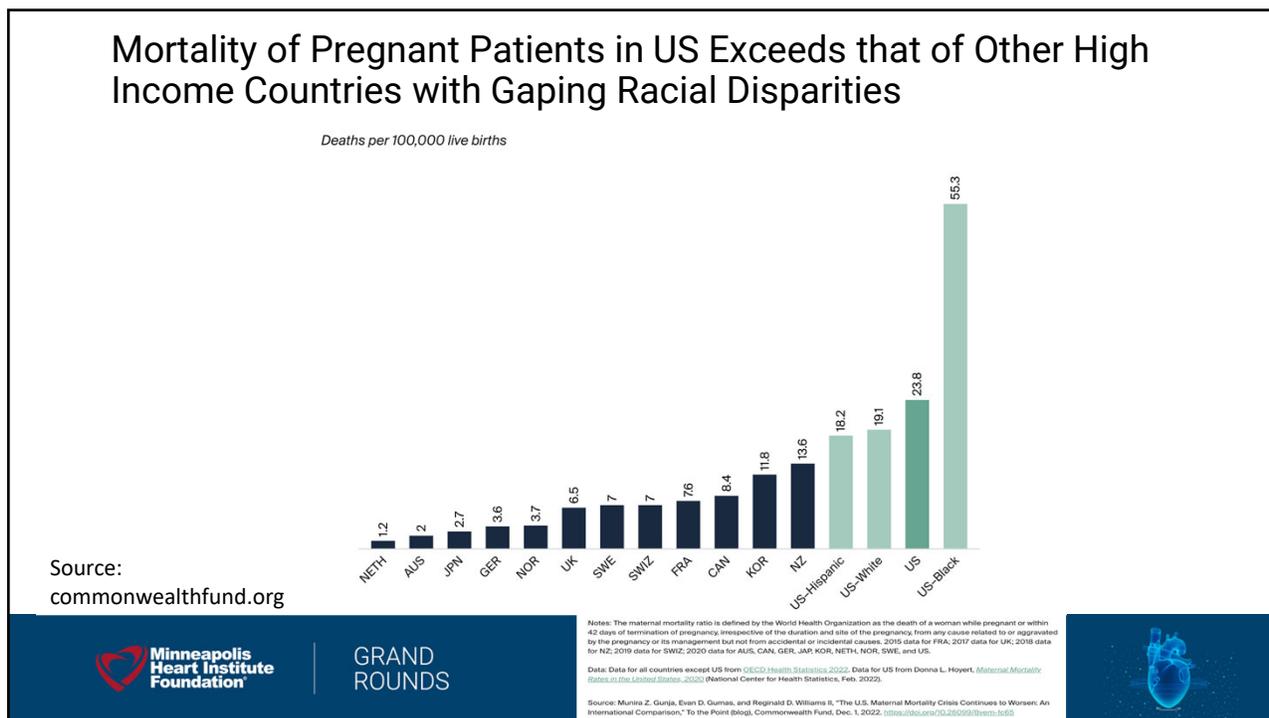
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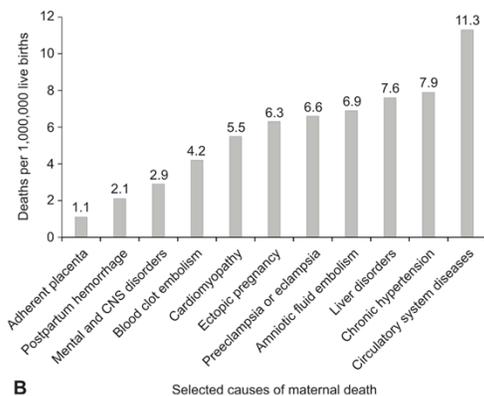


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## Cause-Specific Deaths in Pregnant Patients



**Fig. 3.** Maternal deaths within International Classification of Diseases, Tenth Revision (ICD-10) cause-of-death categories, United States, 2018. **A.** Maternal mortality rates (per million live births) within each ICD-10 cause-of-death category (all O chapter codes except those for late maternal death included). **B.** Cause-specific maternal mortality rates (per million live births) for specific causes of death of obstetric interest. Note that numbers in **A** represent cause-specific maternal mortality rates per million live births. The components of the pie chart are mutually exclusive and all-inclusive and sum to an overall maternal mortality rate of 17.4 per 100,000 live births. CNS, central nervous system.

Joseph. Maternal Mortality in the United States. *Obstet Gynecol* 2021.

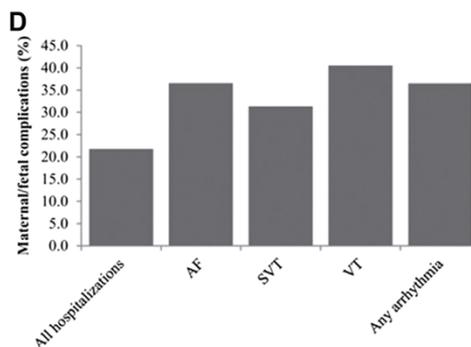
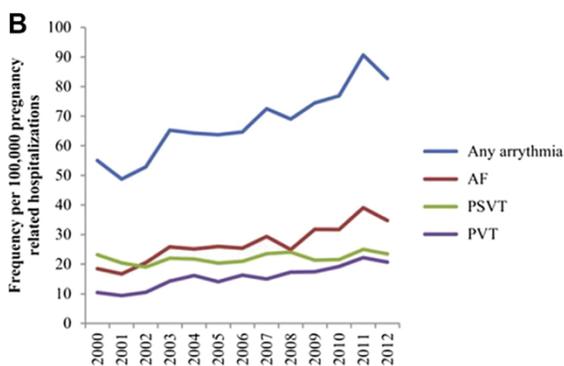


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## Frequency of Arrhythmias in Pregnancy and Associated Mortality and Complications Between 2000 and 2012



