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Heart Disease and the Pregnant Patient

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MASSACHUSETTS GENERAL HOSPITAL
INSTITUTE FOR HEART, VASCULAR AND STROKE CARE

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Heart Disease and Pregnancy

FINANCIAL DISCLOSURE:

No relevant financial relationship exists

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Introduction

- Heart disease is present in up to 4% of all pregnancies
- Data from the UK suggest that heart disease is the number one cause of indirect maternal death
- As maternal age advances, preexisting heart conditions more likely
- Increase in obesity and diabetes in population increase risk of CV complications during pregnancy
- Patients with congenital heart disease are surviving to reproductive age
- Childhood cancer survivors with cardiotoxic effects from therapy
- Limited prospective and RCT data

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Objectives

- Understand the hemodynamic changes of pregnancy
- Review normal clinical and structural findings in pregnancy
- How to risk stratify a woman with cardiac disease

- Review specific cardiac conditions in pregnancy
- Review value of troponin and BNP in pregnancy
- Discuss importance of maternal placental syndromes

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Cardiovascular Disease and Pregnancy Service

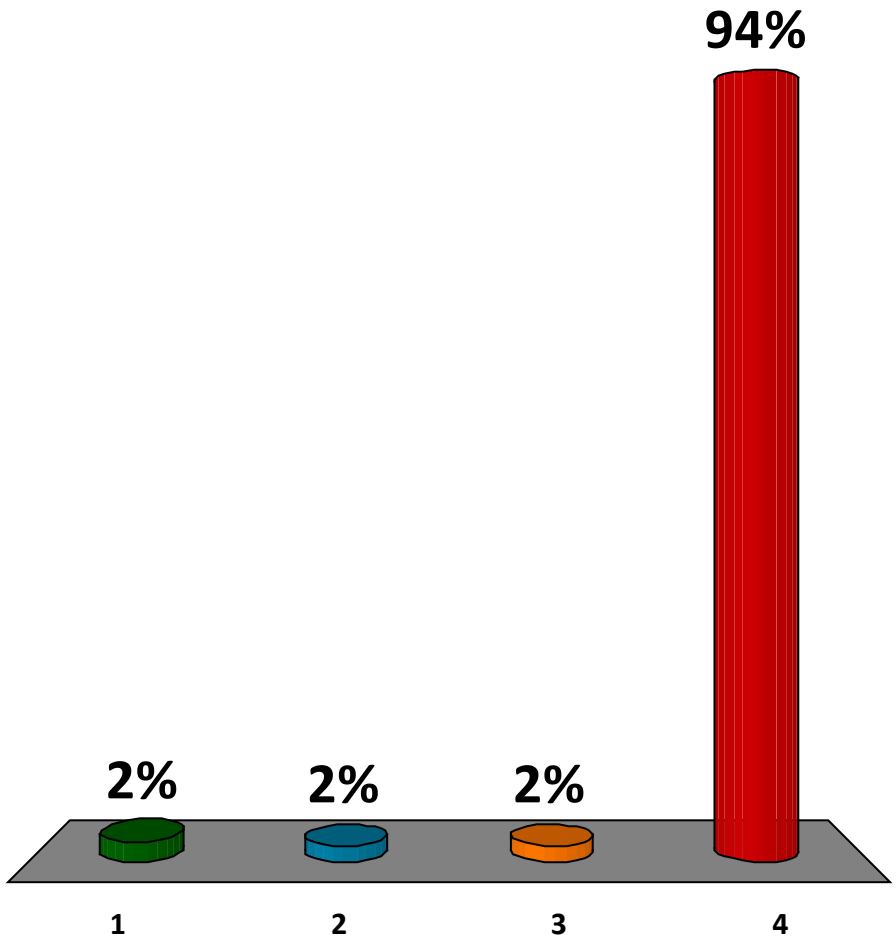
- This is how we started….

  42 year old s/p VF arrest with ostial LAD occlusion treated with Xience to LAD - July 2011
  Xience to RCA September 2011

  December 2011 becomes pregnant

Please choose the best answer:

1. Dual antiplatelet therapy is safe during pregnancy and delivery
2. Dual antiplatelet therapy is safe for epidural catheter placement
3. There is an abundant amount of safety data on drug coated stents during pregnancy
4. None of the above



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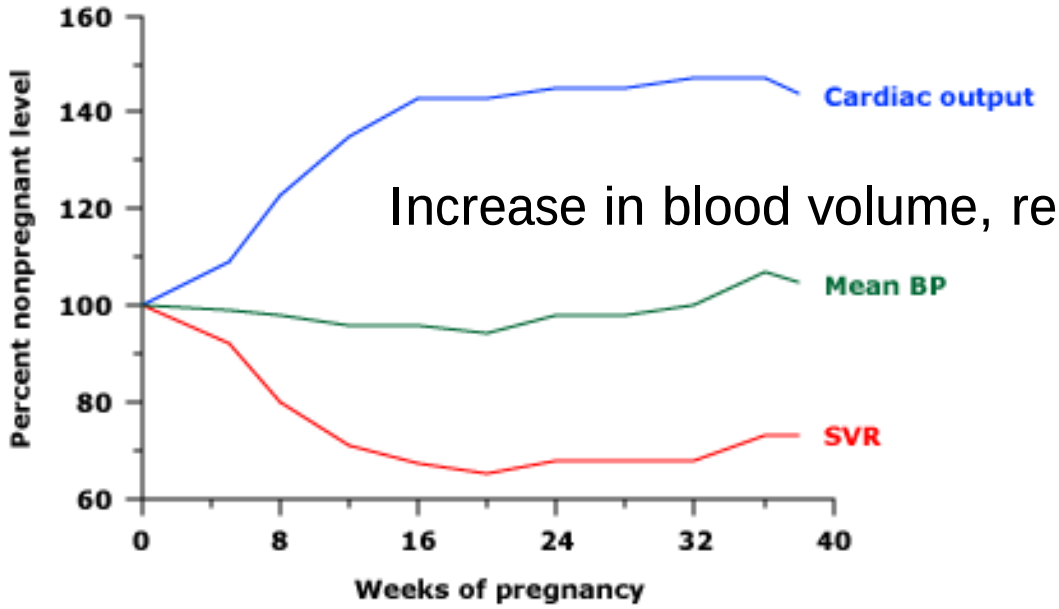
Our most concerning case….

- 32 year old originally from Somalia
- Saw cardiologist in 2009 – moderate rheumatic MS/AS/AI
- ‘Reminded her that pregnancy was contra-indicated’

- Did not return until 2012 – called OB to let them know she was 15 weeks pregnant

Hemodynamic changes in normal pregnancy

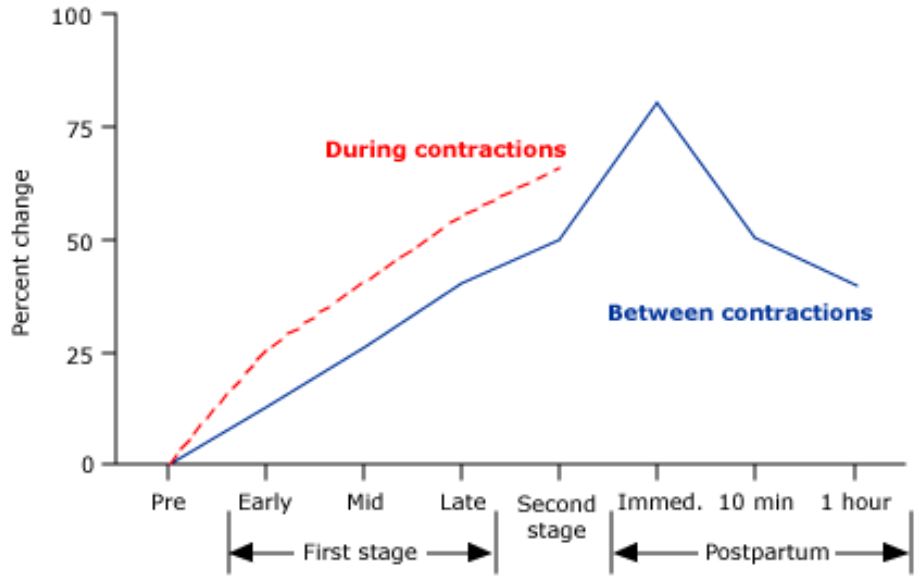


Increase in blood volume, red cell mass and HR

CO rises to 30-50% non pregnant levels
Rises even further with twin pregnancy
12% CO to uterus

Histological changes in aortic media

Cardiac output during normal labor, delivery, and postpartum



Data from Bonica, JJ, McDonald, JS. Principles and Practice of Obstetric Analgesia and Anesthesia, 2nd ed, Williams &Wilkins, Baltimore, 1994. p. 62.

