Looking for fetal heart disease

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Objectives

• To make looking at hearts easy!
• At the end of this presentation MDs and sonographers will be able to:
  – Move beyond 4 chamber view and know why
  – Evaluate hearts routinely based on simple sets of criteria

Disclosures

• None

Infant mortality, USA, 2006

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Number</th>
<th>Rate*</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital anomalies</td>
<td>5,769</td>
<td>133.3</td>
<td>19.7</td>
</tr>
<tr>
<td>Premat, LBW, RDS</td>
<td>4,678</td>
<td>108.4</td>
<td>15.9</td>
</tr>
<tr>
<td>SIDS</td>
<td>2,118</td>
<td>49.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Mat complications</td>
<td>1,770</td>
<td>41.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Accidents</td>
<td>1,238</td>
<td>28.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Placenta, cord, membranes</td>
<td>1,139</td>
<td>26.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Bacterial septis</td>
<td>790</td>
<td>18.3</td>
<td>2.7</td>
</tr>
<tr>
<td>RDS</td>
<td>735</td>
<td>17.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>614</td>
<td>14.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Other</td>
<td>10,390</td>
<td>240.7</td>
<td>35.6</td>
</tr>
</tbody>
</table>

*Death < 1 year/100,000 liveborn


2007 Infant mortality

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Number</th>
<th>Rate*</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All causes</td>
<td>1363</td>
<td>290.7</td>
<td>24.5</td>
</tr>
<tr>
<td>Congenital malformations and chromosomal anomalies</td>
<td>5,196</td>
<td>109.9</td>
<td>109.9</td>
</tr>
<tr>
<td>Other congenital anomalies</td>
<td>2,099</td>
<td>43.9</td>
<td>13.9</td>
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<tr>
<td>Sudden infant death syndrome</td>
<td>4,687</td>
<td>97.7</td>
<td>31.5</td>
</tr>
<tr>
<td>Maternal complications</td>
<td>1,041</td>
<td>21.5</td>
<td>8.0</td>
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<tr>
<td>Bacterial infections</td>
<td>735</td>
<td>15.8</td>
<td>11.1</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>614</td>
<td>13.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Other</td>
<td>10,390</td>
<td>240.7</td>
<td>35.6</td>
</tr>
</tbody>
</table>

1363/5785 due to cardiovascular anomalies (23.5%)

Infant mortality, USA, 2005

- All causes
- Congenital malformations
- Accidents
- Homicide
- Suicide
- Prematurity
- Preeclampsia
- Other maternal causes
- Other maternal causes
- Perinatal causes
- Other causes

CHD Impact on Infant Mortality

- Cardiovascular: 1601 (27%)
- MSK: 608 (10%)
- CNS: 419 (7%)
- Respiratory: 393 (7%)

Nat Vital Stats Reps 2009;58:1-51

Full fetal echo views

- Four chamber
- Long axis left ventricle
- Short axis great vessels
- Aortic arch
- Pulmonary artery/ductal arch
- SVC/IVC
- 3 vessel trachea
- Pulmonary veins

Components of 4 chamber view

- Heart in left chest (√ stomach)
- Atria = sizes
- Ventricles = sizes
- Left atrium posterior
- Foramen ovale flap in LA
- Apical offset tricuspid valve
- Intact interventricular septum
- Moderator band in RV
- Axis 30-60° (mean 45°)
- Heart occupies 1/3 of chest area

4 Chamber Screening, Trieste, Italy

- Trieste, Italy
- Single institution
- N = 7024
- Total CHD = 65 (9.3/1000)
  - Major defects 4.4/1000
- Sensitivity
  - 35% overall
  - 52% “prenatally detectable”

Cost analysis:
- 7024 patients, 15% scanned twice
  - Total cost: $323,104
  - Cost/positive diagnosis: $14,048

### Cost analysis:
- **Total cost**: $323,104
- **Cost/positive diagnosis**: $14,048
- **Cost/scan**: $40

### Looking for fetal heart disease

- **4 Chamber Screening, Trieste, Italy**
- **Cost analysis**:
  - 7024 patients, 15% scanned twice
  - Total cost: $323,104
  - Cost/positive diagnosis: $14,048
  - Cost/scan: $40