Tamirisa et al, JACC 2022



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## Risk Stratification and Recommended Cardiac Follow-up for Cardiac Arrhythmias During Pregnancy

	mWHO I	mWHO II	mWHO III
Diagnosis	Sinus tachycardia, sinus bradycardia, isolated PACs or PVCs	Supraventricular arrhythmias	Ventricular arrhythmias
Risk	No significant increased risk	Small increased risk of morbidity/mortality	Significant increased risk of maternal mortality or severe morbidity
Recommended pregnancy heart team members	Obstetrician, primary care physician, consider cardiology consultation	Obstetrician, primary care physician, maternal-fetal medicine, cardiologist	Obstetrician, primary care physician, maternal-fetal medicine, expert cardiology subspecialist, obstetric and cardiac anesthesiologists, neonatologist, geneticist,* mental health specialist,* pharmacist*
Frequency of cardiac follow-up during pregnancy	Once or twice	Once per trimester	Every 4-8 wk
Delivery location	Local hospital	Referral center	Expert Center for Cardio-Obstetric Care

Lindley et al, Clin Obst and Gyn 2020

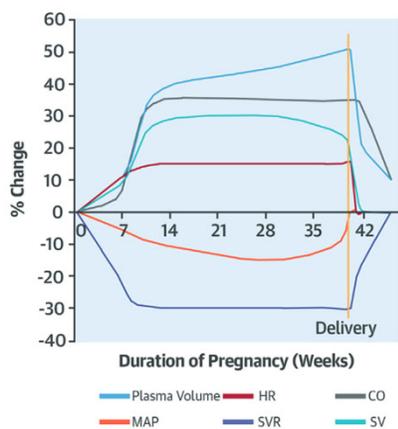


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## Hemodynamic Changes in Pregnancy



Halpern et al, JACC 2019

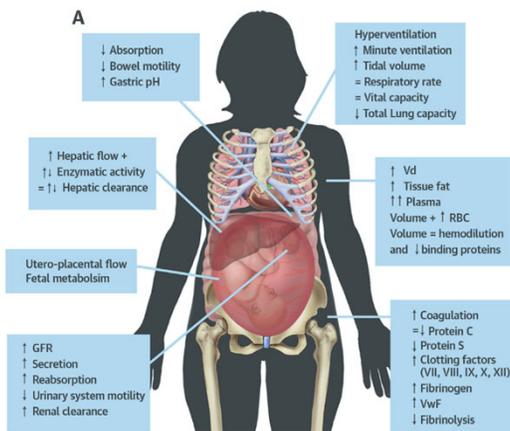


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## Pharmacologic Changes in Pregnancy



Halpern et al, JACC 2019



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## Cardiovascular Medications in Pregnancy

Ktwr jwKIF Hfyjltwix

Pregnancy Category	Description
A	Appropriate human studies - no risk
B	Insufficient human studies, but animal research suggests safety <b>or:</b> Animal studies show issues but human studies show safety
C	Insufficient human studies, but animal studies show problems <b>or:</b> No animal studies, and insufficient human studies
D	Human studies, with/without animal research show fetal risks, but the drug is important to some women to treat their conditions
X	Fetal risks are evident; there are no situations where the risk/benefit justifies use

**TABLE 1** FDA's Current Pregnancy, Lactation, and Reproductive Potential: Labeling for Human Prescription Drug and Biological Products

**Pregnancy**  
This subsection contains information on pregnancy, including labor and delivery.  
Narrative summaries of the risks of a drug during pregnancy and discussions of the data supporting those summaries are required in labeling to provide more meaningful information for clinicians under the following subheadings:

- **Pregnancy exposure registry:** to inform health care providers of the availability of a pregnancy exposure registry for a product with contact information (e.g., a toll-free telephone number, web URL) needed to enroll in or to obtain information about the registry.
- **Risk summary:** If information on birth defects and miscarriage is available for the patient population for whom the drug is labeled, it must be included. When use of a drug is contraindicated during pregnancy, this information must be stated first.
  - "Structural abnormalities" describes dysmorphology, which includes malformations, variations, deformations, and disruptions.
  - "Embryo-fetal and/or infant mortality" describes developmental mortality, which includes miscarriage, stillbirth, and infant death (including neonatal death).
  - "Functional impairment" describes functional toxicity, which includes such outcomes as deafness, endocrinopathy, neurodevelopmental effects, and impairment of reproduction.
  - "Alterations to growth" describes such outcomes as growth restriction, excessive growth, and delayed and early maturations.
- **Clinical considerations**
  - Disease-associated maternal and/or embryo/fetal risk;
  - Dose adjustments during pregnancy and the postpartum period;
  - Maternal adverse reactions;
  - Fetal/neonatal adverse reactions;
  - Labor or delivery
- **Data**
  - Human data;
  - Animal data

Halpern et al, JACC 2019



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## Cardiovascular Medications in Pregnancy

Arrhythmias	
Adenosine	● C ●
Metoprolol/propranolol	● C ●
Digoxin	● C ● F
Lidocaine	● B ●
Verapamil	● C ●
Diltiazem	● C ●
Procainamide	● C ●
Sotalol	● B ● F
Flecainide	● C ● F
Propafenone	● C ●
Amiodarone	# ● D ●

# may be used if other therapies fail

  
Safety in pregnancy

  
FDA category

  
Safety in lactation

  
Used also for fetal treatment

● Considered safe

● Limited data/to be used with caution

● Contraindicated

● Conflicting data/unknown

Halpern et al, JACC 2019



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## Case 1: Palpitations

Ms. Smith is a 30 year old female with past medical history of paroxysmal atrial fibrillation who is 8 weeks pregnant. She has not been seen by cardiology in 3 years. She notes to her OB a history of a prior ablation and was told that she was "cured." She calls with increased palpitations. In addition to an appointment with cardiology, you recommend:

- a) ASAP echo, EKG
- b) Monitor to quantify palpitations (real-time monitor)
- c) Start warfarin with goal INR 2-3
- d) Start weight-based therapeutic enoxaparin
- e) a and b



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## Case 1: Palpitations

Ms. Smith had an echo and EKG that were within normal limits with a resting HR of 70 bpm. Her 7-day monitor demonstrated two episodes of AF that were 5-6 minutes long (AVG HR 140 bpm). She is now 12 weeks pregnant. You see her in clinic and recommend:

- a) Metoprolol 12.5 gm po bid
- b) Flecainide 50 mg po bid and metoprolol tartrate 12.5 mg po bid
- c) Start warfarin with goal INR 2-3
- d) Watchful waiting
- e) a, b or d



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## Case 2: Irregular Heartbeat

Ms. Doe is a 35 year old female with past medical history of DM1 and low-burden PVCs who is now 7 weeks pregnant and calls in with increased symptoms. In addition to a cardiology appointment, you recommend:

- a) ASAP EKG and echo
- b) 24-48 hour holter monitor
- c) Start ASA 81 mg daily
- d) a, b and c



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## Case 2: Irregular Heartbeat

Ms. Doe had an EKG with normal intervals with a HR of 80 with occasional RVOT PVCs, an echo with a normal EF and a 24 hour holter with 10% PVCs and no VT. You see her in clinic at 13 weeks and recommend:

- a) Start metoprolol 12.5 mg po bid
- b) Start flecainide 50 mg po bid
- c) Watchful waiting
- d) Follow-up 2 months post-delivery
- e) a or c



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## Case 3: Fluttering

Ms. Hill is a 38 year old female with past medical history of anxiety who calls in with sensation of heart fluttering. In addition to a cardiology appointment, you recommend:

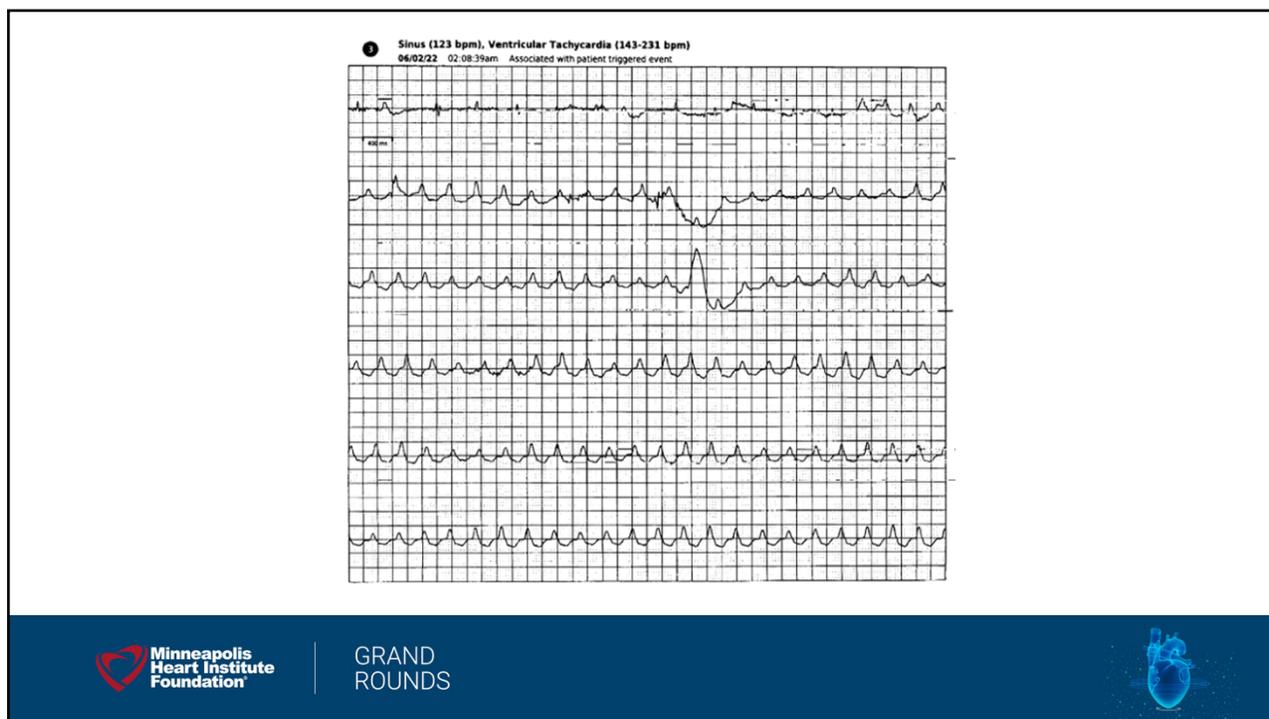
- a) ASAP EKG and echo
- b) 7-day real-time monitor
- c) TSH
- d) a, b and c



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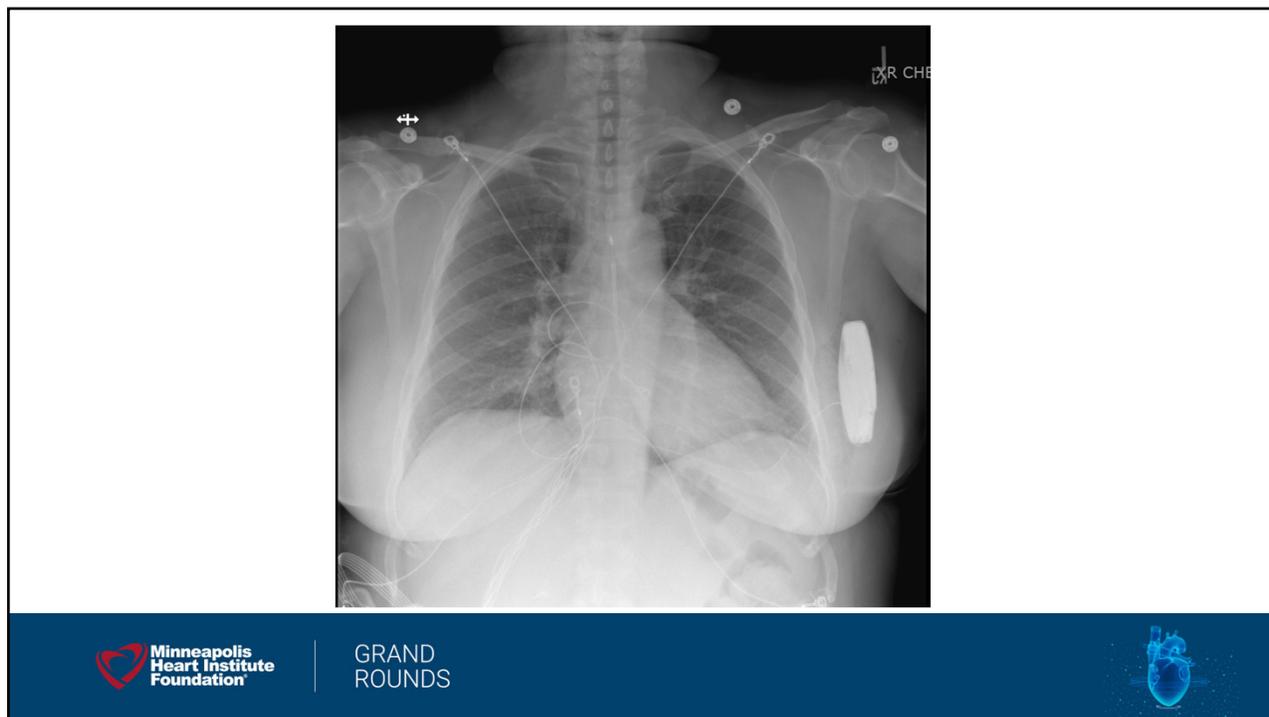
## Case 3: Fluttering