UpToDate

Catecholamine induced rise HR/SV
Increase BP and CO
Tachycardia reduces diastole time
Relief of IVC compression causes increased preload

POST
Autotransfusion
Blood loss
Loss of low resistance placenta
Mobilization of dependent edema

Symptoms

- Symptoms tha … se in non pregnant patie …
- Fatigue, dyspn … edema and orthopnea all c … tional anemia, decreased ver … pression
- Edema from in … and reduced colloid osmotic pressure

Abnormal
Dyspnea that limits activity
Progressive orthopnea/PND
Syncope with exertion
Palpitations
Chest pain
hemoptysis

Normal physical examination

- Normal findings would otherwise be abnormal in non pregnant
- Prominent X and Y … of JVP
- Full systemic arter…
- Hyperdynamic LV…
- Palpation of the R…
- Loud S1, splitting…
- Flow murmurs
- Diastolic murmurs may occur due to increased flow across MV and TV valves
- Continuous murmur: venous hum over right supraclavicular fossa, mammary souffle

Abnormal
Pulse over 100, less than 60
Cyanosis/clubbing
Diastolic murmur
Systolic murmur 3/6
S3/S4

CARPREG – to risk stratify pregnancies

Prospective multicenter study of pregnancy outcomes in women with heart disease

(Siu et al. Circulation 2001)

562 consecutive women with heart disease

13 Canadian centers

617 pregnancies

1994-1999

derivation (60%) - validation (40%) model

74% congenital heart lesions

CARPREG: Outcomes

Major cardiac events in 80 (13%)

- 73 of these were either CHF or arrhythmia

4 patients had an embolic CVA

- Dilated CMP, MVR w/suboptimal INR, MS, D-TGA s/p Mustard with low RVEF

3 patients died

- Mustard, Dilated CM, severe pulmonary HTN

CARPREG risk score

Table 4 Predictors of maternal cardiovascular events and risk score from the CARPREG study[12]

Prior cardiac event (heart failure, transient ischaemic attack, stroke before pregnancy or arrhythmia).
Baseline NYHA functional class >II or cyanosis.
Left heart obstruction (mitral valve area <2 cm^2, aortic valve area <1.5 cm^2, peak LV outflow tract gradient >30 mmHg by echocardiography).
Reduced systemic ventricular systolic function (ejection fraction <40%).

CARPREG risk score: for each CARPREG predictor that is present a point is assigned. Risk estimation of cardiovascular maternal complications
0 point 5%
1 point 27%
>1 point 75%
LV = left ventricular; NYHA = New York Heart Association.

Siu et al. Circulation 2001;104:515-521

Modified WHO Classification of Maternal cardiovascular risk

- WHO 1
  uncomplicated or mild: PS, PDA,MVP
  repaired simple lesions
  ectopic beats
- WHO 2
  unoperated ASD/VSD
  repaired Tetralogy of Fallot
  most arrhythmias
- WHO 2-3
  mild LV impairment

  HCM
  heart transplant
  Marfans without aortic dilatation
  valvular disease not in WHO 4

Modified WHO Classification of Maternal cardiovascular risk

- WHO 3
  - mechanical valve
  - systemic RV
  - post Fontan
  - cyanotic heart disease
  - other complex congenital heart disease
  - aortic dilatation above 40 mm in Marfans
  - aortic dilatation above 45 mm in BAV

Modified WHO Classification of Maternal Cardiovascular Risk

- WHO 4

  Pulmonary artery hypertension
  LV EF less than 30%
  NYHA 3-4
  Previous PPCM with residual impairment
  Severe MS
  Severe symptomatic AS
  Marfan with root over 45 mm
  BAV with root over 50 mm
  Severe coarctation

- **PREGNANCY IS CONTRA INDICATED**

European Heart Journal
doi:10.1093/eurheartj/ehs270

CLINICAL RESEARCH

Outcome of pregnancy in patients with structural or ischaemic heart disease: results of a registry of the European Society of Cardiology

Jolien W. Roos-Hesselink[1*], Titia P.E. Ruys[1], Jörg I. Stein[2], Ulf Thilén[3], Gary D. Webb[4], Koichiro Niwa[5], Harald Kaemmerer[6], Helmut Baumgartner[7], Werner Budts[8], Aldo P. Maggioni[9], Luigi Tavazzi[10], Nasser Taha[11], Mark R. Johnson[12], and Roger Hall[13], on behalf of the ROPAC Investigators

- Created in 2007
- Goal: improve understanding of consequences of heart disease during pregnancy

Now over 2500 patients worldwide

MGH is now a member of this registry

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Correlation with WHO category

Table 4 Outcome and complications per WHO categories for severity of heart disease

	WHO 1 (*n* = 241)	WHO 2 (*n* = 514)	WHO 3 (*n* = 504)	WHO 4 (*n* = 53)	*P*-value
	241	514	504	53	
Maternal mortality (%)	0.4	0.6	1.5	4.0	0.035
Maternal hospital admission (%)	13	18	36	66	<0.001
Cardiac					
Heart failure (%)	1.2	5.6	19	57	<0.001
Supraventricular arrhythmias (%)	0.4	1.4	1.4	3.8	0.13
Ventricular arrhythmias (%)	1.7	0.8	3.4	1.9	0.068
Obstetrics complications					
Pregnancy-induced hypertension (%)	1.7	3.1	2.4	0.0	0.91
(pre-)Eclampsia (%)	2.1	2.9	3.4	3.8	0.32
Caesarean section (%)	27	37	49	60	<0.001
Post-partum haemorrhage (%)	0.0	1.2	5.2	11	<0.001
Foetal					
Apgar score <7 (%)	4.1	10	11	17	0.001
Preterm birth <37 weeks (%)	8.7	15	17	30	<0.001
Foetal death (%)	0.4	0.6	2.8	5.7	0.001
Neonatal death (%)	1.2	0.4	0.4	0.0	0.24
Birth weight (g)	3109	3074	2925	2735	<0.001
Pregnancy duration (weeks)	39	38	38	37	<0.001

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Contraceptive Counseling

- Consideration of pregnancy risk
- Available contraception, risks, benefits and failure rates
- Consequences of unplanned pregnancy
- Patient's preference

- ACC/AHA guidelines ' it is the duty of the cardiologist to provide advice regarding informed decision on contraception'

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Contraceptive choices

Most comprehensive guidance comes from British Working Group

WHO 1 – no restriction on use of combined contraceptives

WHO 2 – benefits outweigh risks of the use of combined

WHO 3 - risk of combined OC outweighs benefits

WHO 4 – highest risk group for combined OCP

IUD is probably safest in women with cyanotic CHD and pulmonary vascular disease

Risk of vagal reactions at time of implant

Aortic Disease

- Hormonal changes lead to histologic changes in aorta increasing the susceptibility to dissection
  - fragmentation of reticular fibers
  - diminished acid mucopolysaccharides
  - loss of normal corrugation of elastic fibers
  - Circulating elastase breaks up elastic lamellae and weakens media
  - Relaxin detectable in serum causes reduced collagen synthesis
- Hemodynamically uterine compression can increase outflow resistance of lower arterial tree
- Pregnancy high risk period for all patients with aortic pathology
- Dissection occurs most often in the last trimester or early postpartum

Guideline Recommendations for Marfans

- 2011 ESC – if ascending aorta over 45 mm, treat surgically pre pregnancy
- 2009 Canadian Guidelines recommend surgery before pregnancy if over 45 mm
- 2010 American Thoracic Aortic Guidelines recommend surgery if over 40 mm

Marfans and Aortic Growth during Pregnancy
Donnelly et al. JACC 2012

- 69 women with 199 pregnancies followed, 29 controls
- 86% live births
- Mean aortic root diameter was 36.1 mm +/- 4.4 mm
- 27% started with root over 40 mm
- Increased by 3 mm during pregnancy
- 2 carotid dissections
- One patient with root 49, rapid increase in AR
- No aortic dissections

Donnely et al. JACC 2012

Table 2 Long-Term Cardiovascular Outcomes

Variable	Pregnant (n = 69)	Nulliparous (n = 29)	p Value
Elective surgery	13.0% (9)	6.5% (2)	0.03
Adverse outcome	23.0% (16)	0% (0)	0.002

Values are % (n).