### Screening worldwide

<table>
<thead>
<tr>
<th>Author</th>
<th>Total N</th>
<th># CHD</th>
<th>Rate/1000</th>
<th>Sens (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Todros</td>
<td>8,299</td>
<td>40</td>
<td>4.8</td>
<td>15</td>
</tr>
<tr>
<td>Luck</td>
<td>8,523</td>
<td>27</td>
<td>3.2</td>
<td>36</td>
</tr>
<tr>
<td>Chitty</td>
<td>8,342</td>
<td>11</td>
<td>1.3</td>
<td>63</td>
</tr>
<tr>
<td>Rosendahl</td>
<td>9,012</td>
<td>22</td>
<td>2.4</td>
<td>36</td>
</tr>
<tr>
<td>Crane</td>
<td>7,685</td>
<td>42</td>
<td>5.5</td>
<td>21</td>
</tr>
<tr>
<td>Levi</td>
<td>16,370</td>
<td>102</td>
<td>6.2</td>
<td>29</td>
</tr>
<tr>
<td>Vergani</td>
<td>5,336</td>
<td>32</td>
<td>6.0</td>
<td>81</td>
</tr>
<tr>
<td>Achiron</td>
<td>5,347</td>
<td>23</td>
<td>4.3</td>
<td>48</td>
</tr>
<tr>
<td>Stoll</td>
<td>26,490</td>
<td>215</td>
<td>8.1</td>
<td>13</td>
</tr>
<tr>
<td>Scheel</td>
<td>602</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grnander</td>
<td>7,459</td>
<td>90</td>
<td>12.1</td>
<td>10</td>
</tr>
<tr>
<td>Buskens</td>
<td>5,319</td>
<td>57</td>
<td>10.7</td>
<td>04</td>
</tr>
<tr>
<td>Total</td>
<td>108,182</td>
<td>661</td>
<td>6.1</td>
<td>32</td>
</tr>
</tbody>
</table>

### Looking for fetal heart disease

- **Screening in Europe**
  - Range of detection 30% ASD to 70% HLHS
  - TOF, TGA, PS/PA, AS all ~50%

### Are outflows standard?

- AIUM, ACOG, SMFM, ACR guidelines now include both RVOT & LVOT as a routine part of the “standard examination”

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Stoll Prenat Diagn 2001;21:243-52

Cardiac Axis

• Normal 45 ± 15°
• Increased in abnormalities
• Outflow tracts especially
• Also increased with gastroschisis, omphalocele

Shipp Obstet Gynecol 1995;85:97-102
Smith Obstet Gynecol 1995;85:187-91
Looking for fetal heart disease

**Cardiac Axis**

Override aorta & Trisomy 18

Looking for fetal heart disease

**Cardiac Axis**

Transposition of the great arteries

Looking for fetal heart disease

**Cardiac Axis**

Kirk Obstet Gynecol 1994;84:427-31
Looking for fetal heart disease

**Differing views**

- Retrospective cohort study
  - 10 years, 1474 cases, Utah
  - 64% missed with abnormal outflow
  - 42% missed with abnormal 4 chamber
  - All theoretical, overall real detection rate: 39%

Pinto Ultrasound Obstet Gynecol 2012;40:418-25

- Prospective evaluation 200 infants undergoing cardiac surgery
  - Abnormal 4 ch view expected in 63%
  - Abnormal outflows expected in 91%
  - Overall actual detection rate 33%


Looking for fetal heart disease

**Meta-analysis cardiac views**

<table>
<thead>
<tr>
<th>View</th>
<th>Detection rate (%)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 chamber alone</td>
<td>52</td>
<td>50 - 55</td>
</tr>
<tr>
<td>4 ch + outflows OR 3VT</td>
<td>65</td>
<td>61 - 69</td>
</tr>
<tr>
<td>4 ch + outflows AND 3VT</td>
<td>90</td>
<td>86 - 93</td>
</tr>
</tbody>
</table>

Li PLOS One 2013;8:e65484

Looking for fetal heart disease

**Conclusions**

- Fetal echo does make a difference
- Screening must improve
- Outflows part of the solution
Fetal Heart: The Odd Numbers
3-Vessel and 5-Chamber Views

Lynn L. Simpson, MD
Chief, Division of Maternal Fetal Medicine
Director, Center for Prenatal Pediatrics & OB/GYN Ultrasound
Columbia University Medical Center, New York

Objectives

Upon completion of this lecture, participants will be able to:

1. Describe how to obtain the 5-chamber and 3-vessel-trachea views during cardiac screening
2. Define the important features of these views
3. Recognize abnormal 5-chamber and 3-vessel-trachea views and detect additional heart anomalies often missed by 4-chamber view alone

5-Chamber View: How to Obtain

1. Four Chamber View
2. Left Ventricular Outflow Tract
3. Right Ventricular Outflow Tract

AIUM practice guideline for the performance of fetal echocardiography. Ultrasound Med 2013

5-Chamber View: Key Features

✔ Aorta arises from the middle of the heart between the two atrioventricular valves
✔ Left-to-right orientation
✔ Wide angle between interventricular septum and anterior wall of ascending aorta

5-Chamber View: Key Features

✔ Continuity of the anterior wall of the aorta with ventricular septum
✔ Continuity of the posterior wall of the aorta with the mitral valve
✔ Two superior pulmonary veins enter left atrium at 5-chamber view level

Five-Chamber View

AIUM practice guideline for the performance of fetal echocardiography. Ultrasound Med 2013
Five-Chamber View:
Normal and Abnormal Views

- LV connections
- LVOT alignment
- LVOT size
- Valves
- Direction of flow
- Turbulent flow

Crisscross of Outflow Tracts
Transposition of Great Arteries

Normal or Abnormal?