You recommend:

- a) Urgent outpatient appointment to discuss next steps
- b) Start metoprolol 25 mg po bid
- c) Start amiodarone 400 mg po bid
- d) Admit to the hospital for further management



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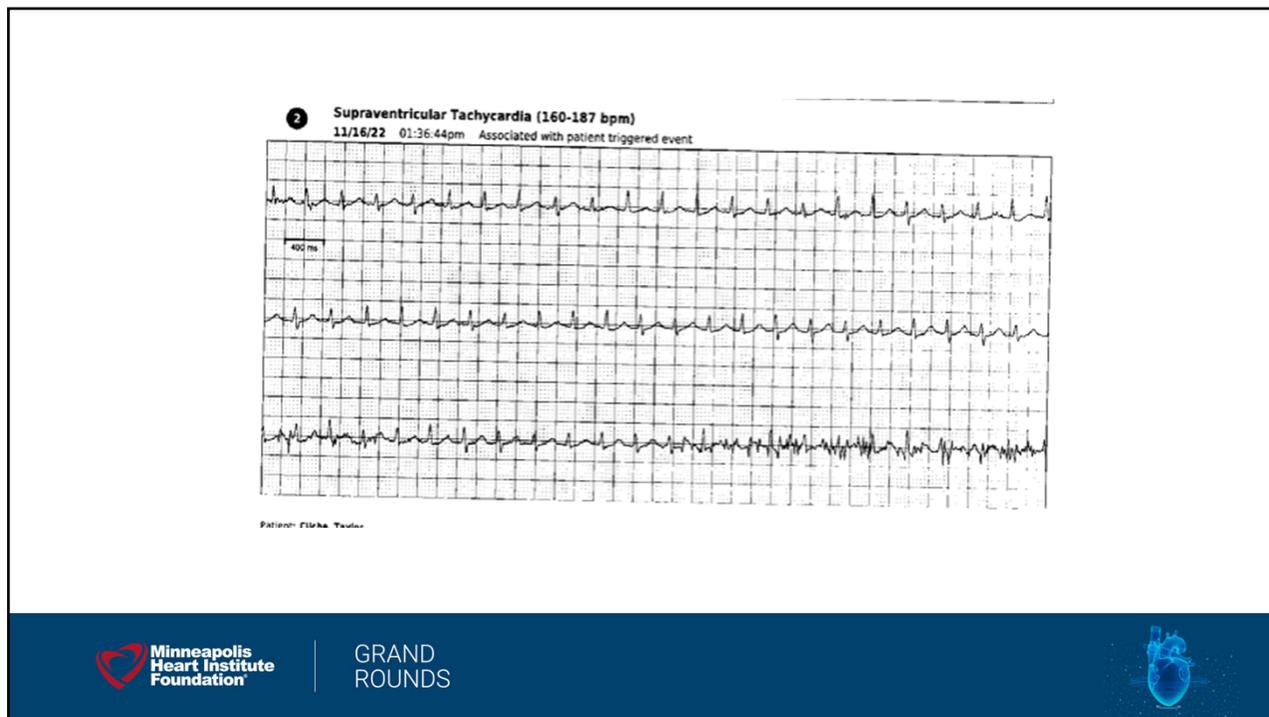
## Case 4: Tachycardia

Ms. Hale is a 38 year old female with past medical history of known SVT who is 6 weeks pregnant. She has not been seen by cardiology in 4 years and calls with increased episodes of tachycardia. She takes atenolol 25 mg daily. In addition to an appointment with cardiology, you recommend:

- a) ASAP echo, EKG
- b) Monitor to quantify palpitations (real-time monitor)
- c) TSH
- d) Switch from atenolol to metoprolol tartrate 25 mg po bid
- e) a, b, c and d

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## Case 4: Tachycardia

Ms. Hale had a standard Zio monitor placed instead which comes back in 3 weeks. It demonstrates sustained SVT with HRs in the 170s for hours at a time. You add her urgently to your schedule and she is 14 weeks by the time you are seeing her. Her echo demonstrated a low-normal EF and her BP is 105/65 mmHg. You recommend:

- Stop metoprolol tartrate and start sotalol 80 mg po bid
- Add flecainide 50 mg po bid with an EKG 2 days later
- No change to regimen
- Amiodarone 400 mg po bid



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## Case 5: Slow Heart Rates

Ms. Block is a 23 year old female who is 21 weeks pregnant who has a history of congenital heart block. She is overall feeling well without exertional symptoms or lightheadedness. In addition to an appointment with cardiology, you recommend:

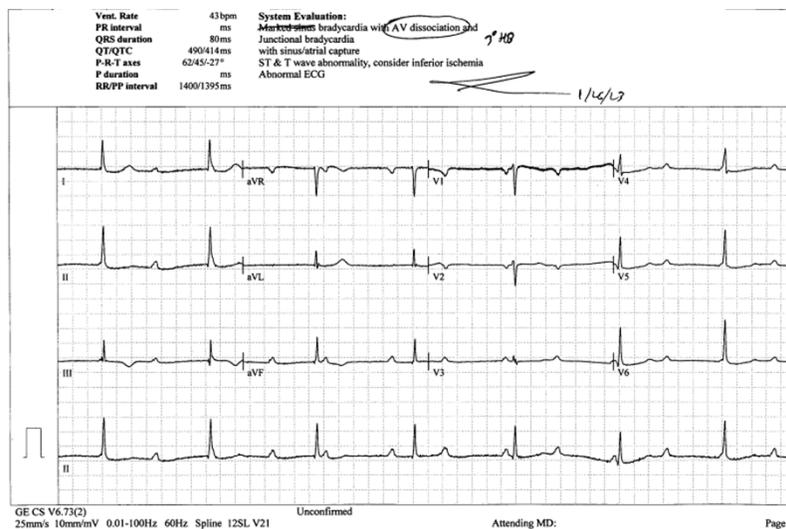
- a) ASAP echo, EKG
- b) 24 hour holter (ask her to exercise while wearing)
- c) TSH
- d) a, b and c



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## Case 5: Slow Heart Rates

Ms. Block presents for an in-person appointment after having a 7-day monitor with an AVG HR of 42 bpm, max HR of 64 bpm and longest pause of 3 seconds. No VT. Echo was within normal limits. She is now 26 weeks and still denies any exertional symptoms. You recommend:

- a) Watchful waiting
- b) Emergent pacemaker implant with limited fluoroscopy
- c) Delivery at a tertiary care center with electrophysiology available
- d) a and c



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## Isolated Congenital Complete Heart Block

Recommendations		
COR	Isolated Congenital Complete Atrioventricular Block	LOE
I	Permanent pacemaker implantation is indicated for patients with CCAVB with symptomatic bradycardia.	B-NR
I	Permanent pacemaker implantation is indicated for patients with CCAVB with a wide QRS escape rhythm, complex ventricular ectopy, or ventricular dysfunction.	B-NR
I	Permanent pacemaker implantation is indicated for CCAVB in asymptomatic neonates or infants when the mean ventricular rate is $\leq 50$ bpm. Ventricular rate alone should not be used as implant criteria, as symptoms due to low cardiac output may occur at faster heart rates.	C-LD
IIa	Permanent pacemaker implantation is reasonable for asymptomatic CCAVB beyond the first year of life when the mean ventricular rate is $< 50$ bpm or there are prolonged pauses in ventricular rate.	B-NR
IIa	Permanent pacemaker implantation is reasonable for CCAVB with left ventricular dilation ( $z$ score $\geq 3$ ) associated with significant mitral insufficiency or systolic dysfunction.	C-LD
IIb	Permanent pacemaker implantation may be considered for CCAVB in asymptomatic adolescents with an acceptable ventricular rate, a narrow QRS complex, and normal ventricular function, based on an individualized consideration of the risk/benefit ratio.	C-LD

Silka et al, HRJ 2021



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## Device Management During Pregnancy/Delivery

- Routine device checks!
- Echo and EP or cardiology appointment at some point during early pregnancy in most cases
- Magnet if cautery use during delivery (should be on a monitor if ICD in place as will inhibit tachycardia-therapies)
- No telemetry monitoring during delivery required unless evidence of unstable rhythms



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## Special Populations

- Congenital heart disease or advanced structural heart disease
  - Pre-conception counseling with CP team ideal
  - Increased risk for both atrial and ventricular arrhythmias peri-partum
- HCM
  - Pre-conception counseling
  - Risk increases with increasing symptoms/LVOT obstruction

Hammond et al, HRJ 2022



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## Congenital Long QT

Table 1:  $\beta$ -blockers Used in Long QT Syndrome, Pregnancy, and While Breastfeeding

Drug	Preferred in LQTS	Considered Safe in Pregnancy	Safety in Lactation
Nadolol	Yes (preferred)	Yes (limited data)	Caution (highly excreted in breastmilk)
Propranolol	Yes	Yes	Yes (preferred)
Bisoprolol	Yes	Yes (limited data)	Very limited data for safety
Labetalol	Yes (limited data)	Yes (preferred)	Limited data for safety
Carvedilol	Yes (limited data)	Yes	Unknown – may be safe
Atenolol	No (less effective)	Contraindicated	Caution (highly excreted in breastmilk)
Metoprolol	No (less effective)	Yes (preferred)	Yes (preferred)

Taylor et al, US Card Rev 2021



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## Anticoagulation in Pregnancy

- Pre-conception counseling
- Warfarin dose > 5 mg/day → switch to LMWH
- If on warfarin during pregnancy → switch to LMWH at 36 wks
  - Usually switch from one mode of AC to the other is done *in the hospital* if a mechanical valve is present
- Reversal of AC in pregnant patient does not equate to reversal in fetus
- DOACS contraindicated

### Anticoagulants/Antiplatelets/Thrombolytics

#### Anticoagulants

Warfarin	○ D ○
Unfractionated Heparin	○ C ○
Enoxaparin	○ B ○
Fondaparinux	○ B ○
Argatroban	○ B ○
Bivalirudin	○ B ○

#### Antiplatelets

Aspirin (low dose)	○ N ○
Clopidogrel	○ B ○
Prasugrel	○ B ○
Ticagrelor	○ C ○

#### Thrombolytics

Alteplase	○ C ○
Streptokinase	○ C ○

Halpern et al, JACC 2019



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## Summary

- Arrhythmias can cause significant morbidity if they occur during pregnancy and should be addressed quickly
- Expedite evaluation of pregnant patients
- Use holter and real-time monitors
- Reach out to CVOB team providers directly for any referrals



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## Cardiopregnancy Team (not inclusive)

CVOB scheduling: Kristin Sears; EP scheduling: EP coordinators

MPP Nursing Team; MPP Social Worker Pam Cleary

RN Coordinators: Cassie Longtin, Rachel Gobar, Lacey Boisvert

MPP Docs: Cassie Bigelow, Laura Colicchia, Matt Loichinger, Ryan Loftin, William Wagner.