Donnelly et al. JACC 2012 – Marfans

Table 3 Factors Associated With Long-Term Adverse Cardiovascular Outcome in Women With a Prior Pregnancy

Variable	Odds Ratio	95% Confidence Interval
Aortic size	1.3	1.11–1.61
Number of pregnancies	1.5	1.15–1.97
Prospective care	0.1	0.05–0.39
Medications	0.3	0.14–0.92
Aorta >4 cm	3.8	1.11–13.3

Marfans and Pregnancy

Little data on roots over 45 mm – advised against pregnancy

Under 40 mm root lower risk

Bottom line: aorta will increase during pregnancy
will not return to normal
increase risk of long term adverse outcomes

low risk of dissection if less than 45 mm

BAV – 50% have dilatation of ascending aorta

Risks of pregnancy not been well studied

Consider surgery preconception if root over 50 mm

BAV and Marfans and aortic disease

- Echo every 4-12 weeks throughout pregnancy and 6 months post partum
- Beta blockers

- C section should be considered when aortic diameter over 45 mm in Marfans
- Vaginal delivery if less than 40 mm

- If prior dissection should be advised against pregnancy

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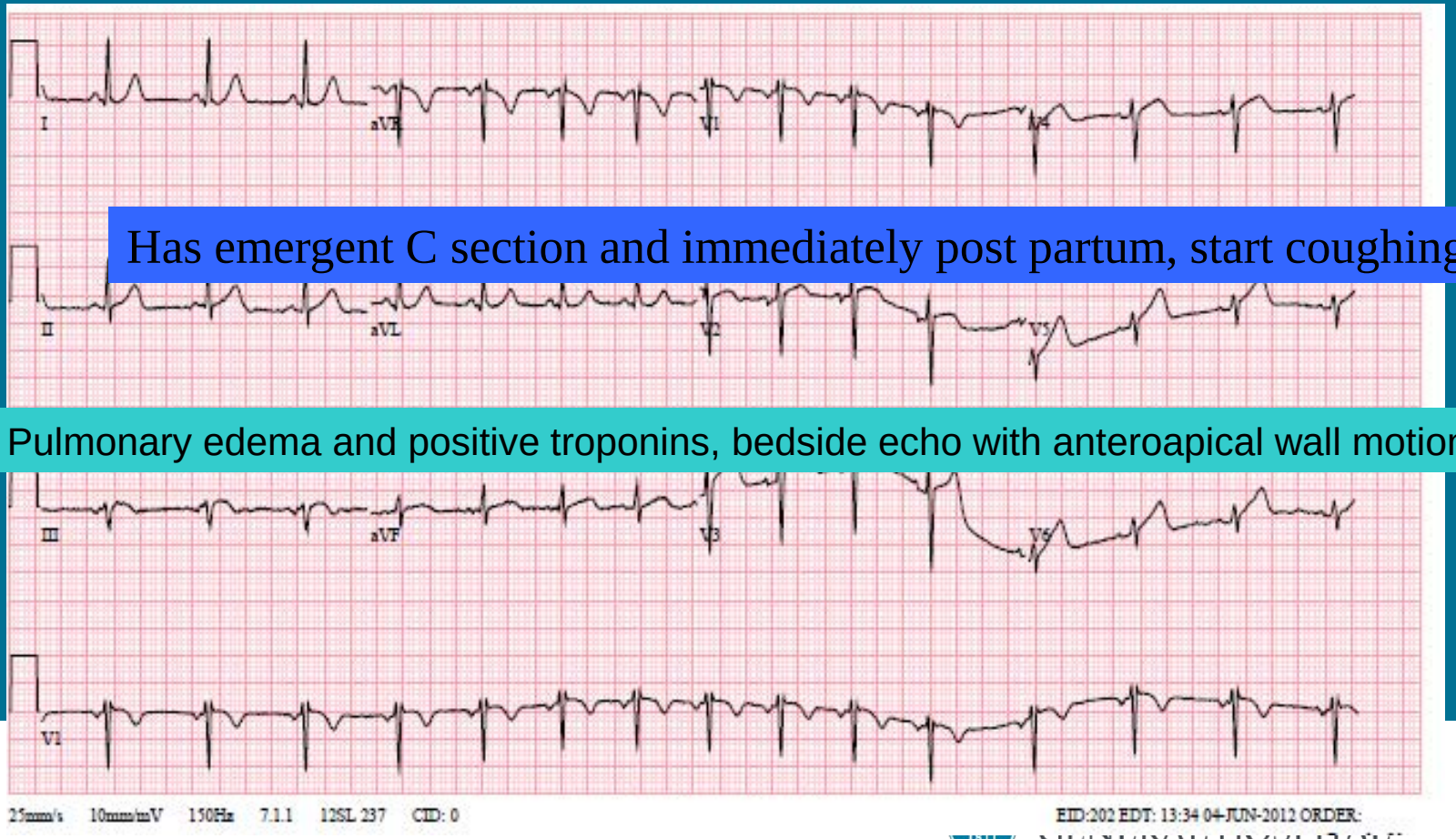
Call from OB:
35 year old, preterm labor 30 weeks



Has emergent C section and immediately post partum, start coughing

Pulmonary edema and positive troponins, bedside echo with anteroapical wall motion