Coarctation

Five-Chamber View

Five-Chamber View

Normal or Abnormal?
**Five-Chamber View**

**VSD with Great Vessel Override**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Diagnostic Clue</th>
<th>Additional Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOF</td>
<td>Aorta overriding</td>
<td>Antenatal or retrograde flow in DA</td>
</tr>
<tr>
<td></td>
<td>Patent narrow PA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antegrade flow in PA</td>
<td></td>
</tr>
<tr>
<td>PA with VSD</td>
<td>Aorta overriding</td>
<td>DA tortuous with retrograde flow</td>
</tr>
<tr>
<td></td>
<td>Very narrow PA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No antegrade flow in PA</td>
<td></td>
</tr>
<tr>
<td>DORV</td>
<td>PA overriding</td>
<td>Mimics TGA with VSD</td>
</tr>
<tr>
<td></td>
<td>PA and Ao in parallel</td>
<td></td>
</tr>
<tr>
<td>Truncus Arteriosus</td>
<td>Arterial trunk overrides</td>
<td>Valve of arterial trunk may be regurgitant</td>
</tr>
<tr>
<td></td>
<td>PA arises from trunk</td>
<td></td>
</tr>
</tbody>
</table>

**Anomalies Detected by 5-Chamber View**

<table>
<thead>
<tr>
<th>Finding</th>
<th>Possible Cardiac Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow aortic valve, post-valvular dilation, turbulent flow across aortic valve</td>
<td>Valvular aortic stenosis</td>
</tr>
<tr>
<td>VSD with Ao arising from LV</td>
<td>Perimembranous VSD</td>
</tr>
<tr>
<td>Non-opening aortic valve, no flow across aortic valve</td>
<td>Coarctation</td>
</tr>
<tr>
<td>Aortic atresia; HLHS</td>
<td>Interrupted aortic arch</td>
</tr>
<tr>
<td>VSD with Ao override</td>
<td>TOF</td>
</tr>
<tr>
<td>VSD with Ao override</td>
<td>Pulmonary atresia with VSD</td>
</tr>
<tr>
<td>Lack of wide angle, larger vessel arising from LV (with or without VSD)</td>
<td>Absent pulmonary valve syndrome</td>
</tr>
<tr>
<td></td>
<td>Common arterial trunk</td>
</tr>
<tr>
<td>Aortic regurgitation</td>
<td>TGA</td>
</tr>
<tr>
<td></td>
<td>Common arterial trunk</td>
</tr>
<tr>
<td></td>
<td>Valvular dysplasia</td>
</tr>
<tr>
<td></td>
<td>Endocardial fibroelastosis</td>
</tr>
<tr>
<td></td>
<td>Cardiomyopathy</td>
</tr>
</tbody>
</table>
3-Vessel-Trachea View: How to Obtain

Cephalad to origin of great vessels
Demonstrates main pulmonary artery, ductus arteriosus, transverse aortic arch, aortic isthmus, and superior vena cava
Aortic and ductal arches form a “V” as they merge together into the descending aorta
Both arches are to the left of the spine and trachea
SVC is seen in cross-section to right of aortic arch

3-Vessel-Trachea View: Key Features

- Left/anterior to right/posterior: DA, Ao arch, SVC
- DA>Ao>>>SVC
- Trachea has bright wall lying to right of great vessels and posterior to SVC
- No vessel posterior to trachea
- Color flow important in evaluation; anteroposterior flow in both arches, laminar, no turbulence or reversal

Three-Vessel-Trachea View: Normal and Abnormal Views

Three-Vessel-Trachea View

Three-Vessel-Trachea View: Abnormalities of Aortic Arch

Anomalies Detected by 3-Vessel-Trachea View

<table>
<thead>
<tr>
<th>Finding</th>
<th>Possible Cardiac Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilated PA with turbulent antegrade flow</td>
<td>Pulmonary stenosis</td>
</tr>
<tr>
<td>Dilated Ao with turbulent antegrade flow</td>
<td>Aortic stenosis</td>
</tr>
<tr>
<td>Narrow PA but antegrade flow</td>
<td>TOF; Ebstein anomaly; DORV; tricuspid atresia with VSD</td>
</tr>
<tr>
<td>Narrow Ac but antegrade flow</td>
<td>Mid CoA</td>
</tr>
<tr>
<td>Narrow Ac but retrograde flow</td>
<td>HLHS; severe CoA</td>
</tr>
<tr>
<td>Non-visualized Ao</td>
<td>Interrupted arch; severe CoA</td>
</tr>
<tr>
<td>Narrow PA but retrograde flow</td>
<td>Pulmonary atresia with/without VSD</td>
</tr>
<tr>
<td>One large artery with antegrade flow</td>
<td>Common arterial trunk; TGA; DORV</td>
</tr>
<tr>
<td>Vessel behind the trachea</td>
<td>Aberrant right subclavian artery; right aortic arch; dilated aortic arch</td>
</tr>
<tr>
<td>Four vessels</td>
<td>Left-sided SVC, dilated azygous vein</td>
</tr>
</tbody>
</table>