APRNS: Heidi Sannes, Nicole Williams, Elin Nelson, Amy Hurst, Sabrina Fink, Natalie Johnson

OB Hospitalist group

Inpatient coordinators: Niki Leske, Jody Krou

Anesthesia: Mark Milshteyn, Ben Reynolds, Ann-Marie Manley

Med peds: David Tetzlaff

Cardiology Docs: Courtney Baechler, JoEllyn Moore, Charles Gornick, Michael Samara, Retu Saxena

Echo: Steph Klopper

ICU: Lisa Kirkland

Pharmacy: Greg Laffen



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# Cardiac Arrhythmias in Pregnancy: **Caring for Both Patients**

Dr. Chris Carter  
Co-Director, Electrophysiology  
The Children's Heart Clinic/Children's Minnesota



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## Disclosures

None



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## Overview

- Review most common fetal arrhythmias and their evaluation
- Decision-making on transplacental therapies for arrhythmia
- Review ongoing studies in fetal arrhythmias

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## Background

- The conduction system of the fetal heart is functionally mature by 16 weeks of gestation.
- Normal fetal heart rate is between 110 and 160 bpm
- Fetal arrhythmias affect 1-2% of all pregnancies

Rhythm Abnormality	Frequency
Premature Atrial Contractions	87.6%
Supraventricular tachycardia	4.9%
Complete Heart Block	2.8%
Atrial Flutter	1.5%
2 <sup>nd</sup> Degree Heart Block	0.7%
Sinus tachycardia	0.6%
Ventricular tachycardia	0.5%
Atrial fibrillation	0.3%
Junctional tachycardia	0.01%
Sinus bradycardia	0.01%

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## Case Study #1

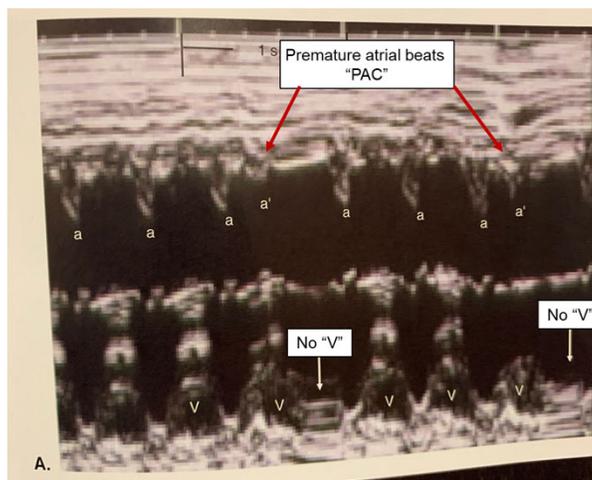
- 28 yo G4P1
- 21 weeks gestation
- Fetal bradycardia and irregular rhythm noted on routine exam
- Referred to fetal cardiology for further evaluation

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## Premature Atrial Contractions



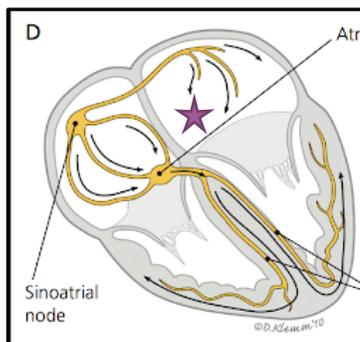
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## Premature Atrial Contractions

- PACs are common (present in 51% of newborns)
- Compromise 43% of fetal arrhythmias
- Occur as early as 15 weeks, most common in 3<sup>rd</sup> trimester (1-3% of pregnancies)



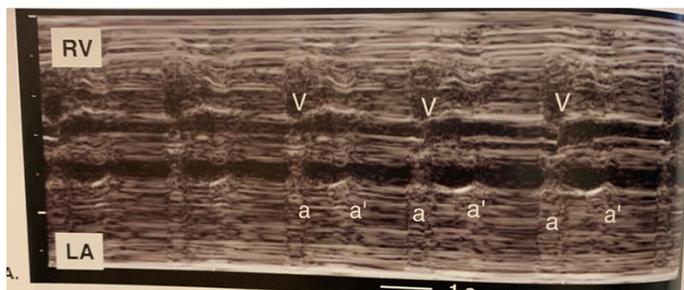
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## Blocked Atrial Bigeminy

- Results in a very regular, slow ventricular rhythm (b/c every other atrial beat not conducted)
- Often confused with 2<sup>nd</sup> or 3<sup>rd</sup> degree heart block
- Distinguishing BAB from heart block is based on atrial timing (regular in heart block, irregular in BAB)



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## Premature Atrial Contractions

- Benign findings
- Require no therapy
- Resolve spontaneously in vast majority of cases as myocardium matures

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## Case Study #2

- 34 yo G4P2012
- 27 weeks
- Referred to MFM for IUGR and echogenic bowel
- MFM noted abnormal rhythm
- Referred to fetal cardiology for further evaluation

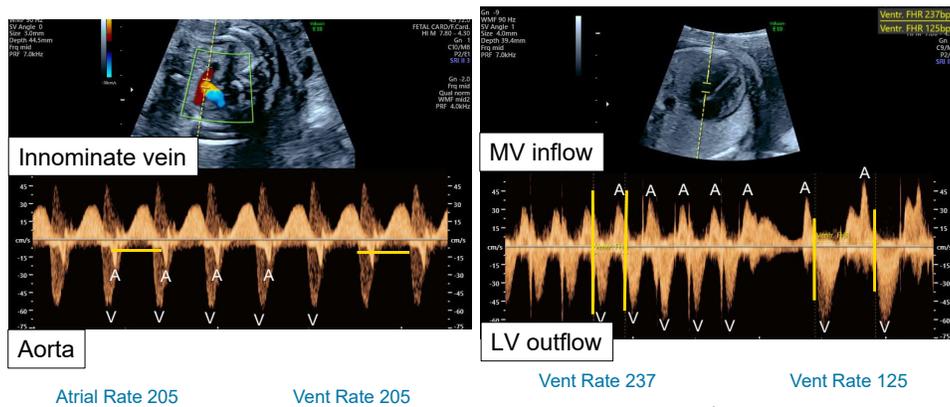
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## Supraventricular Tachycardia

