Ultrasound in Obstetrics: Prenatal Imaging & Fetal Heart Screening

Saturday, June 7, 2014
8 a.m. – 4 p.m.

Memorial Hermann–Texas Medical Center
Hermann Conference Center

This event is approved for 6 AMA PRA Category 1 Credits™.

For more information or to register, visit texasfetalcenter.org/UltrasoundCME
The Ultrasound in Obstetrics: Prenatal Imaging & Fetal Heart Screening event is sponsored by the Texas Fetal Center at Children’s Memorial Hermann Hospital and the division of Maternal-Fetal Medicine at UTHealth Medical School.

Advances in ultrasound have transformed the field of obstetrics through improved imaging capabilities, providing physicians with the ability to provide early diagnosis for high-risk pregnancy conditions and fetal anomalies.

OBJECTIVES
At the completion of this course, maternal-fetal medicine specialists and sonographers should be able to:

• Utilize new strategies in the first trimester evaluation to identify pregnancies that require additional surveillance for fetal anomalies commonly affecting multiple births.

• Examine the American Institute of Ultrasound in Medicine’s (AIUM) “as low as reasonably achievable” (ALARA) principle and identify the importance of appropriate probe selection and image processing options that exist in order to achieve the ALARA goal while optimizing ultrasound imaging quality.

• Explain how to use tools such as Doppler and color flow to enhance understanding of fetal heart physiology and compliment the standard structural evaluation of the fetal heart.

• Explain the new recommendations for cervical length screening for risk of preterm labor and identify which patients should be referred to a specialist for cervical length screening.

• Identify the importance of prenatal detection of major congenital heart defects (mCHD) to decrease perinatal morbidity and mortality rates, improve screening modalities for the early detection of mCHD and explain the importance of a timely referral to a specialist for a fetal echocardiogram.

CONTINUING EDUCATION
This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Texas Medical Association (TMA) through the joint sponsorship of Memorial Hermann Health System and UTHealth Medical School. Memorial Hermann Health System is accredited by TMA to provide continuing medical education for physicians.

Memorial Hermann Health System designates this live activity for a maximum of 6 AMA PRA Category 1 Credits™. Participants should only claim credit commensurate with the extent of their participation in the activity.
AGENDA

Saturday, June 7, 2014

7:15 - 8 a.m.  Check in and Continental Breakfast

8 - 8:15 a.m.  Welcome and Introductions
                Michael Bebbington, M.D., M.H.Sc.

8:15 - 9 a.m.  Fetal Evaluation in the First Trimester: Where are we going?
                Blair Stevens, M.S., CGC

9 - 9:45 a.m.  Improving your Ultrasound Image While Maintaining the ALARA Principle
                Erin Canon, B.S., RDMS, and
                Genevieve Campbell, B.S., RDMS

9:45 - 10:30 a.m.  The Functional Evaluation of the Fetal Heart
                    Gurur Biliciler-Denktas, M.D.

10:30 - 11 a.m.  Coffee Break

11 - 11:45 a.m.  What About the Cervix? Screening for Preterm Delivery
                    Michael Bebbington, M.D., M.H.Sc.

11:45 a.m. - 12:30 p.m.  Fetal Cardiac Screening
                            Helena Gardiner, M.D., Ph.D.

12:30 - 1:15 p.m.  Lunch

1:15 - 1:45 p.m.  Break; Walk over to Texas Fetal Center (UTP, Suite 210) for workshop

1:45 - 3:45 p.m.  Cardiac Screening Hands-on Workshop
                    • Breakout Session A: Presentation of Common Fetal Heart Anomalies
                    • Breakout Session B: Morphology of the Fetal Heart

3:45 - 4 p.m.  Conclusion
SPEAKERS

Michael Bebbington, M.D., M.H.Sc.  
*Course Director*
Director, Prenatal Diagnosis and Fetal Imaging, Texas Fetal Center  
Professor, Division of Maternal-Fetal Medicine, UTHealth Medical School

Helena Gardiner, M.D., Ph.D.  
*Course Director*
Co-Director, Fetal Cardiology Program, Texas Fetal Center  
Professor, Department of Obstetrics, Gynecology and Reproductive Sciences, and Division of Pediatric Cardiology, UTHealth Medical School

Gurur Biliciler-Denktas, M.D.  
Co-Director, Fetal Cardiology Program, Texas Fetal Center  
Assistant Professor, Division of Pediatric Cardiology, UTHealth Medical School

Genevieve Campbell, B.S., RDMS  
Perinatal Sonographer, Texas Fetal Center

Erin Canon, B.S., RDMS  
Perinatal Sonographer, Texas Fetal Center

Blair Stevens, M.S., CGC  
Prenatal Genetic Counselor, Texas Fetal Center  
Assistant Professor, Department of Obstetrics, Gynecology and Reproductive Sciences, UTHealth Medical School
Fetal Evaluation in the First Trimester: Where are we going?
Blair Stevens, M.S., C.G.C
Fetal Evaluation in the First Trimester: Where are we going?

Blair Stevens, CGC
Assistant Professor, Department of Obstetrics, Gynecology and Reproductive Sciences
Prenatal Genetic Counselor

Disclosures

I do not have relevant financial relationships with commercial interests related to the content of this presentation.

Objectives

1. Utilize new strategies in the first trimester evaluation to identify pregnancies that require additional surveillance for fetal anomalies commonly affecting multiple births;

2. List available options for first trimester screening for aneuploidy along with their benefits and incorporate first trimester determination of chorionicity and twin designation into the evaluation of multiple gestations.
Outline

- Prenatal Screening/Testing Options
  - Screening tests for aneuploidy
    - Age
    - Ultrasound
    - Maternal serum screening
    - Non-invasive prenatal testing (NIPT)
  - Diagnostic testing
    - Invasive procedures
    - Karyotype vs. CMA

Pretest Counseling

- Imperative to patient autonomy and informed decision making
  - How much information is desired during pregnancy?
    - What would patient do with information?
    - What type of test is most appropriate for patient?
  - Pretest counseling can be time consuming and requires up to date knowledge of testing options
    - Genetic Counseling
Advanced Maternal Age

- AMA = 35 years or older at the time of delivery (singleton)

The majority of Down syndrome births are to women younger than 35.
Maternal Serum Screening

First Trimester Screen

- Combination of biochemistry and nuchal translucency
- 78-91% detection rate for DS depending on study
  - 5% false positive rate
- 91-96% detection rate for Trisomy 18
  - 0.3% false positive rate
- Performed between 11w0d-13w6d