Acute Myocardial Infarction Associated with Pregnancy – Roth et al. JACC 2008

Literature review of 95 cases between 1995-2005

Majority of patients were over 30

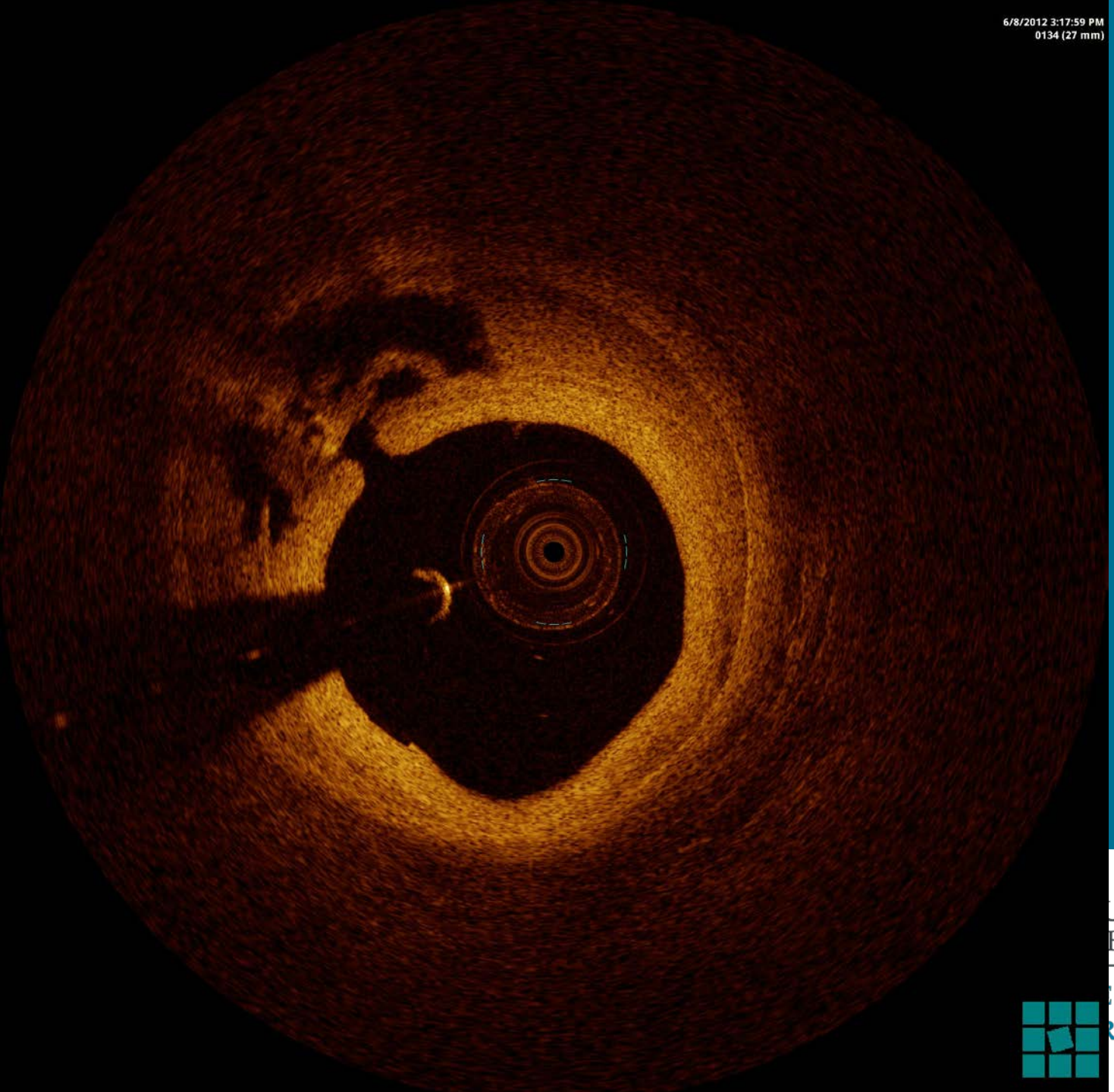
1 in 16, 129 deliveries nationwide

High incidence of known risk factors

11% maternal mortality rate

9% fetal death

40% stenosis, 8% thrombus, 27% dissection, 2% spasm, 13% normal



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Spontaneous Coronary Artery Dissection

Tweet et al. *Circulation.* 2012;126:579-588

- Retrospective cohort of 87 patients
- Mean age 42.6, 82% women
- 18% postpartum, mean age 33, mean 38 days postpartum
- Detect fibromuscular dysplasia in other territories
- Median follow-up 47 months, 17% recurrence
  all female
- 10 year mortality 7.7% and MACE 47%

CPR during pregnancy

- Relieve IVC compression – occurs around 20 weeks
- Deliver with 5 minutes – need to consider viability
- Anoxia occurs earlier due to reduced FRC

- Consider Magnesium toxicity

- Chest compressions, hand placement more cephalad

Troponins

- Troponin levels have also been studied during pregnancy and are generally felt to remain in the normal range, but may rise to the upper limit of normal
- They are higher in those with hypertensive disorders of pregnancy, particularly pre-eclampsia.

Brain Natriuretic Peptide

- Conflicting results but generally felt that:

  despite increase in volume load during pregnancy, values at upper limits of normal

- Higher than normal in preeclampsia

- Toronto Pregnancy and Heart Disease Research Program studied BNP in pregnant women with heart disease

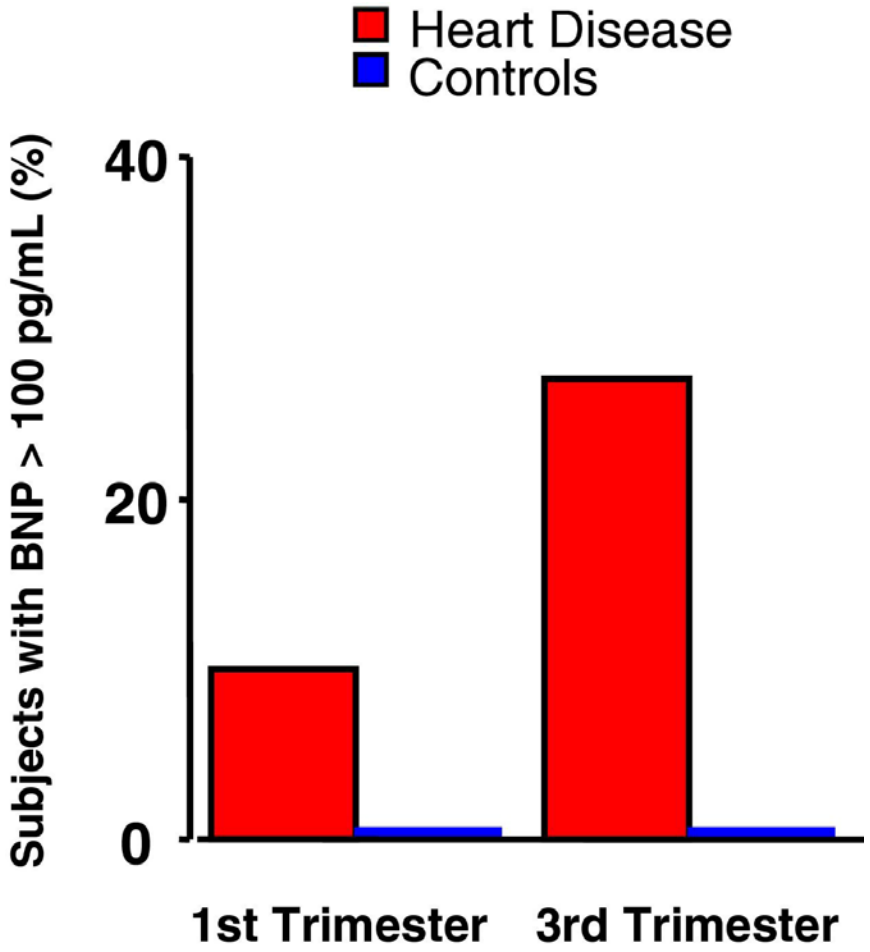
B-Type Natriuretic Peptide in Pregnant Women With Heart Disease

David Tanous, MBBS, PHD,* Samuel C. Siu, MD, SM,*† Jennifer Mason, RN,*
Matthias Greutmann, MD,* Rachel M. Wald, MD,* John D. Parker, MD,* Mathew Sermer, MD,*
Jack M. Colman, MD,* Candice K. Silversides, MD, SM*
Toronto and London, Ontario, Canada

- Prospectively enrolled 66 women with heart disease and 12 healthy controls
- BNP at 14 +/-5 weeks antenatal
- Repeat BNP third trimester and > 6 weeks postpartum