### AVRT



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## Supraventricular Tachycardia

- Incessant or paroxysmal episodes of increased fetal heart rates  $>180$  beats/min.
- Represents  $\sim 10\%$  of fetal arrhythmias
- 5-10% are associated with underlying CHD
- AV reciprocating tachycardia (AVRT, 70%) and atrial flutter (AF, 30%) are most commonly observed SVT types.
- Associated with fetal morbidity and mortality
  - Mortality is low when treated
  - Morbidity can be significant depending on how difficult it is to control

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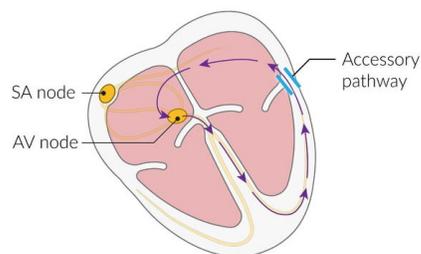
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## Supraventricular Tachycardia

### AVRT

- Accessory pathway mediated tachycardia
- If pathway has antegrade conduction it causes preexcitation on EKG
  - WPW
- Most often the circuit is antegrade through the AVN and retrograde through the AP



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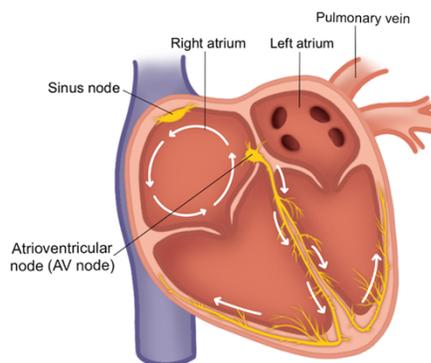
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## Supraventricular Tachycardia

### Atrial Flutter

- Circuit is in the atrium above the AVN
- Variable conduction of 2:1 or 3:1 is most common
- Typical flutter in most infants with classic EKG findings



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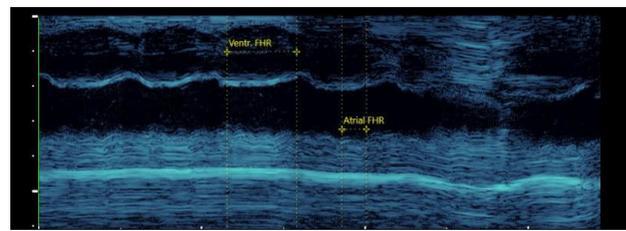
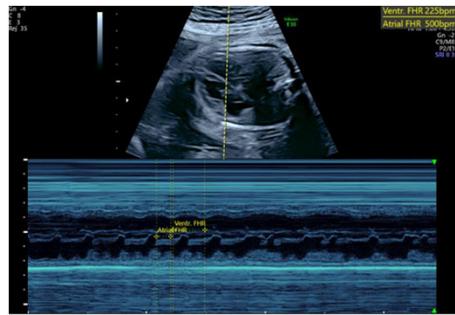
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# Supraventricular Tachycardia

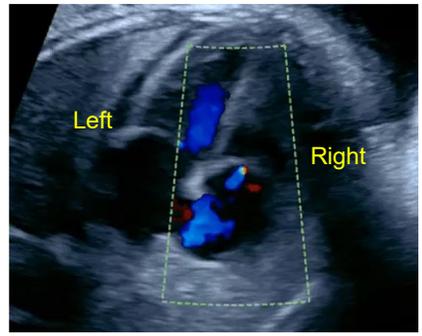
## Atrial Flutter

Ventricular Rate 225 BPM  
Atrial Rate 529 BPM



Ventricular Rate 141 BPM  
Atrial Rate 400 BPM

# Complications



Tricuspid Regurgitation



Hydrops

## Therapy

- Patients are admitted prior to starting medications for maternal and fetal monitoring
- Multidisciplinary care team:
  - MFM
  - Adult and pediatric electrophysiology
  - Fetal cardiology
  - Any additional specialists as needed
- Once discharged followed closely by MFM and fetal cardiology for any changes

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## Therapy Goals

- Avoid or reverse hydrops and heart failure symptoms
- Rhythm control is ideal but rate control is also acceptable
- Stable mother and fetus within acceptable monitoring parameters based on medication
- Sinus rhythm or rate control through gestation and delivery at term or as close as possible



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## Drug Choice

- Use drugs with acceptable transplacental transfer
  - Digoxin>Flecainide>Sotalol
- Dosing is often on the higher side
  - Achieve adequate fetal levels
  - Account for increased volume of distribution in pregnancy
- Maternal risk factors may affect drug choice
  - EKG findings: QTc, conduction abnormalities
  - Maternal heart rate
  - Medication interactions
  - Electrolytes
- Fetal condition
  - Hydrops can affect the transplacental transfer of some drugs

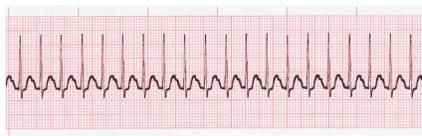
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## AVRT Therapy

- Sustained without hydrops
  - First line therapy
    - Digoxin historically
      - Reported 60% conversion but anecdotal experience is less
    - Flecainide currently is coming into favor based on several small studies
  - Second line therapy
    - Flecainide + digoxin
    - Sotalol
    - Sotalol + digoxin
  - Third line therapy
    - Amiodarone
    - Intrauterine digoxin



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## AVRT Therapy

- Sustained with hydrops
  - First line therapy
    - Flecainide
  - Second line therapies
    - Flecainide + digoxin
    - Sotalol +/- digoxin
  - Third line therapies
    - Amiodarone
    - Direct fetal IM digoxin



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## Atrial Flutter Therapy

- Sustained with or without hydrops
  - First line therapy
    - Sotalol
      - Reported success rate is 60%
  - Second line therapy
    - Sotalol + digoxin
    - Flecainide
    - Flecainide + digoxin
  - Third line therapy
    - Amiodarone