<table>
<thead>
<tr>
<th></th>
<th>PAPP-A</th>
<th>Free β-hCG</th>
<th>NT</th>
<th>Risks</th>
<th>Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Down syndrome</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>&gt; 1 in 300</td>
<td>78-91%</td>
</tr>
<tr>
<td>Trisomy 18</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>&gt; 1 in 100 (or 1 in 150)</td>
<td>91-96%</td>
</tr>
<tr>
<td>Trisomy 13</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>&gt; 1 in 100</td>
<td>91-96%</td>
</tr>
</tbody>
</table>
1st and 2nd Trimester Combined

- Integrated Screening
  - Serum
  - Total/Full
- Stepwise Sequential
- Contingent

Maternal Serum Screening: Twin Gestations

- First Trimester Screen
  - DS: 70-80% detection rate, 5-7% false positive rate depending on lab
  - Tri 18: 80% detection rate, 1% false positive rate or not reported depending on lab
- Quad Screen
  - DS: 50% detection rate, 5% false positive rate
  - Tri 18: Insufficient
  - NTD: 58%

Maternal serum screening cannot be performed in higher order multiples

Maternal Serum Screening

- Pitfalls
  - Higher FPR in AMA women
  - Limited gestational age window (11-14w)
  - High detection rates, but poor positive predictive value
  - Cannot evaluate for trisomy 13* or sex chromosome aneuploidy
Non-Invasive Prenatal Testing (NIPT)

Circulating Cell-Free Fetal DNA (ccff DNA)
- Source of ccff DNA
  - Appear to be largely from the placenta
  - Possibly through the breakdown of fetal cells in circulation
- Percentage in circulation
  - ~3-6% of circulating DNA in maternal plasma is fetal in origin
  - >10% in recent studies
  - Heavy women have lower average fetal fraction (Palomaki et al.)
  - Fetal fraction may increase with gestational age

Methodology
Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Laboratory (Test Name)</th>
<th>Technology</th>
<th>Conditions Tested For</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequenom (MaterniT21+)</td>
<td>NIPS</td>
<td>Trisomy 21, Trisomy 18, Trisomy 13, Y Chromosome</td>
<td>T21 = 99.1%</td>
<td>T21 = 99.9%</td>
<td>Positive/Negative Failure</td>
</tr>
<tr>
<td>Verinata (Verify)</td>
<td>NIPS</td>
<td>Trisomy 21, Trisomy 18, Trisomy 13, Monosomy X</td>
<td>T21 = 99.9%</td>
<td>T21 = 99.9%</td>
<td>Positive/Negative Failure</td>
</tr>
<tr>
<td>Ariosa (Harmony)</td>
<td>SNP based</td>
<td>Trisomy 21, Trisomy 18, Trisomy 13, Monosomy X, Triploidy</td>
<td>T21 = 100%</td>
<td>T21 = 99%</td>
<td>Risk Ratio via algorithm 1/10,000–99/100</td>
</tr>
<tr>
<td>Natera (Panorama)</td>
<td>SNP based</td>
<td>Trisomy 21, Trisomy 18, Trisomy 13, Monosomy X, Triploidy</td>
<td>T21 = 100%</td>
<td>T21 = 99%</td>
<td>Risk Ratio via algorithm 1/10,000–99/100</td>
</tr>
</tbody>
</table>

Reporting

- Positive/Negative
- Risk Score
Results Interpretation

- Positive/Increased Risk
  - Very concerning, but NOT diagnostic
  - Requires diagnostic testing for confirmation

- Negative/Decreased Risk
  - Very reassuring, but NOT ruled out
  - Only evaluated for certain conditions

NIPT Pitfalls

- Still a screening test
- Evaluates placental chromosomes
- Only evaluates for common aneuploidies
- Valid in average risk populations?
- Valid in multiple gestations?

NIPT: Twin Pregnancies

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Size</th>
<th>Aneuploid Pregnancies</th>
<th>False Negatives</th>
<th>False Positives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrospective</td>
<td>207</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Prospective</td>
<td>68</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>n=25</td>
<td>4 aneuploid pregnancies (7 twins, 1 triplet)</td>
<td>0 false negatives</td>
<td>0 false positives</td>
<td></td>
</tr>
<tr>
<td>n=115</td>
<td>4 aneuploid pregnancies</td>
<td>0 false negatives</td>
<td>0 false positives</td>
<td></td>
</tr>
</tbody>
</table>
NIPT: Twin Pregnancies

• Limitations
  – Less data available
  – Which twin is affected?
  – Lower fetal fraction? Higher failure rate?

NIPT: Low Risk Populations

- Cohort study of 2049 women
- Overall trisomy DR was 100% (10 of 10 cases)
- 8 T21 and 2 T18 pregnancies correctly identified
- A combined FPR of 0.1%
  - 2 euploid pregnancies screened positive for T18
  - 1 T18 pregnancy did not get result due to failed assay

NIPT: Low Risk Populations

Positive Predictive Value
ABSTRACT: Noninvasive prenatal testing that uses cell free fetal DNA from the plasma of pregnant women offers tremendous potential as a screening tool for fetal aneuploidy. Cell free fetal DNA testing should be an informed patient choice after pretest counseling and should not be part of routine prenatal laboratory assessment. Cell free fetal DNA testing should not be offered to low-risk women or women with multiple gestations because it has not been sufficiently evaluated in these groups. A negative cell free fetal DNA test result does not ensure an unaffected pregnancy. A patient with a positive test result should be referred for genetic counseling and should be offered invasive prenatal diagnosis for confirmation of test results.