Current Screening Strategies

<table>
<thead>
<tr>
<th>Approach</th>
<th>Prenatal Detection of Major CHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-chamber view</td>
<td>40-50%</td>
</tr>
<tr>
<td>Four-chamber view &amp; LVOT/RVOT</td>
<td>60-80%</td>
</tr>
<tr>
<td>Four-chamber view &amp; 3-vessel view</td>
<td>&gt;80%</td>
</tr>
<tr>
<td>Fetal echocardiography</td>
<td></td>
</tr>
<tr>
<td>Traditional risk factors</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Indication-based</td>
<td>&lt;50%</td>
</tr>
<tr>
<td>Universal</td>
<td>&gt;90-95%</td>
</tr>
</tbody>
</table>

Conclusions

1. Five-chamber view is used to assess the LVOT and increases the detection of conotruncal anomalies and abnormalities of aortic valve
2. Three-vessel-trachea view is used to assess the PA/DA, Ao/arch, and SVC and increases the detection of abnormalities of the great vessels and venous return
3. Routine assessment of the odd number views will improve the prenatal detection of CHD

Thank You

Lynn L. Simpson, MD
Chief, Division of Maternal Fetal Medicine
Director, Center for Prenatal Pediatrics & OB/GYN Ultrasound
Columbia University Medical Center, New York
Fetal Heart: Early Scans - How Low Can you Go?

Just Images (mostly)

Normal Cardiac Anatomy 11-14 weeks

4-Chamber View

Gray Scale

Color Flow Doppler

Outflow Tracts

LVOT

RVOT

RVOT

Aortic Arch
**Ductal Arch**

**Pulmonary Veins**

**STIC-TUI 12 weeks**

**Congenital Heart Defect**

**Early Visualization Cardiac Structures**

**Literature Review**

<table>
<thead>
<tr>
<th>GA (weeks)</th>
<th>4-CV</th>
<th>Outflow tracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>17.85%</td>
<td>0-75%</td>
</tr>
<tr>
<td>12</td>
<td>36.97%</td>
<td>40-93%</td>
</tr>
<tr>
<td>13</td>
<td>74-100%</td>
<td>38-100%</td>
</tr>
</tbody>
</table>

**Frequency Visualization Specific Cardiac Structures**

<table>
<thead>
<tr>
<th>Structure</th>
<th>11-12 weeks</th>
<th>13-14 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Axis</td>
<td>71%</td>
<td>73%</td>
</tr>
<tr>
<td>4-CV</td>
<td>27%</td>
<td>41%</td>
</tr>
<tr>
<td>AoA</td>
<td>18%</td>
<td>30%</td>
</tr>
<tr>
<td>Ductal arch</td>
<td>15%</td>
<td>24%</td>
</tr>
<tr>
<td>LVOT</td>
<td>39%</td>
<td>58%</td>
</tr>
<tr>
<td>RVOT</td>
<td>37%</td>
<td>61%</td>
</tr>
</tbody>
</table>

Success Rates of Cardiac Visualization

Combined Transvaginal and Transabdominal Ultrasound

- Weeks 11
- Weeks 12
- Weeks 13
- Weeks 14

Case#1
Early Cardiac Evaluation
- 13 weeks
- Extreme Obesity

Transabdominal Scan

Transabdominal NT Attempt

Transvaginal US

Transvaginal
Case#2
12 weeks
Large VSD

Case#3
14 weeks
Large VSD

Outcome
- Normal Cardiac Anatomy

Case#3
History
- 29 y.o G1P0
- No significant prior medical or family history

TR
Outcome

- Trisomy 21

Case#4
22 Year-Old G2P1

- No risk factors for congenital heart disease

14 weeks Scan

Case#5
22-weeks

History

- 22 year-old
- G3 P0020
- US at ~14 weeks suspicious for multiple anomalies
- Transvaginal early echocardiogram performed at 14 + 1 weeks

TGA

Transabdominal
Outcome

- Suction dilatation and evacuation at 16 weeks
- Truncus arteriosus confirmed by anatomic pathology

1st Trimester Detection: Non-Chromosomal CHD


Exam
abdominal situs
4-CV
Equal ventricles-CFD
Cesarean aorta and MPA
AoA and DA flow
(2.1% view inadequate)

100 cases CHD/447 no CHD (Odd ratio)

93
90.5
88
85.5
83
FPR < 0.5%
1st Trimester Detection : Non-Chromosomal CHD

4-chamber view
+ Tricuspid regurg

10% CHD cases

Syngelaki A et al., Prenat Diagn 2011

Non-Chromosomal First-trimester CHD

Syngelaki A et al., Prenat Diagn 2011

Case#6

History

- 36 y.o G6P2
- Referred for increased NT
- Scheduled for amnio

13 0/7 weeks
13 0/7 weeks

Follow-up

- Normal second trimester fetal echocardiogram
- Delivery at term w/ trisomy 21 confirmed
- No congenital heart disease by postnatal echocardiogram