JACC 2010

B-Type Natriuretic Peptide in Pregnant Women With Heart Disease



Adverse maternal events in 13%
Peak BNP over 100 in all, predated Event in 88%

100% negative predictive value
100% sensitivity
70% specificity

In women with CARPREG 0
No events if BNP < 100
8% if BNP over 100

In women with CARPREG 1
No events if BNP < 100
60% if over 100

JACC Volume 56, Issue 15 2010 1247 - 1253

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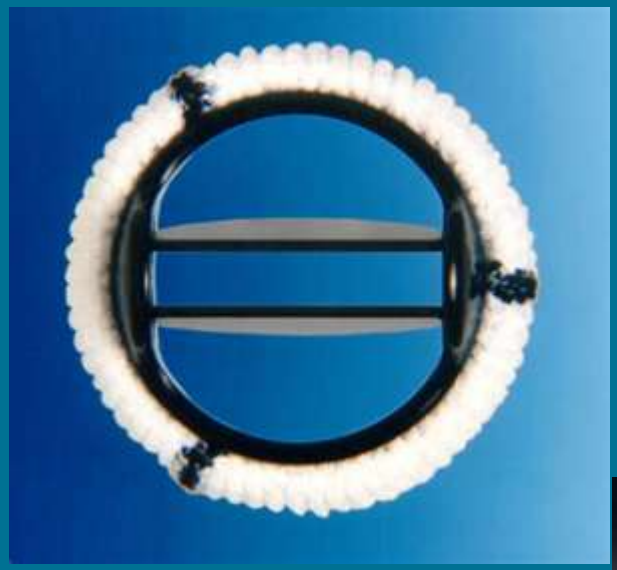
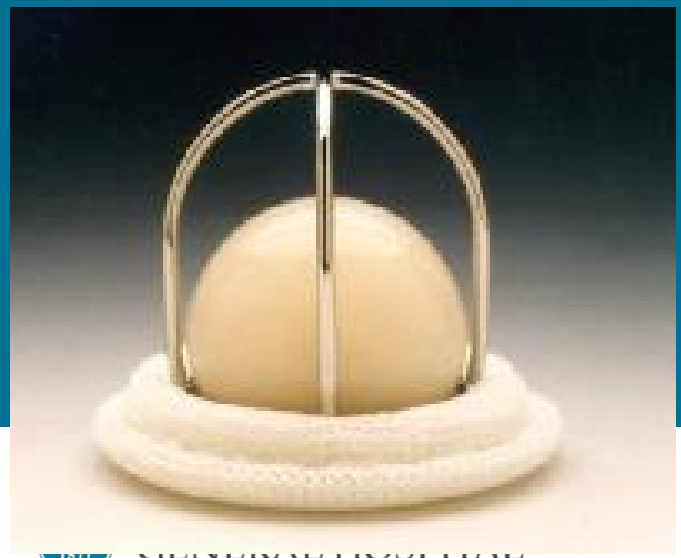
Prosthetic Valves





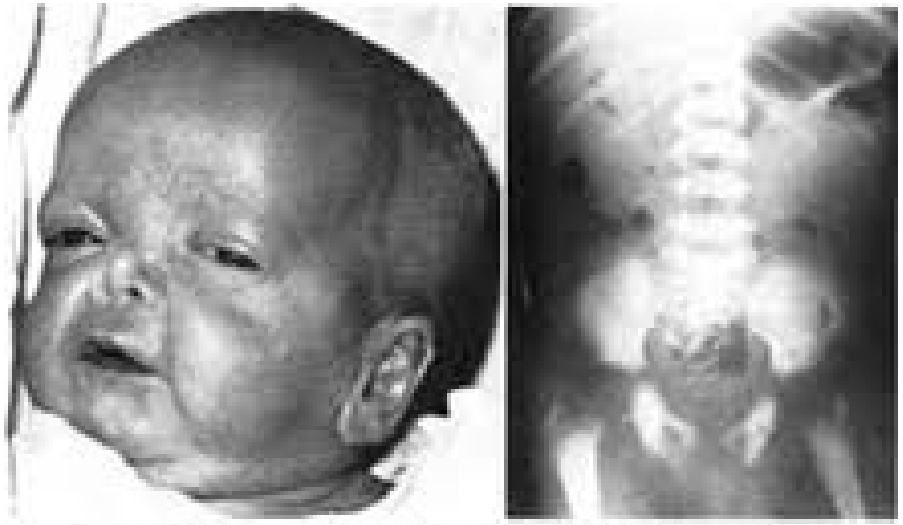
Valve Selection Pre Conception

- Bioprosthetic: risk of structural valve deterioration may be accelerated by pregnancy
- Mortality for redo higher
- Newer bioprosthetic valves are lower profile with improved hemodynamics
- Very little information available
- Mechanical: need for lifelong anticoagulation

Warfarin Embryopathy

- Flattened nasal bridge
- Bone deformities
- CNS abnormalities
- Bleeding
- Spontaneous abortion

- Low IQ
- Optic atrophy



: infant with hypoplastic nose, flat face and low nasal bridge as well as altered calcific ation (Sm ith 1982).

Anticoagulation During Pregnancy for Mechanical Valves

- Increased risk of thrombosis due to hypercoagulable state of pregnancy

- Unfractionated heparin and LMWH do not cross placenta

- In a large review, the risk of valve thrombosis was
  - 3.9% with warfarin throughout pregnancy
  - 9.2% with UFH in first trimester then warfarin
  - 33% with UFH throughout pregnancy

Anticoagulation during pregnancy for mechanical valves

- Safest option for valve is warfarin throughout pregnancy

- Lower risk of warfarin embryopathy if dose less than 5 mg

Anticoagulation options for mechanical valves Chest 9th edition antithrombotic guidelines

One of the following recommended:

- BID LMWH throughout pregnancy (max peak anti Xa levels)
- BID UFH throughout pregnancy, PTT > 2 X normal
- UFH/LMWH until 13th week, then warfarin, resume UFH/LMWH close to delivery

High risk for thrombosis: warfarin throughout, replacement with UFH/LMWH close to delivery

MGH Obstetricians DO NOT use warfarin during pregnancy

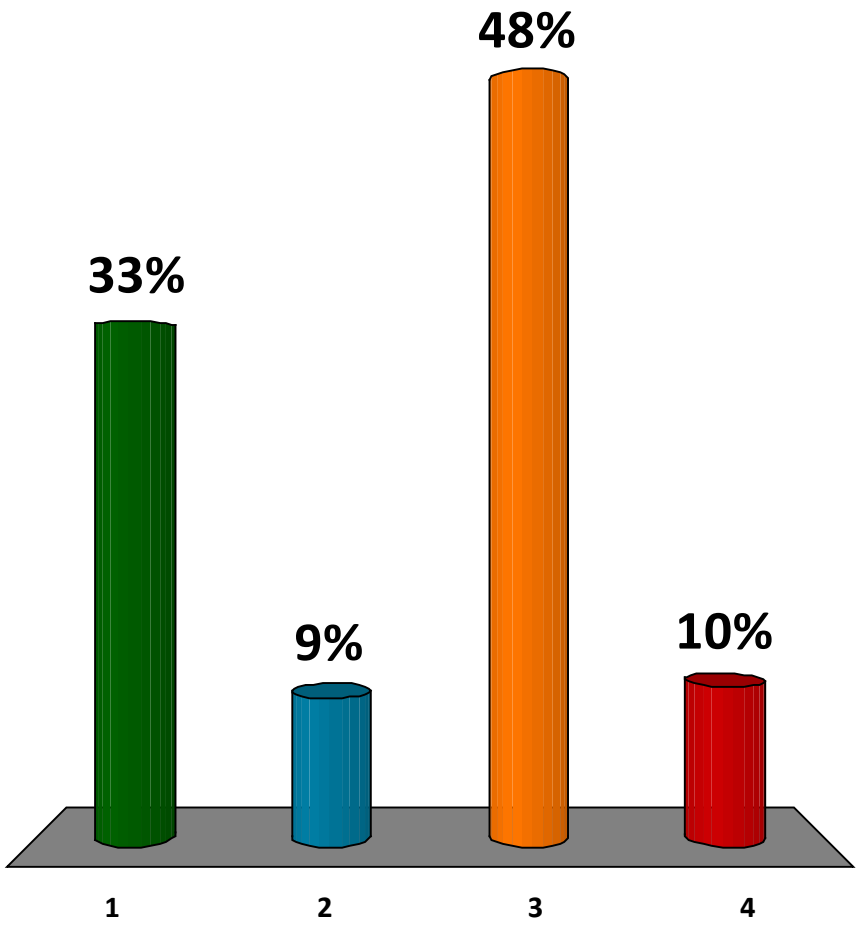
Case

- 35 year old, G1P0 presents 38 weeks pregnant with shortness of breath, edema and orthopnea
- Physical exam supports congestive heart failure

- Echo demonstrates: reduced LV EF at 32%

Please choose the best answer:

1. She should be started on beta blockade, ace inhibitor, lasix and referred for immediate C section
2. She should be diuresed with furosemide, then discharged home to await spontaneous labor
3. She should be diuresed with furosemide, labor should be induced with plans for vaginal delivery if remains stable
4. She should receive an IABP to support blood hemodynamics for C section



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Peripartum Cardiomyopathy

- Idiopathic cardiomyopathy presenting with heart failure secondary to left ventricular systolic dysfunction towards the end of pregnancy or months following
- Diagnosis of exclusion