UT MFM Practice

• Who are we offering this to?
  – All patients with singleton or twin pregnancies who are at an increased risk for T21, T13 or T18 and are seen by a genetic counselor (AMA, screen positive for T21, T18, or T13, family history of Down syndrome*, abnormal ultrasound)

• When are we offering this?
  – After 10 weeks gestation

• Patients are counseled that confirmatory testing via CVS or amniocentesis is recommended, if positive

• Results take 1-2 weeks

Future of NIPT

• Validation in low risk populations

• Ability to screen for additional conditions
  – Microdeletion and microduplication screening already offered
  – Whole genome sequencing: “Within the next 10 years, the complete fetal genome will be successfully sequenced from maternal plasma”

  Lo (Prenat Diagn 2010;30:702-3)
Invasive Testing

Chorionic Villus Sampling

- Performed after 10 weeks
  - Preferably 11-13⁵⁄₇ weeks to obtain sufficient sample
- Ultrasound to locate placenta
  - Transcervical (TC) or Transabdominal (TA)
  - 5-40 grams of chorionic villi
- Full bladder preferred
- 24 hours of restricted activity following procedure
Chorionic Villus Sampling

Accuracy
- US Collaborative Study (1992)
  - 11,473 CVS samples
  - 99.7% successful cytogenetic diagnosis
  - 0.8% Mosaicism
  - >75% normal on follow-up
  - Confined placental mosaicism
  - UPD concern

CVS: Safety

In experienced individuals and centers, CVS procedure-related loss rates may be the same as those for amniocentesis.
Testing Options

- Aneuploidy FISH
  - Chromosomes: 21, 18, 13, X, Y
  - 24-48 hour TAT
  - Pregnancy decisions should NOT be based off of FISH results*

Testing Options

- Karyotype
  - Provides definitive diagnosis for major chromosome abnormalities
  - Cannot detect del/dups <10Mb (such as 22q11 del)

Chromosome Microarray

1. Label patient DNA with Cy3
2. Label control DNA with Cy5
3. Mix
4. Hybridize DNA to genomic clone microarray
5. Analyze Cy3/Cy5 fluorescence ratio of patient to control
6. Cy3/Cy5 ratio >1
   - Duplication
7. Cy3/Cy5 ratio <1
   - Deletion
8. Cy3/Cy5 ratio >1
   - Deletion
9. Cy3/Cy5 ratio <1
   - Duplication
CMA Results

Gain of all Chromosome 21 clones

Benefits

• Can evaluate for more genetic conditions than routine karyotype
  – Clinically significant findings in pregnancies with routine indications (AMA, abnl screen), normal ultrasound and normal karyotype
    • 1-2%
  – Clinically significant findings in pregnancies with abnormal ultrasound and normal karyotype
    • 6%

Table: Frequency and Clinical Significance of Abnormalities and Reversals in Chromosomal Micros in the NEL Syndrome

| Indicator for Prenatal Diagnosis | Normal | Carrier | Infantile | Linkage | Genetic/Non-Genetic | Total Clinical Significance
|---------------------------------|-------|--------|-----------|---------|---------------------|--------------------------
| Diagnosed with CMA              | 14 (12.5%) | 2.00 (2) | 1.1 (1) | 2.2 (2) | 1.0 (1) | 0.6 (0.6)
| Diagnosed with Down Syndrome    | 2.00 (2) | 1.0 (1) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0)
| Diagnosed with Trisomy 21      | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0)

Total: 14, 2, 1, 2, 1, 0
Benefits

• Typically has quicker TAT: 7-10 days*
• Does not require cell growth (culture)*
  – Ideal for testing POC

*May require cell culture → 3-4 week TAT

CMA-Limitations

• Cannot detect base pair mutations, very small del/dups or balanced rearrangements
  – Cystic fibrosis, skeletal dysplasias, balanced translocations, etc.
• Limited/no information on a genetic finding
  – Parental blood can help clarify in some cases
  – Variant of unknown clinical significance (1-2%)

CMA- Limitations

• Unanticipated information:
  – Results may reveal parental condition/carrier
  – Non-paternity
  – Consanguinity
• Results may indicate a need for further testing and may also impact other family members
• In patients with a fetus with one or more major structural abnormalities identified on ultrasonographic examination and who are undergoing invasive prenatal diagnosis, chromosomal microarray analysis is recommended. This test replaces the need for fetal karyotype.

• In patients with a structurally normal fetus undergoing invasive prenatal diagnostic testing, either fetal karyotyping or a chromosomal microarray analysis can be performed.

• Most genetic mutations identified by chromosomal microarray analysis are not associated with increasing maternal age; therefore, the use of this test for prenatal diagnosis should not be restricted to women aged 35 years and older.

• Comprehensive patient pretest and posttest genetic counseling from qualified personnel such as a genetic counselor or geneticist regarding the benefits, limitations, and results of chromosomal microarray analysis is essential.

Case Presentation
Questions?
Blair Stevens, MS, CGC
Blair.k.Stevens@uth.tmc.edu
713-486-2292
Imaging your Ultrasound Image While Maintaining the ALARA Principle

Genevieve Campbell, B.S., RDMS
Erin Canon, B.S., RDMS
Objectives

• 1. Examine the American Institute for Ultrasound in Medicine's (AIUM) principle of ‘as low as reasonably achievable’ (ALARA) for all ultrasound examination;
• 2. Define the ALARA Principle and identify the options that exist to achieve the ALARA goal while still obtaining an acceptable image;
• 3. Explain the importance of appropriate probe selection and image processing options in order to improve the ability to optimize ultrasound imaging quality.

Disclosures

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ALARA
Per the AIUM official statement approved April 2, 2014:

• The potential benefits and risks of each examination should be considered. The ALARA (As Low As Reasonably Achievable) Principle should be observed when adjusting controls that affect the acoustical output and by considering transducer dwell times.

http://www.aium.org/officialStatements/39

Did someone say vacation?

Ultrasound

• Longitudinal waves
• Transmit/Receive information
• Greater than 2MHz
Transducers

- 4 MHz to 12 MHz
- Frequency and Depth
  - ↑ Penetration, ↓ Frequency
  - ↓ Penetration, ↑ Frequency

Body Mass Index (BMI)

- <18.5: Underweight
- 18.5-25: Healthy weight
- 25-30: Overweight
- 30-35: Moderately obese
- 35-40: Severely obese
- >40: Very severely obese

Body Types
It Matters!

BMI 50.0

BMI 20.2

4 MHz Transducer

Huygen’s Wave

- Focal Point
- Focal Depth
- Near Zone
- Far Zone
- Focal Zone

Attenuation

- Directly related to depth and tissue type
- ↑ with higher frequency
- ↓ with lower frequency
Wait, What?