Non-anatomical Markers for CHD Detection

Ductus Venosus Waveform

First-Trimester DV Screening for CHD: meta-analysis


Total 193 cases CHD/ 100,579 no CHD

<table>
<thead>
<tr>
<th>Group</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>50%</td>
<td>93%</td>
</tr>
<tr>
<td>Increased NT</td>
<td>83%</td>
<td>80%</td>
</tr>
<tr>
<td>Normal NT</td>
<td>19.0%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Tricuspid Regurgitation
Tricuspid Regurgitation for Detection of CHD

FPR 1% 3% 5%
NT alone 25.9% 30.6% 35.3%
NT and DV 29.4% 40.0% 44.7%

85 cases CHD/ 40,905 no CHD

Chelemen T, et al., Fetal Diagn Ther 2011

Reversed DV "a"-wave

NT and DV Doppler: First-trimester major CHD

85 cases CHD/ 40,905 no CHD

FPR 1% 3% 5%
NT alone 25.9% 30.6% 35.3%
NT and DV 29.4% 40.0% 44.7%

NT Screening for Major CHD

85 cases major CHD/ 40,905 no CHD


CHD Detection: Combination of markers

85 cases major CHD/ 40,905 no CHD


Reversed A-wave (DV) Screening for Major CHD

85 cases major CHD/ 40,905 no CHD

First-Trimester Screening for Major CHD

85 cases major CHD/ 40,905 no CHD

<table>
<thead>
<tr>
<th>Marker</th>
<th>OR</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>delta NT</td>
<td>2.3</td>
<td>P&lt; 0.001</td>
</tr>
<tr>
<td>DVF</td>
<td>7.7</td>
<td>P&lt; 0.001</td>
</tr>
<tr>
<td>TR</td>
<td>17.1</td>
<td>P&lt; 0.001</td>
</tr>
</tbody>
</table>

logistic regression analysis

Fetal Cardiac Anatomy at time of NT Screening

- Being done in the best units
- Feasible in at least half cases
- Objective we should work towards
- Definitely should be attempted in women at high-risk for CHD

Conclusion

- TA and TV approach
- Color Flow Doppler
- Non-anatomy markers can identify ~ 50% cardiac defects: LEARN TO USE THEM

Thank You.
Everything You Always Wanted to Know About Fetal Arrhythmias, in 30 Minutes

Fetal Arrhythmias

What is clinically important?
Tachycardia (>200)
Fixed bradycardia (<~100)
Irregular ???

Distribution - 1977-96

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated extrasystoles</td>
<td>1213</td>
</tr>
<tr>
<td>Supraventricular tachycardia</td>
<td>69</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>21</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>4</td>
</tr>
<tr>
<td>Sinus tachycardia</td>
<td>8</td>
</tr>
<tr>
<td>Junctional tachycardia</td>
<td>2</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>6</td>
</tr>
<tr>
<td>Second degree AV block</td>
<td>10</td>
</tr>
<tr>
<td>Sinus bradycardia</td>
<td>2</td>
</tr>
<tr>
<td>Complete heart block</td>
<td>39</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1378</strong></td>
</tr>
</tbody>
</table>

Clinical question:

How often do irregular fetal heart rates signal:
• significant fetal arrhythmias
• neonatal arrhythmias
• other fetal cardiac problems
Irregular FHR: Risk of structural CHD

CHD in 2/614 (0.3%, 95% CI 0-0.7%)
• SVT & overriding aorta
• 2º heart block & corrected TGA
Small VSD’s found in 2 additional neonates

Irregular FHR: Significant Arrhythmias

<table>
<thead>
<tr>
<th>Arrhythmia</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supraventricular tachycardia</td>
<td>5</td>
</tr>
<tr>
<td>Atrial flutter</td>
<td>2</td>
</tr>
<tr>
<td>Ventricular tachycardia</td>
<td>1</td>
</tr>
<tr>
<td>CHD &amp; significant arrhythmia</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
</tr>
</tbody>
</table>

Irregular FHR: Referral for arrhythmia

Total referrals for arrhythmia: 595
Arrhythmia on exam: 255 (42.9%)
NSR on exam: 330 (55.5%)
Other arrhythmias: 10 (1.7%)
Irregular FHR: Pediatric Follow-up

Significant postnatal arrhythmia - 5
WPW 3
Postnatal day 1 2
Age 4 years 1
Chaotic atrial rhythm 1
Frequent PVC’s 1
All had extrasystoles on prenatal scan

Irregular FHR: Proper Management

Current standard:
Fetal echocardiogram
Weekly auscultation
Alternative:
Single fetal monitor session 30-60 minutes
Problem: 23.2% present < 24 weeks
No follow-up if no arrhythmia found
Continue auscultation for those with PAC’s
Fetal SVT
• Be sure of diagnosis
  –
  –
• Talk to your local cardiologist/electrophysiologist
• Be careful with meds:
  –
    can CAUSE one too!
  –Multiple drug interactions
  –Observation often best Rx

Heart block
• Half structural heart disease
  –Complex lesions
• AV Septal defects
• Corrected transposition
  –Heterotaxias (asplenia, polysplenia)
• Half immunologic
  –Anti-SSA/Ro, SSB/La
  –Structural anomalies rare
  –? Treatments in future