- 1:3000-4000 pregnancies
- 1:300 Haiti
- In US 1:2229, higher in African-Americans
  lowest in Hispanics (1:9861)

- Incidence rising in US

Peripartum Cardiomyopathy

- Predisposing factors: multiparity, multiple childbirths, family history, ethnicity, smoking, diabetes, hypertension, preeclampsia, malnutrition, advanced age, teenage pregnancy

- Suspected to be the consequence of oxidative stress leading to proteolytic cleavage of prolactin which causes apoptosis

Peripartum Cardiomyopathy

- Heart failure can develop rapidly
- Prognosis better than dilated cardiomyopathy
- Significant proportion normalizing/improving LV EF over 6 months
- 50 % spontaneous recovery- lower in African Americans
- Predictors of recovery: LV EDD less than 50 mm
  LV EF over 30%
  low BNP, troponin

  diagnosis after delivery

Peripartum Cardiomyopathy – Management

- If mother unstable – urgent delivery
- Anticoagulation for low LV EF
- Usual medical therapy for CHF except: avoid ACE/ARB during pregnancy, ACE OK if breastfeeding
- Diuretics judiciously

- Plan vaginal delivery
- Consider NO breastfeeding

- Await 6 months if possible to decide on ICD/transplant

Peripartum Cardiomyopathy – Novel therapies

- Immune globulin – 6 patient study
- Pentoxifylline – prevents apoptosis – 30 patient study, LV EF 52% vs. 27%, no other studies, safety unknown during pregnancy
- Bromocriptine – prolactin blocker – 20 patient study – LV EF 31% vs. 9%, lower mortality in treatment group

  Bromocriptine also suppresses milk reduction and risk of acute MI

Peripartum Cardiomyopathy – subsequent pregnancies

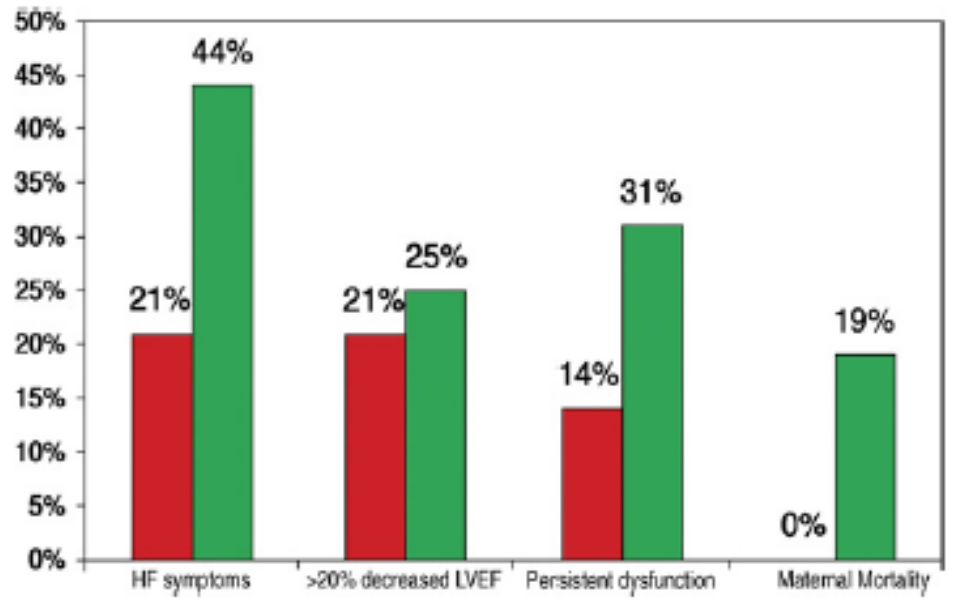

Figure 6 **Incidence of Maternal Complications Associated With Subsequent Pregnancy in Women With PPCM**

Red bars represent women with recovered left ventricular (LV) function before subsequent pregnancy; **green bars** represent women with persistent LV dysfunction. HF = heart failure; LVEF = left ventricular ejection fraction. Data derived from Elkayam et al. (76).

Stress echo preconception to evaluate contractile reserve

Elkayam et al. JACC 2011

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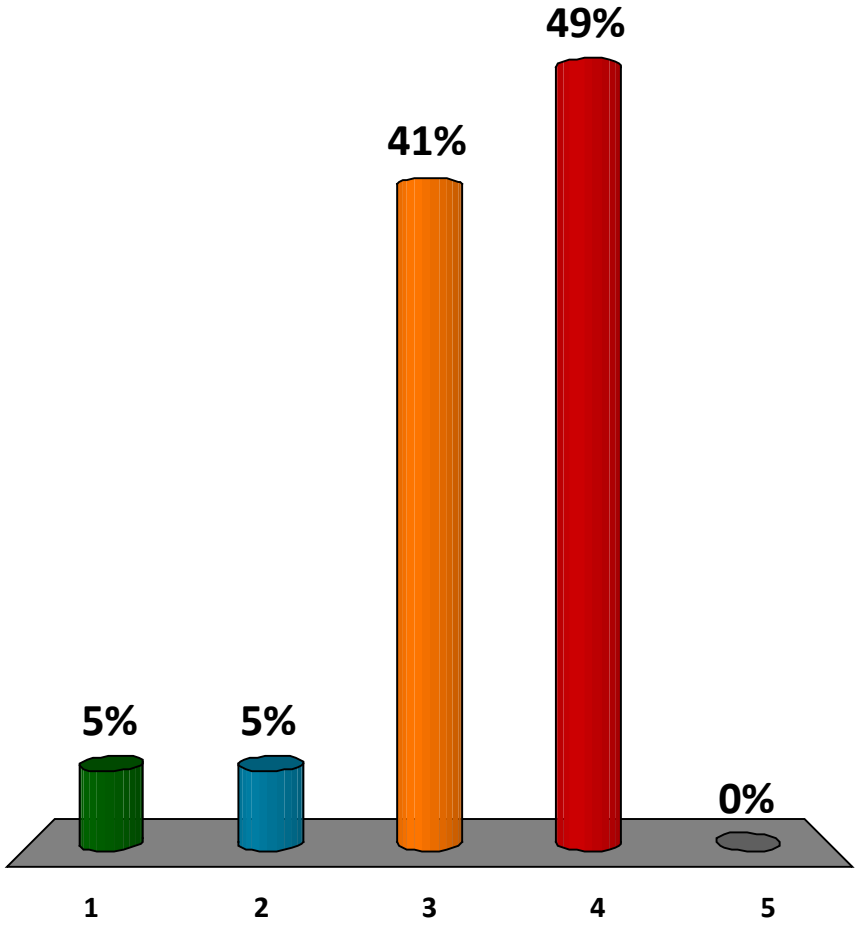
Which of the following conditions increases a woman's risk of cardiovascular disease

1. in vitro fertilization
2. prolonged labor
3. multiple gestation pregnancy
4. preeclampsia
5. cervical incompetence



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Maternal Placental Syndromes