4 MHz
• ↓ frequency
• ↑ penetration
• ↑ depth
• ↓ attenuation

12 MHz
• ↑ frequency
• ↓ penetration
• ↓ depth
• ↑ attenuation

Temporal Resolution

• Determined by
  – Depth
  – Line density
  – Sector size
  – Number of focal zones

Ideally:
• Shallow depth
• Low line density
• Small sector size
• One focal zone
Indices

- Mechanical Index: the potential to induce cavitation in tissues
  - Should be less than 1.9

- Thermal Index: the potential to induce tissue heating
  - Should be less than or equal to 1.0

Statement on the Safe Use of Doppler Ultrasound During 11-14 week scans (or earlier in pregnancy) – Approved 4/18/2011

- Pulsed Doppler (spectral, power, and color flow imaging) ultrasound should not be used routinely.
- Pulsed Doppler ultrasound may be used for clinical indications such as to refine risks for trisomies.
- When performing Doppler ultrasound, the displayed Thermal Index (TI) should be less than or equal to 1.0 and exposure time should be kept as short as possible (usually no longer than 5-10 minutes) and not exceed 60 minutes.
- When using Doppler ultrasound for research, teaching, and training purposes, the displayed TI should be less than or equal to 1.0 and exposure time should be kept as short as possible (usually no longer than 5-10 minutes) and not exceed 60 minutes. Informed consent should be obtained.
- In educational settings, discussion of first trimester pulsed or color Doppler should be accompanied by information on safety and bioeffects (e.g. TI, exposure times, and how to reduce the output power).
- When scanning maternal uterine arteries in the first trimester, there are unlikely to be any fetal safety implications as long as the embryo/fetus lies outside the Doppler ultrasound beam.

Examples:
Color Doppler:

Balance

Visualization (penetration) Image Quality (resolution)

Tricks of the Trade

Transducer Dynamic Contrast
Gain Power
Orientation Image Size
Focal Zone Harmonics
1st Step – Transducer Selection

Right tool for the right job

Exam Type
Body Habitus

Transducer Selection

Smaller Patient

Larger Patient

Frequency

Resolution

Penetration

2nd Step - Orientation

• Orientation notch
  – RIGHT for TRANSVERSE images
  – HEAD for SAGITTAL images
Orientation

- Incorrect orientation
  - Confusion
  - Mislabeling of the right and left sides
  - Misdiagnosis

3rd Step – Image Optimization

Power * Gain and TGC * Dynamic Range * Harmonics * Focal Zone
Power

- The strength of the ultrasound energy sent into the patient from the transducer
  
- Increased penetration of the sound beam
  - Better visualization in the far field

- Biggest Effector of MI and TI

Gain (Overall Gain)

- Gain – applies the same level of signal amplification throughout the entire ultrasound image
  
  - Acts like a dimmer
  - Live or frozen image
  - No effect on MI or TI
Gain (Overall Gain)

- Choose the level of signal amplification at a specified depth
  - Low setting in Near Field
  - High setting in Far field
  - Live image only
  - No effect on MI or TI

Time Gain Compensation (TGC)

- Choose the level of signal amplification at a specified depth
  - Low setting in Near Field
  - High setting in Far field
  - Live image only
  - No effect on MI or TI
Dynamic Contrast

- Alters the Sharpness of the image by adjusting the number of shades of gray
- Live or Frozen Image
- Enhance borders
- Reduces Artifacts
- No effect on MI or TI

Dynamic Contrast

Low DC
- \( \uparrow \) shades of gray
- More homogenous
- Borders less sharp

High DC
- \( \downarrow \) shades of gray
- More heterogeneous
- Borders sharper

Dynamic Contrast

C1 MI 0.6 TIB 0.0
C5 MI 0.6 TIB 0.0
C12 MI 0.6 TIB 0.0
Dynamic Contrast

- Low
- High

Harmonics

- Multiples of the fundamental frequency
- Higher frequency than Transmitted Frequency

- Better resolution
- Fewer artifacts
- Loss of penetration
- Reduction in Frame Rate
- Slight effect of MI and TI

Harmonics – Improved Resolution

- MI 0.8
- Mi 1.0
- Ti 0.0
- Ti 0.1
### Harmonics – Loss of Penetration

- Off
- On

### Focal Zone

- Best Lateral Resolution by narrowing the beam width
  - Lateral borders are sharpest at the Focal Zone
  - Improves the accuracy of lateral measurements
  - Femur and Humerus
  - Multiple Zones will reduce Frame Rate

### Focal Zone

- Ultrasound imaging with and without focal zone enhancement.
The Functional Evaluation of the Fetal Heart

Gurur Biliciler-Denktas, M.D.
The Functional Evaluation of the Fetal Heart

Gurur Bilicler-Denktas, MD, FACC, FAAP, FASE
Co-Director, Fetal Cardiology Program
Texas Fetal Center

Disclosures

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Objectives

1. Explain how to use Doppler and color flow to enhance understanding of the physiology of the fetal heart - a practical approach using tips and tools
2. Describe how Doppler and color flow can complement the standard structural evaluation of the fetal heart
3. Evaluation of fetal cardiac function
Fetal Heart

• Two parallel circulations
• Two shunts
  – Ductus arteriosus
  – Foramen ovale

Components of Fetal Echocardiogram: Ventricular Function Parameters

• Exclusion of hydrops
• Exclusion of cardiomegaly
• Qualitative assessment of ventricular contractility
• Systemic venous Doppler examination
• Pulmonary venous Doppler examination
• Ventricular Doppler inflow examination

Components of Fetal Echocardiogram: Ventricular Function Parameters

• Right and left ventricular cardiac output
• Ventricular shortening fraction
• Isovolumic contraction and relaxation time
• Myocardial performance index
• Cardiovascular profile score
**Fetal Heart Function**  
**Methods of Evaluation**  
- 2D and M Mode
  - Chamber sizes
  - Shortening fraction
  - Ejection fraction
- Pulsed Wave Doppler
  - RV and LV filling indices
  - Systemic venous Doppler
  - Pulmonary venous Doppler
  - Ductus venosus, umbilical artery and vein Doppler

**Fetal Heart Function**  
**Methods of Evaluation**  
- Color Doppler
  - AV valve insufficiency
  - Semilunar valve insufficiency
  - Flows in the outflows and vessels
- Tissue Doppler
- Strain
- Speckle and tissue tracking

**Fetal Cardiac Dysfunction**  
- Structural heart defects
- Intrinsic abnormalities of the fetal myocardium
- Persistent arrhythmias (tachycardia, bradycardia)
- Altered loading conditions
**Cardiac size - Cardiomegaly**

- Cardiac size relative to the thorax
  - Cardi thoracic diameter
  - Cardi thoracic area ratio (C/T area)
  - Cardi thoracic circumference ratio (C/T circumference)