Complete Heart block
• Frequent association with hydrops
• Complete heart block + structural heart disease + hydrops = deadly
• Complete heart block & hydrops with immunologic cause may be treatable
Time of Detection of CHB (N= 264)

Complete Heart Block
- Ventricular rate can increase with β- mimetics
- AV contraction sequence is critical
- Myocarditis also present

Risk CHB with anti-Ro/La?
- Prospective study 118 pregnancies/100 women
- All anti-Ro
- CCHB 2% first pregnancies
  - (95% CI 0.2-7%)
- CCHB 0/18 second pregnancies

CHB Early Diagnosis
- Measurement mechanical PR interval
  - Mitral “a” wave = EKG P wave
  - Ventricular systole = QRS complex
  - Time interval onset a wave to systole
- Normal 110-140 msec 2nd & 3rd Δ
- ? ability to identify 1° heart block by prolonged PR interval

CHB Rx steroids
- First reported 1995 (Yale)
- Other case reports
- Review Neonatal Lupus Registry
  - No difference progression with steroids
  - Possible benefit resolution effusions
  - ? Rx started too late to benefit

CHB Rx steroids
- First reported 1995 (Yale)
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  - ? Rx started too late to benefit

Neonatal Lupus Registry
- Subsequent pregnancies in 49
- CHB recurred in 16%
- Neonatal lupus rash in 6%

Brucato Arthritis Rheum 2001;44:1832-5

CHB Early Diagnosis
- Measurement mechanical PR interval
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Brucato Arthritis Rheum 2001;44:1832-5

Glickstein Am J Cardiol 2000;86:236-9

Buyon J Am Coll Cardiol 1998;31:1658-66

J Buyon 10/27/08

70% ≤ 24 weeks
Results

- Complete heart block in 3, all <23 weeks
- TOP 2 for NIH, both after dex
  - Both had normal echo <2 wk earlier
  - Both had TR at prior echo
  - Atrial densities in 1
- 3rd alive at 1 year, with pacemaker

1º heart block in 3:
- 2 detected @ 18-22 weeks
  - Resolved with 3-7 days of dex
  - Both normal EKG at birth
- 1 normal PR through 30 wk
  - Born @ 32 wk
  - 1º degree block on EKG
  - Still present @ 3 years
Summary
- 1° heart block may be reversible with dex
- High recurrence rate substantiated
- Advanced block & cardiomyopathy can occur within 1 week of a normal mechanical PR interval
- Tricuspid regurgitation and atrial echodensities may be important markers of impending conduction system injury
- 3° block not reversible despite immediate intervention

Conclusions
- Even weekly evaluation of mechanical PR interval alone may not be sufficient
- We are unable to conclude whether 1° block is a necessary step along a path to complete block
- Needed: A reliable marker of early disease and/or a safe and economical method of prophylaxis

Speculation
- Weekly echo from 17 - 23 weeks
- If either:
  - Atrial echodensity
  - Tricuspid regurgitation
  - Prolonged mechanical PR interval
- Offer maternal dexamethasone
CHB in Labor External Tracing

CHB in Labor Internal Scalp Electrode

Ultrasound Image
Coding the Ob scan
Joshua A. Copel, MD
Professor, Obstetrics-Gynecology & Pediatrics
Yale University School of Medicine

Objectives
At the conclusion of this presentation you will be able to:
1. Code your scans more accurately
2. Understand new CPT & ICD codes

Conflicts
• Member of AMA
• No financial conflicts
• Depend on insurance companies for income
• Contribution to my salary from Yale Corporation for being a Professor: $0

Coding in Ob Sonography
The Bibles:

• CPT book sets rules
• Descriptions imperfect
• Review usual Ob codes, recent changes, future trends

Coding in Ob Sonography

“When I use a word,” Humpty Dumpty said in rather a scornful tone, “it means just what I choose it to mean - neither more nor less.”

Lewis Carroll, Through the Looking Glass
“Give ‘em hell, Harry. I never give them hell. I just tell the truth and they think it’s hell.”

Harry S. Truman

**Coding in Ob Sonography**
- Codes assigned by CPT Committee of AMA
- Representation from ACOG, ACR, AIUM
- Changes proposed from members

**Coding in Ob Sonography**
- If accepted, Relative Value Units (RVUs) assigned by Relative Value Committee (RUC) after polling practitioners
- RVUs are based on average work
- Budget neutrality often an issue in assigning RVUs
- RVUs used by some payors to determine reimbursement

**Coding in Ob Sonography**
- -22 Unusual complexity (good luck)
- -26 Professional component
  - Facility bills -TC
- Bill global only if all 3 of these are true:
  - YOU own or lease the machine, and
  - YOU own or rent the space, and
  - YOU employ the sonographer
- Otherwise you MUST use -26!

**FAQs**
If I have a low risk patient and do a REALLY thorough scan, can I bill 76811 instead of 76805?

Answer: Unfortunately no. Code the indication, not the procedure

**FAQs**
But my compliance office says that’s fraud!

Answer: They’re wrong. Code the indication, not the scan
FAQs
I scan my diabetics and hypertensives regularly for growth and always do a thorough examination of fetal anatomy. How do I code?
Answer: 76816, those are follow up exams.