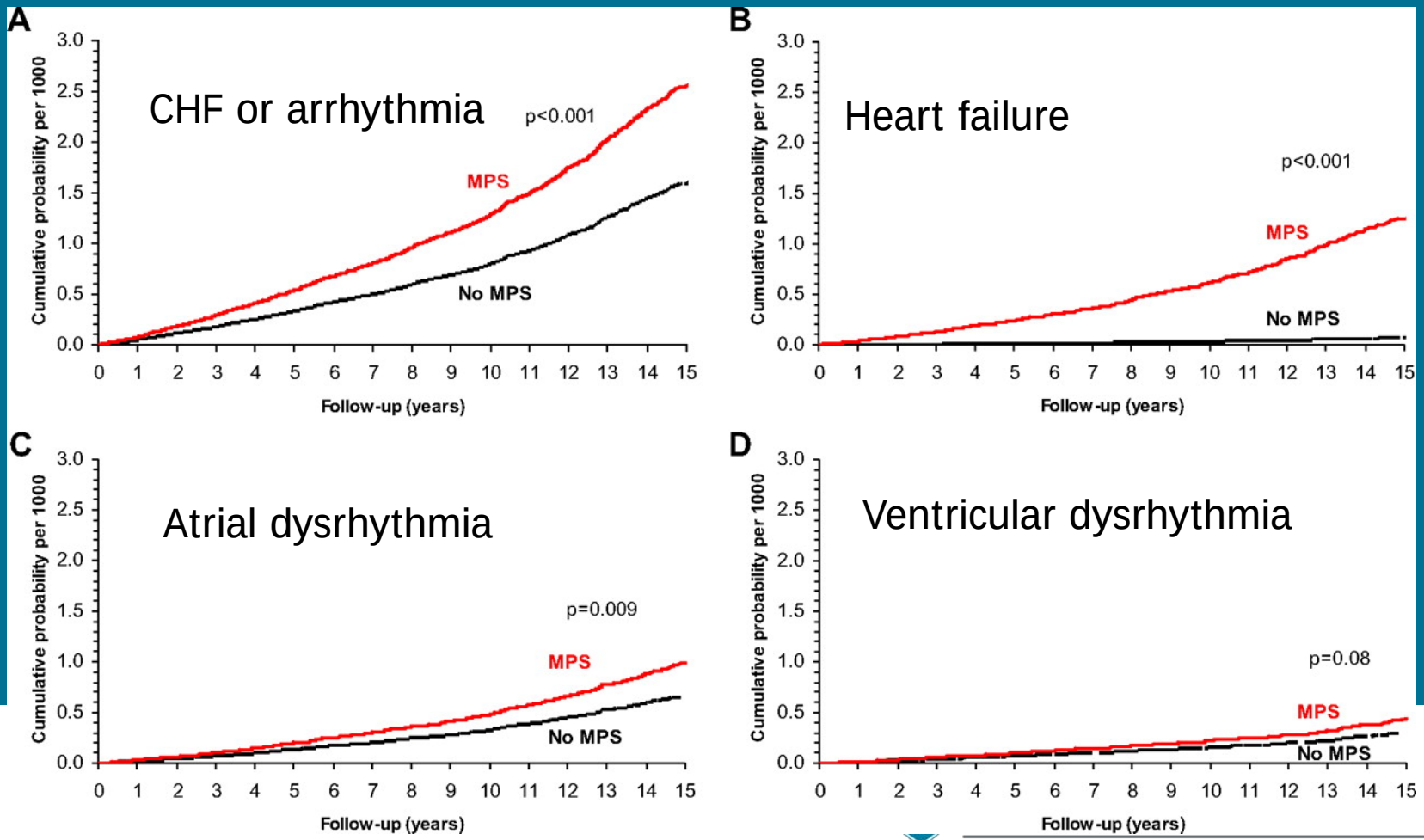
- Hypertensive disorders of pregnancy
- Placental abruption and infarction

- Doubles the risk of cardiovascular disease over lifetime - first described in 1927

- If preterm and severe preeclampsia – risk is highest

HAD MPS Study – Ray et al. Heart 2012

- Retrospective cohort in 1 130 764 women in Ontario
  - » 6.7% had MPS (75 242)
  - » 42% gestational hypertension
  - » 35% preeclampsia
  - » 15% placental abruption
  - » 12% placental infarction
  - » 3.6% combination of above
- Median duration of follow-up 7.8 years
- 61% relative increase in risk of CHF/arrhythmias



Ray J G et al. Heart 2012;98:1136-1141

AHA Guideline

Effectiveness-Based Guidelines for the Prevention of Cardiovascular Disease in Women—2011 Update

A Guideline From the American Heart Association

- Women with gestational diabetes, preeclampsia or pregnancy induced hypertension puts a woman ‘at risk’ for CVD
- Perhaps unmask early or pre-existing endothelial dysfunction
- Failed Stress test of Pregnancy

Circulation 2011

Arrhythmias

- Most palpitations in pregnancy are benign
- Premature beats and sustained tachyarrhythmia become more frequent or manifest for first time in pregnancy
- Studies on use of antiarrhythmics during pregnancy are limited
- Individualized decision re: risk of continuing antiarrhythmics vs. stopping
- Postpone ablation to second trimester as high radiation
- Presence of ICD does not contraindicate future pregnancy

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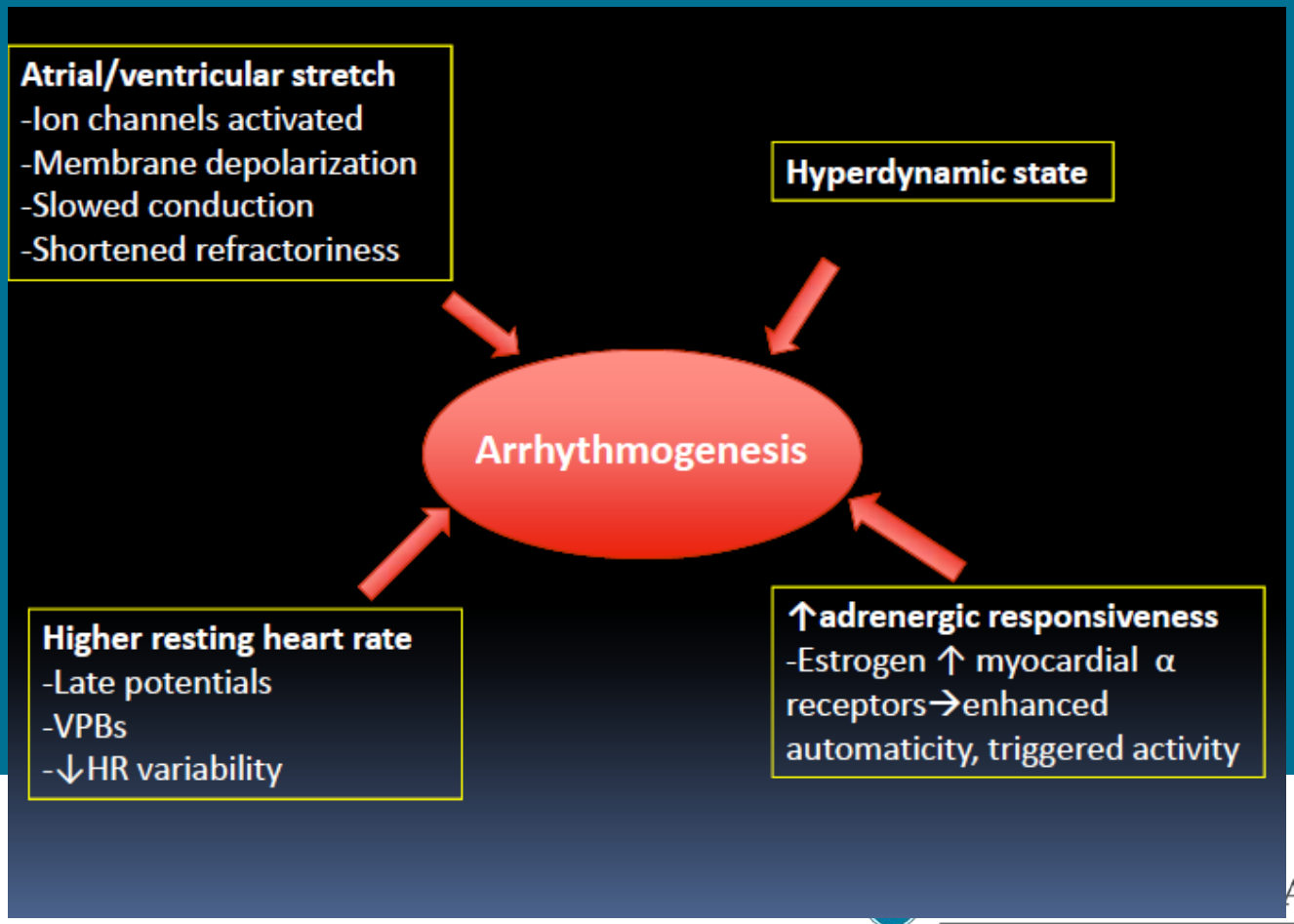
Arrhythmias during Pregnancy