**Cardiothoracic Area and Circumference**

- C/T area = 0.25 - 0.35

**Cardiothoracic Area and Circumference**

- C/T circumference
- Mean = 0.45 at 17 weeks
  - 0.50 at term
Fractional Shortening (FS)

- Segmental abnormalities are rare
- M-Mode can be used for calculation of FS
- Percentage rather than fraction
  
  \[ FS = \frac{EDD - ESD}{EDD} \]

- The diameter of right and left ventricle should shorten more than 28%
- Useful in serial assessments

Figure 1: Recording of the M-mode from the four-chamber view. Measurements are made from the M-mode tracing at end-diastole (Di), which is identified as the point when the tricuspid and mitral valves close. End-systole (Si) is defined as the maximal inward movement of the ventricular walls. Measurement of the maximal opening of the tricuspid valve (TVE) and mitral valve (MVE) occurs at the end of the rapid filling phase. BVOD, biventricular outer dimension; RVID, right ventricular inner dimension; LVID, left ventricular inner dimension; WT, wall thickness; RV, right ventricle; LV, left ventricle; RA, right atrium; and LA, left atrium.


Ultrasound in Obstetrics CME - June 7, 2014
**Fetal Shortening Fraction**

Quantification of cardiac function using M-mode ultrasound

<table>
<thead>
<tr>
<th>Valve</th>
<th>5th percentile</th>
<th>Mean</th>
<th>95th percentile</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right ventricle</td>
<td>0.25</td>
<td>0.52</td>
<td>0.80</td>
<td>0.09</td>
</tr>
<tr>
<td>Mean uncorrected shortening</td>
<td>0.55</td>
<td>1.20</td>
<td>1.59</td>
<td>0.10</td>
</tr>
<tr>
<td>Left ventricle</td>
<td>0.26</td>
<td>0.39</td>
<td>0.61</td>
<td>0.06</td>
</tr>
<tr>
<td>Mean uncorrected shortening</td>
<td>0.52</td>
<td>1.34</td>
<td>1.77</td>
<td>0.21</td>
</tr>
</tbody>
</table>

**Atrioventricular Valve and Ventricular Inflow**

- Doppler interrogation of MV and TV inflow gives information on ventricular diastole and its relaxation

**Atrioventricular Valve and Ventricular Inflow**

- E = Early filling phase of diastole (passive rush of blood from atrium to ventricle)
- A = Atrial contraction (active filling)
Atrioventricular Valve and Ventricular Inflow

- Fetal heart is noncompliant and stiff
- E<A
- As ventricles become more compliant passive diastolic filling increases
Atrioventricular Valve and Ventricular Inflow

- From 15-16 weeks to term, both E and A velocities increase with E wave increasing more thus increasing the E/A ratio.

Atrioventricular Valve and Ventricular Inflow

- When ventricular compliance worsens (cardiac hypertrophy, ventricular dysfunction), active filling becomes more important
  - A dominance increases
  - E and A fusion
Atrioventricular Valve and Ventricular Inflow

Hepatic Veins and Systemic Veins

- Triphasic
- S = Ventricular systole
- D = Early diastole
- A = Reversal of flow (atrial contraction)

Hepatic Veins and Systemic Veins

- A wave is increased with increased atrial pressure (decreased ventricular compliance or increased right atrial pressure)
- Decreased S wave in TR in decreased systolic function
**Pulmonary Veins**

- S = Systolic
- D = Early Diastolic
- A = Atrial contraction
- Increased LA pressure secondary to ventricular dysfunction or poor LV compliance → Increase in A wave reversal velocity

**Ductus Venosus**

- Triphasic
- Antegrade
- S = Ventricular systole
- D = Early diastole
- A = Atrial contraction (still antegrade but with decreased flow velocity)
- Small reversal before 17 weeks acceptable
Ductus Venosus

- Reversal of flow with atrial contraction
  - Poor circulatory state
  - IUGR

Umbilical Vein and Artery

Umbilical Vein

- Carries blood from the placenta to the fetus
- Non-phasic, continuous, low velocity
- Mild undulations in late third trimester with fetal attempts at respiration
**Umbilical Vein**
- Phasic UV flow with pulsations
- Decrease in UV velocity in diastole (UA tracing)
  - Myocardial diastolic dysfunction
- Decrease in UV velocity in systole (UA tracing)
  - Severe TR (decreased systolic function)

**Umbilical Artery**
- UA supplies the fetal circulation to the placenta (low resistance)
- Both systolic and diastolic flow
- Pulsatility index (PI) - measure of resistance at the distal placental circulation

**Umbilical Artery**
- S/D ratio = (systolic / diastolic ratio)
- Resistance index (RI) = (systolic velocity - diastolic velocity / systolic velocity)
- Pulsatility index (PI) = (systolic velocity - diastolic velocity / mean velocity)
**Umbilical Artery**

- Elevated placental resistance causes decreased diastolic flow
- Increased PI
  - IUGR
  - TTTS - donor twin

**Tei Index**

**Myocardial Performance Index-MPI**

- Measures global myocardial performance
  - Systolic
  - Diastolic
- Not dependent on ventricular geometry
- Can be used for RV and LV
- No significant changes through fetal life
- Load dependent

**Tei Index**

**Myocardial Performance Index**

\[ \text{MPI} = \frac{A - B}{\text{ICT} + \text{RT}} \]

where:
- A: AVW inflow
- B: Ventricle outflow
- ICT: Inflow convergence time
- RT: Regurgitation time
Tei Index
Myocardial Performance Index

- Isovolumic activity = the time it takes the ventricle to get ready for ejection
- Ejection time = Cardiac output
- Shorter ICT + IRT, higher ET -> lower MPA -> good global myocardial function
Tei Index
Myocardial Performance Index

- Normal
  - LV MPI = 0.36 ± 0.06
  - RV MPI = 0.35 ± 0.05

- Abnormal
  - RV MPI > 0.45
  - LV MPI > 0.40

Cardiac Output

- Left ventricle cardiac output (LCO)
- Right ventricle cardiac output (RCO)
- Combined cardiac output (CCO)

Cardiac Output

- High-output
  - Anemia
  - Sacrococcygeal Teratoma
  - AV malformation

- Low-output
  - Cardiomyopathy
  - Heart block
  - Bradycardia
  - CCAM
Cardiac Output Measurements