FAQs
How should I code Ductus Venosus Doppler?
Answer: it's a freebie.
Relax, you're not doing that in isolation, are you?

FAQs
Can I assign 740-759 series codes as a secondary code when a fetal anomaly is found?
Answer: Codes from Chapter 14 Congenital Anomalies (740-759.9) should not be reported as a secondary code
Use codes from the 655.xx series
These codes on maternal record give the mother the anomaly

Coming Attraction(s)
• October 1, 2013: ICD-10
• Used in rest of world
• Now ~14,500 codes
• ICD-10 has ~70,000!

New term: GEMS
• General Equivalence Mapping
• "A sentence translated from English to Chinese may not be able to capture the full meaning of the original because of fundamental differences in the structure of the language. Likewise, a code set may not be able to seamlessly link the codes in one set to identical counterparts in the other code set."
NCHS web site

GEMS rules
• There are no rules
• Variable number of new codes
• Arranged according to different "axes"
“Unequal axes of classification”

Classified by stage of pregnancy: ICD-10-CM

- 026.851 Spotting complicating pregnancy, 1st tri
- 026.852 Spotting complicating pregnancy, 2nd tri
- 026.853 Spotting complicating pregnancy, 3rd tri
- 026.859 Spotting complicating pregnancy, unspecified trimester

Classified by episode of care: ICD-9-CM

- 649.50 Spotting complicating pregnancy, unspecified episode of care
- 649.51 Spotting complicating pregnancy, delivered
- 649.53 Spotting complicating pregnancy, antepartum

ICD-10 rules

- Some similar to ICD-9
- Deformations and chromosomal abnormalities (Q00-Q99)
- Codes from this chapter are not for use on maternal or fetal records

Our areas of interest

- Chapter 14 contains “Inflammatory diseases of female pelvic organs,” and “Noninflammatory disorders of female genital tract”

Endometriosis

- N80.0 Endometriosis of uterus
- Adenomyosis
- N80.1 Endometriosis of ovary
- N80.2 Endometriosis of fallopian tube
- N80.3 Endometriosis of pelvic peritoneum
- N80.4 Endometriosis of rectovaginal septum and vagina
- N80.5 Endometriosis of intestine
- N80.6 Endometriosis in cutaneous scar
- N80.8 Other endometriosis
- N80.9 Endometriosis, unspecified

Pregnancy- Chapter 15

Codes from this chapter are for use for conditions related to or aggravated by the pregnancy, childbirth, or by the puerperium (maternal causes or obstetric causes)

- Trimesters are counted from the first day of the last menstrual period. They are defined as follows:
  - 1st trimester- less than 14 weeks 0 days
  - 2nd trimester- 14 weeks 0 days to less than 28 weeks 0 days
  - 3rd trimester- 28 weeks 0 days until delivery

- Use additional code from category Z3A, Weeks of gestation, to identify the specific week of the pregnancy

Actual screen shot

- D16.0 Pre-existing essential hypertension complicating pregnancy, childbirth and the puerperium
  - Any condition in ICD specified as a reason for obstetric care during pregnancy, childbirth or the puerperium
- D16.01 Pre-existing essential hypertension complicating pregnancy
- D16.011 Pre-existing essential hypertension complicating pregnancy, first trimester
- D16.012 Pre-existing essential hypertension complicating pregnancy, second trimester
- D16.013 Pre-existing essential hypertension complicating pregnancy, third trimester
- D16.019 Pre-existing essential hypertension complicating pregnancy, unspecified trimester
- D16.02 Pre-existing essential hypertension complicating childbirth
- D16.03 Pre-existing essential hypertension complicating the puerperium
How about ultrasound?

- “Congenital” only used in relation to uterine anomalies
- “Defect” only used for coagulation defects

Look familiar?

- 035.0 Maternal care for (suspected) central nervous system malformation in fetus
- 035.1 Maternal care for (suspected) chromosomal abnormality in fetus
- 035.2 Maternal care for (suspected) hereditary disease in fetus
- 035.3 Maternal care for (suspected) damage to fetus from viral disease in mother
- 035.4 Maternal care for (suspected) damage to fetus from alcohol
- 035.5 Maternal care for (suspected) damage to fetus by drugs
- 035.6 Maternal care for (suspected) damage to fetus by radiation
- 035.7 Maternal care for (suspected) damage to fetus by other medical procedures
- 035.8 Maternal care for other (suspected) fetal abnormality and damage
- 035.9 Maternal care for (suspected) fetal abnormality and damage, unspecified

Coding in Ob Sonography

Additional resources:
  - Available at <www.smfm.org>
- ACOG “CPT Coding in Obstetrics & Gynecology”
  Both updated annually

Coding in Ob Sonography

1st Trimester

- 76801 Ultrasound, pregnant uterus, real time with image documentation, fetal and maternal evaluation, first trimester (<14 weeks 0 days), transabdominal approach; single or first gestation
- 76802 ; each additional gestation (List separately in addition to code for primary procedure performed)