Slide borrowed from L. Feinberg MD

Pregnancy Drug Class

- Category A: controlled studies in women show no risk, possibility of fetal harm remote
- Category B : animal studies have shown no risk, no controlled studies in women
- Category C: animal studies have shown adverse effects, no studies in women, or no studies in animals/women
- Category D: evidence of human fetal risk, but risk may be acceptable for some
- Category X : contra-indicated

Cardiac Medications during Pregnancy

Drugs	Classification (Vaughan Williams for AA drugs)	FDA category	Placenta permeable	Transfer to breast milk (fetal dose)	Adverse effects
Abciximab	Monoclonal antibody with antithrombotic effects	C	Unknown	Unknown	Inadequate human studies; should be given only if the potential benefit outweighs the potential risk to the fetus.
Acenocoumarol[a]	Vitamin K antagonist	D	Yes	Yes (no adverse effects reported)	Embryopathy (mainly first trimester), bleeding (see further discussion in Section 5 for use during pregnancy).
Acetylsalicylic acid (low dose)	Antiplatelet drug	B	Yes	Well-tolerated	No teratogenic effects known (large datasets).
Adenosine[b]	Antiarrhythmic	C	No	No	No fetal adverse effects reported (limited human data).
Aliskiren	Renin inhibitor	B	Unknown	Unknown	Unknown (limited experience).
Amiodarone	Antiarrhythmic (Class III)	D	Yes	Yes	Thyroid insufficiency (9%), hyperthyroidism goitre, bradycardia, growth retardation, premature birth.
Ampicillin, amoxicillin, cephalosporins, erythromycin, mezlocillin, penicillin	Antibiotics	B	Yes	Yes	No fetal adverse effects reported.

Drugs	Classification (Vaughan Williams for AA drugs)	FDA category	Placenta permeable	Transfer to breast milk (fetal dose)	Adverse effects
Imipenem, rifampicin, teicoplanin, vancomycin	Antibiotics	C	Unknown	Unknown	Risk cannot be excluded (limited human data).
Aminoglycosides, quinolones tetracyclines	Antibiotics	D	Unknown	Unknown	Risk to the fetus exists (reserved for vital indications).
Atenolol[c]	β-blocker (class II)	D	Yes	Yes	Hypospadias (first trimester); birth defects, low birth weight, bradycardia and hypoglycaemia in fetus (second and third trimester).
Benazepril[d]	ACE inhibitor	D	Yes	Yes[e] (maximum 1.6%)	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Bisoprolol	β-blocker (class II)	C	Yes	Yes	Bradycardia and hypoglycaemia in fetus.
Candesartan	Angiotensin II receptor blocker	D	Unknown	Unknown; not recommended	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Captopril[d]	ACE inhibitor	D	Yes	Yes[e] (maximum 1.6%)	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Clopidogrel	Antiplatelet drug	C	Unknown	Unknown	No information during pregnancy available.
Colestipol, cholestyramine	Lipid-lowering drugs	C	Unknown	Yes- lowering fat-soluble vitamins	May impair absorption of fat-soluble vitamins, e.g. vitamin K –> cerebral bleeding (neonatal).
Danaparoid	Anticoagulant	B	No	No	No side effects (limited human data).
Digoxin[f]	Cardiac glycoside	C	Yes	Yes[e]	Serum levels unreliable, safe.
Diltiazem	Calcium channel blocker (class IV)	C	No	Yes[e]	Possible teratogenic effects.
Disopyramide	Antiarrhythmic (class IA)	C	Yes	Yes[e]	Uterus contraction.
Enalapril[d]	ACE inhibitor	D	Yes	Yes[e] (maximum 1.6%)	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Eplerenone	Aldosterone antagonist	-	Unknown	Unknown	Unknown (limited experience).
Fenofibrate	Lipid-lowering drug	C	Yes	Yes	No adequate human data.
Flecainide	Antiarrhythmic (class IC)	C	Yes	Yes[e]	Unknown (limited experience).
Fondaparinux	Anticoagulant	-	Yes (maximum 10%)	No	New drug, (limited experience).
Furosemide	Diuretic	C	Yes	Well tolerated; milk production can be reduced	Oligohydramnion.
Gemfibrozil	Lipid-lowering drug	C	Yes	Unknown	No adequate human data.
Glyceryl trinitrate	Nitrate	B	Unknown	Unknown	Bradycardia, tocolytic.
Heparin (low molecular weight)	Anticoagulant	B	No	No	Long-term application: seldom osteoporosis and markedly less thrombocytopenia than UF heparin.

Heparin (unfractionated)	Anticoagulant	B	No	No	Long-term application: osteoporosis and thrombocytopenia.
Hydralazine	Vasodilator	C	Yes	Yes[e] (maximum 1%)	Maternal side effect: lupus-like symptoms; fetal tachyarrhythmias (maternal use).
Hydrochlorothiazide	Diuretic	B	Yes	Yes; milk production can be reduced	Oligohydramnion.
Irbesartan[d]	Angiotensin II receptor blocker	D	Unknown	Unknown	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Isosorbide dinitrate	Nitrate	B	Unknown	Unknown	Bradycardia.
Isradipine	Calcium channel blocker	C	Yes	Unknown	Potential synergism with magnesium sulfate may induce hypotension.
Labetalol	α-/ β-blocker	C	Yes	Yes[e]	Intrauterine growth retardation (second and third trimester), neonatal bradycardia and hypotension (used near term).
Lidocaine	Antiarrhythmic (class IB)	C	Yes	Yes[e]	Fetal bradycardia, acidosis, central nervous system toxicity.
Methyldopa	Central α-agonist	B	Yes	Yes[e]	Mild neonatal hypotension.
Metoprolol	β-blocker (class II)	C	Yes	Yes[e]	Bradycardia and hypoglycaemia in fetus.
Mexiletine	Antiarrhythmic (class IB)	C	Yes	Yes[e]	Fetal bradycardia.
Nifedipine	Calcium channel blocker	C	Yes	Yes[e] (maximum 1.8%)	Tocolytic; s.l. application and potential synergism with magnesium sulfate may induce hypotension (mother) and fetal hypoxia.
Phenprocoumon[a]	Vitamin K antagonist	D	Yes	Yes (maximum 10%), well tolerated as inactive metabolite	Coumarin-embryopathy, bleeding (see further discussion in Section 5 for use during pregnancy).
Procainamide	Antiarrhythmic (class IA)	C	Yes	Yes	Unknown (limited experience).
Propafenone	Antiarrhythmic (class IC)	C	Yes	Unknown	Unknown (limited experience).
Propranolol	β-blocker (class II)	C	Yes	Yes[e]	Bradycardia and hypoglycaemia in fetus.
Quinidine	Antiarrhythmic (class IA)	C	Yes	Yes[e]	Thrombopenia, premature birth, VIII th nerve toxicity.
Ramipril[d]	ACE inhibitor	D	Yes	Yes (maximum 1.6%)	Renal or tubular dysplasia, oligohydramnion, growth retardation, ossification disorders of skull, lung hypoplasia, contractures, large joints, anaemia, intrauterine fetal death.
Sotalol	Antiarrhythmic (class III)	B	Yes	Yes[e]	Bradycardia and hypoglycaemia in fetus (limited experience).
Spironolactone	Aldosterone antagonist	D	Yes	Yes[e] (maximum 1.2%); milk production can be reduced	Antiandrogenic effects, oral clefts (first trimester).
Statins[g]	Lipid-lowering drugs	X	Yes	Unknown	Congenital anomalies.
Ticlopidine	Antiplatelet	C	Unknown	Unknown	Unknown (limited experience).

What happened to our patients?

- 42 year old s/p VF arrest with ostial LAD occlusion treated with Xience to LAD - July 2011

  Xience to RCA September 2011

- 32 year old with multivalvular rheumatic heart disease

- 35 year old with peripartum cardiomyopathy

Conclusions

- Rising incidence of heart disease during pregnancy
- Counseling and management of patients with heart disease should begin before conception
- All diseases are not created equal so evaluation of maternal risk is key
- Limited data on most conditions
- Moderate or high risk patients require close collaboration between OB, anesthesia and cardiology