LCO

Q = 3.14 \times \left(\frac{D}{2}\right)^2 \times VTI \times HR

Cardiac Output Measurements

RCO

Q = 3.14 \times \left(\frac{D}{2}\right)^2 \times VTI \times HR

Cardiac Output

<table>
<thead>
<tr>
<th>Author</th>
<th>Title of Recording</th>
<th>LCO (L/min)</th>
<th>RCO (L/min)</th>
<th>DC0 (L/min/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenny</td>
<td>Outflow tracts</td>
<td>116</td>
<td>303</td>
<td>676</td>
</tr>
<tr>
<td>Rous</td>
<td>Outflow tracts</td>
<td>75</td>
<td>209</td>
<td>447</td>
</tr>
<tr>
<td>Rous</td>
<td>Outflow tracts</td>
<td>78</td>
<td>294</td>
<td>615</td>
</tr>
</tbody>
</table>
Doppler Tissue Imaging-DTI

- At very low velocity scale with adjustment of the signal filters, direction of myocardial tissue movement and velocity measurement
- Assesses function through myocardial movement rather than flow
- Also helps in assessment of myocardial strain and strain rate
Cardiovascular Profile Score

Cardiovascular profile score. The heart failure score is 10 if there are no abnormal signs and reflects 2 points for each of the 5 categories: hydronephrosis, venous Doppler, heart size, cardiac function, and arterial Doppler. AEDV indicates absent end-diastolic velocity; dP/dt, change in pressure over time of TR jet; DV, ductus venosus; LV, left ventricle; MVR, mitral valve regurgitation; MV, mitral valve; Pts, points; REDV, reversed end-diastolic velocity; RV, right ventricle; S.F., ventricular shortening fraction; TR, tricuspid valve regurgitation; TV, tricuspid valve; UV, umbilical vein.
What About the Cervix? Screening for Preterm Delivery
Michael Bebbington, M.D., M.H.Sc.
Cervical Length Screening in Pregnancy

Michael Bebbington MD MHSiC
Professor, Department of Obstetrics, Gynecology and Reproductive Sciences
University of Texas Health Science Center at Houston

Cervical Length Screening in Pregnancy

• Preterm Birth is a problem:
  – 500,000 preterm births/year in US
  – 75% attributable to spontaneous PTL ± PROM
  – In women with a prior history of preterm birth progesterone 250mg IM weekly decreases risk of recurrence by 35%.
  – Can we identify other women at higher risk for preterm birth who may be eligible for an effective treatment?
    – Women with a short cervix measured before 20 weeks are at an increased risk for preterm birth
      • LR+ 4.31 with no prior history of preterm birth
      • LR+ 11.3 with prior history of preterm birth
  – Cervical length screening may qualify as a screening test for women at risk of preterm delivery

Cervical Screening in Pregnancy

Take Home Message: Llévate a casa

• Technique is as important as indication
• Prior preterm birth secondary to spontaneous preterm labor ± PROM
  – Progesterone supplementation 250mg IM weekly
  – Consider cervical length every 2 weeks from 16-24 wks
  – If CL <25mm – consider cerclage
• Multiple gestations
  – No evidence to support CL screening, progesterone therapy or cerclage
Cervical Screening in Pregnancy

Take Home Message: Llévate a casa

- Prior cervical surgery
  - Screen once 18-24 weeks
  - CL < 20mm – vaginal progesterone
- No history of PTB
  - Universal vs risk factor based screening?
  - CL < 25 mm – vaginal progesterone
  (meta analysis)

What do we know about cervical length and preterm delivery?


How short is too short?

The Importance of Technique

Is this a good image showing cervical length?

![Image of ultrasound with labeled structures: Bladder, Ext Os, Int Os, Fetal Head, Posterior Cervical Lip, Cervical Lip]
Measurement of the Cervix

- Insert transvaginal probe to view the cervix — withdraw probe until the image blurs to reduce compression from the transducer, then reapply just enough pressure to create a best image.
- The cervix occupies 75% of the image area:
- The anterior width of the cervix equals the posterior width:
- There is limited concavity created by the transducer:
- The maternal bladder is empty:
- The internal os is seen:
- The external os is seen:
- The endocervical canal is visible throughout:
- Calipers are placed where the anterior and posterior walls of the cervix touch at the internal and external os:
- If the cervix is curved two or more linear measurements are performed and the values added together to obtain the cervical length. Do not trace the cervical length:
- Visualize the cervix for 3-5 minutes and watch for shortening or funneling.

**Why are we screening?**

*Is there an effective intervention?*
Cervical cerclage for prevention of preterm delivery in woman with short cervix

47,123 Screened
470 Cervical length <15mm
253 Randomized

127 Shirodkar (21% prior PTB)
126 Expectant (13% prior PTB)

To MS Lancet 2004;363:1849

Cervical cerclage for prevention of preterm delivery in woman with short cervix

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Cerclage N=127</th>
<th>Expectant N=126</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery &lt;33 wks</td>
<td>22%</td>
<td>26%</td>
<td>0.84 (0.54-1.31)</td>
</tr>
<tr>
<td>GA at delivery</td>
<td>36.4</td>
<td>35.4</td>
<td>0.95 (0.62-2.35)</td>
</tr>
<tr>
<td>Spontaneous onset labor</td>
<td>72%</td>
<td>83%</td>
<td>0.88 (0.77-1.0)</td>
</tr>
<tr>
<td>Iatrogenic</td>
<td>22%</td>
<td>14%</td>
<td>1.54 (0.9-2.64)</td>
</tr>
<tr>
<td>Perinatal death</td>
<td>6%</td>
<td>8%</td>
<td>0.69 (0.27-1.77)</td>
</tr>
</tbody>
</table>

To MS Lancet 2004;363:1849

Prevention of recurrent preterm delivery by 17 alpha-hydroxyprogesterone caprate

2980 screened
463 Randomized

17αOHP 250mg IM weekly 16-20 wks to 36 weeks
153 Placebo

Meis PJ NEJM 2003;348:2379
Outcomes of pregnancy according to treatment assignment