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## Medication Dosing and Maternal Monitoring

- **Digoxin**
  - Baseline EKG and electrolytes
  - IV or PO load total of 1.75 mg over 24 hours then maintenance of 0.25 mg PO q8
  - Goal level 2.5 ng/mL
  - Daily EKG and electrolytes
- **Flecainide**
  - Baseline EKG, echo and electrolytes
  - 100-150 mg PO BID as starting dose
  - Goal level between 0.2 to 1 mcg/ml
  - Daily EKG



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## Medication Dosing and Maternal Monitoring

- **Sotalol**
  - Baseline EKG and electrolytes
  - Starting dose 80 mg PO BID to TID
  - Daily EKG
- **Amiodarone**
  - Baseline EKG, electrolytes and TFT
    - Concern for mother maternal and fetal thyroid dysfunction
  - Starting dose 600-800 mg q8h1-2 for 2-7 days then 200-400 mg/day
  - Daily EKG and electrolytes

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## Monitoring

- Fetal echo is done depending on clinical indications and findings
  - Generally on admission and discharge and sometimes as frequent as daily
- Biophysical profile (BPP) followed as well as indicator of general fetal status



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## FAST Therapy Trial

- First and only prospective multicenter RCT for fetal SVT
- SVT with hydrops
  - Digoxin+Flecainide v Digoxin+Sotalol
- SVT without hydrops
  - Digoxin v Flecainide
- Atrial flutter without hydrops
  - Digoxin v Sotalol
- Each arm with defined steps for inadequate or failed response in dose or medication escalation
- Primary outcome is term delivery with normal rhythm



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## Case Study #3

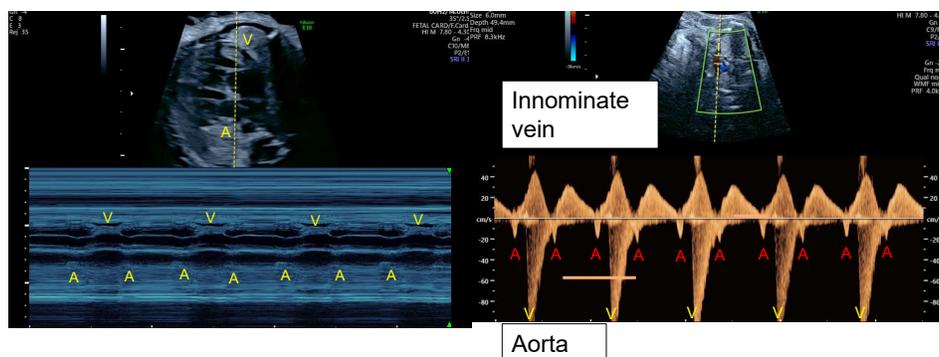
- 35 yo G2P1
- 31 weeks gestation
- Presented to OSH week prior for decreased fetal movement
- Referred to MFM for second opinion
- Found to have bradycardia and referred to fetal cardiology

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## Congenital Complete Heart Block



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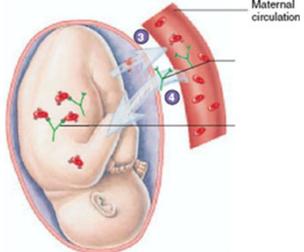
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**Children's**  
MINNESOTA 

## Congenital Complete Heart Block

- Immune mediated
  - Fetal heart is structurally normal
  - Maternal SSA/SSB (Ro/La) antibodies
    - SLE or Sjögren's
    - 2-3% of all pregnancies and only 1-3% get heart block
  - Causes a general myocarditis but most often the conduction system is preferentially affected
  - Mortality rate 11-29%
    - Including prenatal and postnatal mortality
    - 1/5 of mortalities with associated cardiomyopathy
  - 63-93% will receive pacemakers in childhood



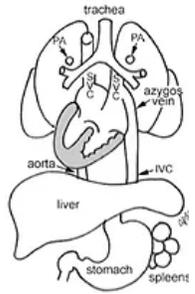
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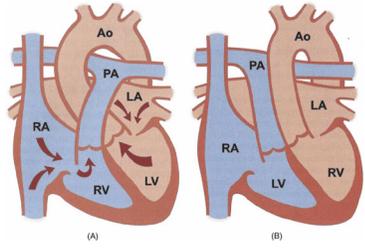
**Children's**  
MINNESOTA 

## Congenital Complete Heart Block

- Congenital malformation
  - Because of structural abnormalities the risk here can often be detected earlier in pregnancy
  - Left atrial isomerism
    - Form of heterotaxy
  - cc-TGA



Visceral heterotaxy with thoracic left isomerism



(A) (B)

Atrial left isomerism

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## Therapy

- Preventative strategies have been attempted
  - Maternal plasmapheresis
  - Transplacental IVIG
  - Early monitoring for incomplete AVB and treatment
  - Prophylactic dexamethasone
  - Maternal preventative hydroxychloroquine
    - Only one with any demonstrable effect
    - SSA+ moms with previously affected offspring
    - Started prior to 10 weeks GA
    - 64% decrease in recurrence rate

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## Therapy

- After complete heart block has developed nothing has been shown to reverse the process
  - Can go from normal to complete in under 12h
- If 1<sup>st</sup> or 2<sup>nd</sup> AVB is detected
  - Dexamethasone
    - 8 mg PO X 10 days then 4 mg PO daily until 30 wk GA
  - IVIG if evidence of additional cardiac disease
    - 70 mg IV X 1, may repeat
- Terbutaline is used to increase fetal rate for pronounced bradycardia
  - Generically in fetal heart rates <55 bpm
  - Greater risk for heart failure and death
  - Monitor mother's heart rate with goal 110-120 bpm

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## STOP BLOQ Trial



- Risk stratify pregnancy with antibody titers at <18 weeks GA
- Use home fetal heart rate monitoring to identify early AVB in high risk patients
  - 3 x daily home checks
  - Weekly in office fetal echo
- Initiate early anti-inflammatory therapy in those with early AVB
  - High dose dexamethasone
  - IVIG
- Primary outcome is percentage of 2<sup>nd</sup> degree AVB patients with NSR at birth

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