<table>
<thead>
<tr>
<th>Outcome</th>
<th>17a OHP N=310</th>
<th>Placebo N=153</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery &lt; 37 weeks</td>
<td>36.3%</td>
<td>54.9%</td>
<td>0.66 (0.55-0.81)</td>
</tr>
<tr>
<td>Delivery &lt; 35 weeks</td>
<td>20.6%</td>
<td>30.7%</td>
<td>0.67 (0.48-0.93)</td>
</tr>
<tr>
<td>Delivery &lt; 32 weeks</td>
<td>11.4%</td>
<td>19.6%</td>
<td>0.58 (0.37-0.91)</td>
</tr>
<tr>
<td>Hospital visit for PTL</td>
<td>16%</td>
<td>13.8%</td>
<td>1.15 (0.72-1.86)</td>
</tr>
<tr>
<td>Tocolytic Therapy</td>
<td>17.3%</td>
<td>15.9%</td>
<td>1.09 (0.7-1.69)</td>
</tr>
<tr>
<td>Fetal Demise</td>
<td>1.9%</td>
<td>0.6%</td>
<td>1.5 (0.31-7.34)</td>
</tr>
<tr>
<td>Neonatal Death</td>
<td>2.6%</td>
<td>2.9%</td>
<td>0.44 (0.17-1.69)</td>
</tr>
</tbody>
</table>

Meis PJ NEJM 2003;348:2379

Effect of Vaginal Progesterone on Preterm Birth <33 weeks in Asymptomatic Sonographically Short Cervix

Progesterone and the risk of preterm birth among women with a short cervix

Pregnant Trial: Vaginal Progesterone reduces the rate of preterm birth in women with a sonographic short cervix

- 32,091 Screened
- 733 cervical length 10-20mm
- 458 Randomized
- 235 Vaginal progesterone gel 90mg
- 223 Placebo

What about Multiple gestations?

Multiple Gestations
- Increased risk for preterm birth
- Generally interventions shown to be effective in singletons are ineffective in multiples
  - 4 trials
    - Rouse 2007 randomized 655 twins – 17P
    - Norman 2009 randomized 500 twins – progesterone vaginal gel
    - Combs 2001 randomized 2450 twins – 17P
    - Caritas 2009 randomized 134 triplets – 17P
  - No difference compared to placebo
Multiple Gestations

165 twins
Cervical length <25mm
(GA 24-31+6 wks)

82 randomized to 500mg 17P twice weekly until 36 weeks of delivery
83 randomized to placebo


Results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>17a OHP N=82</th>
<th>Placebo N=83</th>
<th>RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to delivery (days)</td>
<td>45 (3)</td>
<td>52 (3)</td>
<td>p=0.09</td>
</tr>
<tr>
<td>Delivery &lt; 37 weeks</td>
<td>80%</td>
<td>77%</td>
<td>1.04 (0.74 - 1.47)</td>
</tr>
<tr>
<td>Delivery &lt; 34 weeks</td>
<td>40%</td>
<td>28%</td>
<td>1.45 (0.85 - 2.50)</td>
</tr>
<tr>
<td>Delivery &lt; 32 weeks</td>
<td>29%</td>
<td>12%</td>
<td>2.41 (1.18 - 5.31)</td>
</tr>
<tr>
<td>Prior PTB</td>
<td>11%</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>


Universal or Selective Screening?
Impact of Universal Screening on a Population of 10,000 Women

<table>
<thead>
<tr>
<th>Trial</th>
<th>Rate of short CL</th>
<th>Women with short CL</th>
<th>Rate of PTB (daily P)</th>
<th>Rate of PTB (placebo)</th>
<th>No of PTB (daily P)</th>
<th>No of PTB (placebo)</th>
<th>PTB prevented with daily P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fonseca et al</td>
<td>1.7%</td>
<td>170</td>
<td>19.2%</td>
<td>34.4%</td>
<td>33</td>
<td>58</td>
<td>25</td>
</tr>
<tr>
<td>Hassan et al</td>
<td>2.28%</td>
<td>228</td>
<td>8.9%</td>
<td>16.1%</td>
<td>40</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

Fonseca et al 400 7
Hassan et al 588 13.4

Total 8 US studies to prevent 1 PTB
NNT with P to prevent 1 PTB

Problems?

• Both studies included women with a prior preterm birth
  — Fonseca – 15%
  — Hassan – 13%
• Fonseca – included 9.6% twins
• FDA has not approved progesterone gel for prevention of preterm birth (2012)
  — Cited US participants only had 2.4% reduction in PTB < 33 wks compared to 9.7% in non-US participants
  — 28% non-compliance in US vs 1.6% in non-US centers

Cost Effectiveness of Universal Screening

• Two studies
  — Werner et al Ultrasound Obstet Gynecol 2011;38:32-7
• Both concluded that universal screening and treatment with vaginal progesterone appears to be cost effective
• Werner estimated savings over $12 million and 424 QUALY gained for every 100,000 women screened and treated for a cervical length <15mm
But (1)....

- Werner used data from Fonseca trial and applied costs for singleton, no prior history PTB
- Costs for hospitalization = $0
- Costs for loss of productivity = $0

⇒ No hospitalization or activity restrictions if savings are to be realized!

But (2)....

- Cahill reported 95,920 preterm births <34 weeks prevented annually
- 4,000,000 pregnant women with a 1.2% probability of a cervical length <1.5mm = 48,000 candidates for treatment. A 35% efficacy = 16,800 preterm births prevented

But (3)....

- Cost largely related to severe neonatal morbidity (ultrasound is relatively cheap)
  - Fonseca – individual adverse neonatal outcomes and composite of adverse neonatal outcomes not different between the two treatment groups
  - Hassan – rates of neonatal death and individual adverse neonatal outcomes other than RDS not different between the two treatment groups
    - Rate of composite outcome for any morbidity/mortality was lower in progesterone group 7.6% vs 13%.
    - Translates to 12 cases prevented
But (4).....

- Conclusions are limited to assumptions made
- What if women with a prior preterm birth were excluded from cervical length screening?
- What if women have multiple screening studies?
- How do we ensure that imaging standards are such that only 1 screening exam is required? (QA programs cost)
- Application of screening and intervention to populations not known to benefit
  - Twins
    - Cervical length >15mm

Cervical Screening in Pregnancy
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- No history of PTB
  - Universal vs risk factor based screening?
  - CL < 25 mm – vaginal progesterone
    (meta analysis)
Fetal Cardiac Screening
Helena Gardiner, M.D., Ph.D.
Fetal Cardiac Screening

Helena Gardiner, M.D., Ph.D.
Co-Director, Fetal Cardiology Program
Texas Fetal Center

Disclosures
I do not have relevant financial relationships with commercial interests related to the content of this presentation

Objectives
1. Discuss the poor rate of early diagnosis of major congenital heart defects (mCHD) in the nation
2. Identify the importance of prenatal detection to decrease perinatal morbidity and mortality and improve neonatal treatment and quality of care
3. Improve screening modalities for early diagnosis using a standard protocol
4. Explain the importance of a timely referral to a specialist for a fetal echo and multidisciplinary management
National variation in prenatal diagnosis of CHD: CV Surgery data

18,631 neonates from 44 states operated on in 91 centers between 2006-12

Overall 42% of major CHD detected prenatally in centers submitting to STS rising from 33-49% over era, BUT 23% - 61% across states, p<0.001

Wide variation by lesion:
- 39% 4 Ch vs 20% OFT
- 70% single ventricles
- 30% isolated TGA (TGA/IVS)
- 20% of isolated arch obstruction (CoA, IAA)

Brief History

• 1980’s: Birth of obstetric screening
• 1985: 4-chambers added to routine OB scans
• 1990’s: Cardiac scan extended to Aortic Root
• 2000: 4ch alone = 2/1,000 = 60%; 4ch + Outflow Tracts = 3/1,000 = 90%

Benefits of early prenatal diagnosis

• Increases reliability of ultrasound diagnosis and permits serial evaluation
• Enables parental involvement and choices
• Increases time available for a full evaluation, including genetic tests and alternative imaging modalities
Fetal Echo Survey

Key Questions:
• How do we learn to scan the fetal heart?
• What barriers to learning exist?

Goals: Anonymous survey to provide better training and improve prenatal detection

If you have questions or feedback – please contact Ian Averiss during this meeting or via email: ian.e.averiss@uth.tmc.edu

Fetal Echo Survey - 1

Looking back at your training ...

Fetal Echo Survey

Q1. How were you taught to scan the fetal heart (tick all that apply)?

A. On the job - theory/articles
B. On the job - practical/demonstrations
C. General ultrasound courses
D. Specialized fetal echo courses
E. Colleagues (e.g. sonographers, MFMs, cardiologists)
F. Dedicated hands-on training by specialists
G. Other (e.g. fellowships - please specify)

Q2. What was the most effective form of training you received? A, B, C, D, E, F
Fetal Echo Survey

Q3. Looking back, what was the biggest challenge you faced while learning fetal heart scanning?

Q4. How did you overcome this challenge at the time?

Screening for CHD prenatally

5 Planes
Plane 1: Normal Situs

Plane 2: Four chamber View
Cardiac size
Pericardial effusions
Regular rhythm
Apex to left – axis
Chamber identity
Left atrium posterior
RV anterior
FO to left

Plane 3: Aortic valve
Aortic valve lies in the centre of the heart
Plane 4: Crossover to Pulmonary artery

Pulmonary trunk goes from anterior chest wall to spine and divides

Alternative: Pulmonary artery branches

Pulmonary trunk divides to form right and left branches and arterial duct

Plane 4 to 5: RVOT to 3 VT view
Plane 5: 3VT view

Normal 3VT checklist

- Size of duct to aorta
  Symmetrical arches
  Isthmal:duct ratio >0.75

- Side of arch (trachea)
  Should pass to left of trachea
  A right arch may be normal
  Cardiac malformations & 22q11

- Is there a Left SVC?
  If present, CHD or important extracardiac malformations more likely

- Direction of flow: same direction, without areas of continuous flow

- Note the thymus

Pulmonary and systemic veins

Pulmonary veins can be identified using color from right and left lungs in 4 chamber view
Systemic veins form a bull's head (or Texan Longhorn!) appearance in sagittal plane
Fetal Echo Survey - 2

Knowing what you know now ...

Fetal Echo Survey

Q5. From where you are now, what would you change about your training / what could be improved?
Q6. How long have you been scanning the 2nd Trimester fetal heart? ___ (years)
Q7. How long did it take before you were fairly confident about heart scanning? ___ (years)
Q8. What still remains difficult?

Fetal Echo Survey

Q9. How many hearts do you scan in a week on average? ______
Q10. Since you started scanning how many heart defects have you have picked up? ______
Q11. What heart views do you routinely use?

<table>
<thead>
<tr>
<th>Views</th>
<th>with Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOBM 4 views</td>
<td></td>
</tr>
<tr>
<td>TOPOS 5 views</td>
<td></td>
</tr>
</tbody>
</table>

Other (please specify)
Q12. Questions, comments or feedback
AIUM Guidelines: 2013

- Fetal orientation
- Segmental approach
- 5 transverse views
- Short axis views
- Sagittal views of arches and veins
- Color and pulsed Doppler throughout including DV, but cord optional
- Cardiac measurements if indicated by abnormality
- Cardiac function if qualitatively it seems abnormal

AIUM cartoon – not quite there!

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart

Cardiac screening in mid-gestation rather than a fetal echocardiogram

Abdominal situs  Correct cartoon for the 3VT
AIUM guidelines include sagittal views

“RULE OF 3” – 3 Cardiac Segments

- Atrial segments
- Ventricular segments
- Great arterial segments
3 important aspects of each segment

Morphology

Connections

Relationships

Plane 1: Normal Situs

Infers left atrium on fetal left and right atrium on fetal right

Other vessel arrangements are abnormal

Mirror image  Left isomerism  Right isomerism
Plane 2: Atrial Identity
Coronary sinus - left atrium
Pectinate muscles
Shape of appendages

Morphology of 4 chamber view
- Foramen flap LA
- MV attaches to Left ventricular free wall
- TV has septal attachments
- Off-setting of the inlet valves
- Moderator band in RV

Short axis views
MV is bicuspid and TV is tri-leaflet
RV is anterior in the chest
Aorta lies centrally
All you need to remember....

4-chamber view checklist

- Width of right and left sides
  symmetrical in second trimester, R>L third trimester
- Foramen flap
  Should move into left atrium – rightward motion suggests mitral or aortic stenosis or atresia
- Normal Off-setting?
  Check mitral and tricuspid valves are patent with a discernable off-set – TV lower to apex than MV
- Does the left ventricle form the apex of the heart?
- Is there an enlarged coronary sinus?
  If present, possible left SVC or TAPVC
- Ventricular Septal defects?
- Can you see Pulmonary veins?

Timely Prenatal Diagnosis allows Multi-disciplinary Team approach

- Genetic Counselor
- Neonatology
- Pediatric Cardiology
- Cardiac Surgery
- Perinatal plan
- Primary Obstetrics
- Fetal Cardiology
- Fetal Medicine
- Pediatric Specialists

Primary Obstetrics
Pediatric Specialists
Perinatal plan