Coding in Ob Sonography

2nd Trimester

- 76805 Ultrasound, pregnant uterus, real time with image documentation, fetal and maternal evaluation, after first trimester (≥14 weeks 0 days), transabdominal approach; single or first gestation
- 76810 ; each additional gestation
Coding in Ob Sonography

2nd/3rd Trimester

• 76811 Ultrasound, pregnant uterus, real time with image documentation, maternal evaluation plus detailed fetal anatomic examination, transabdominal approach; single or first gestation
• 76812 each additional gestation (List separately in addition to code for primary procedure)

• 76815 Ultrasound, pregnant uterus, real time with image documentation, limited (eg, fetal heart beat, placental location, fetal position and/or qualitative amniotic fluid volume), one or more fetuses
• Use 76815 only once per exam and not per element

• 76816 Ultrasound, pregnant uterus, real time with image documentation, follow-up (eg, re-evaluation of fetal size by measuring standard growth parameters and amniotic fluid volume, re-evaluation of organ system(s) suspected or confirmed to be abnormal on a previous scan), transabdominal approach, per fetus
• Report 76816 with modifier ‘-59’ for each additional fetus examined in a multiple pregnancy

• Physician interpretation and signed final report are components of all of the codes
• Cannot bill 76805 or 76810 simultaneously to 76815, they are mutually exclusive

• What about when patient comes back much later?
• Is there a new indication or is this scan for the same indication?
  – If new indication, use 76805
  – If not new, use 76816
Yes, even if you do all the biometry, etc

Coding in Ob Sonography

Vaginal Sonography

• 76817 Ultrasound, pregnant uterus, real time with image documentation, transvaginal
• For gyn transvaginal ultrasound, use 76830
• If transvaginal examination is done in addition to transabdominal obstetrical ultrasound, use 76817 in addition to appropriate transabdominal code
### Coding in Ob Sonography

**Biophysical Profile**

- **76818** Fetal biophysical profile; with non-stress testing
- **76819** Fetal biophysical profile; without non-stress testing

**Coding in Ob Sonography**

**Biophysical Profile**

- **76818 & 76819** both include MD interpretation and report
- **76819** replaces downcoding 76818 when BPP by Radiologist, NST by Ob-Gyn
- For AFI alone use 76815 (limited)
  - Add 59025 if NST done too

---

**Coding in Ob Sonography**

**Doppler**

- **76820** Umbilical artery Doppler
- **76821** Middle cerebral artery Doppler
- **76827** Echocardiography (heart)
- **93325** Color Doppler echocardiography
  - Use with 76825, Fetal echo
  - NOT for finding the umbilical arteries

---

**Coding in Ob Sonography**

**3D/4D Sonography**

- **76376** Multiplanar reconstruction of ultrasound, computerized tomography, magnetic resonance imaging, or other tomographic modality using US machine
- **76377** same but off-line reconstruction
- **Add on codes**

**Coding in Ob Sonography**

**3D/4D Sonography**

- **76376** assigned 4.39 RVUs (in CT)
  - Technical: 4.19
  - Professional: 0.20 ($7.58)
- What’s good old 76805?
  - Total: 3.75
  - Technical: 2.27
  - Professional: 1.48

---

**Coding the NT exam**

- New codes January ’07
  - 76813 First fetus
  - 76814 Each additional fetus
  - Regardless of TA or TV approach
  - Stand-alone or add-on (IF you do full 76801)
Coding in Ob Sonography

- 59000 Genetic or Lung Maturity amnio
  - Bill with 76946 for guidance (if YOU do it)
- 59001 Therapeutic amnioreduction
  - Treatment of twin-twin transfusion syndrome, severe polyhydramnios
  - Code includes ultrasound guidance so DO NOT bill that separately!

### SMFM Statement on 76811

Because this new code will be assigned more RVUs than the basic obstetrical sonogram (76805), the SMFM believes that the new code describes an examination involving significantly more work, and requiring greater expertise than that required for 76805. Additionally, sophisticated equipment, rather than typical office level ultrasound machines, will be required to obtain the necessary imaging detail.

### SMFM Statement on 76811

“The level of expertise required to perform this examination can generally only be obtained through the extended education beyond residency that is acquired in a fellowship in Maternal-Fetal Medicine or Radiology... Use of this code by general obstetricians should be the exception rather than the rule.”

### Coding in Ob Sonography

- 59070 Transabdominal amnioinfusion
- 59072 Umbilical cord occlusion
- 59074 Fetal fluid aspiration
- 59076 Fetal shunt placement
- 59897 Other unlisted fetal procedure

### Base RVU Assignments

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>RVU</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>76805</td>
<td>Basic scan</td>
<td>1.00</td>
<td>+0.01</td>
</tr>
<tr>
<td>76810</td>
<td>Multiple*</td>
<td>0.97</td>
<td>-1.00</td>
</tr>
<tr>
<td>76815</td>
<td>Limited</td>
<td>0.65</td>
<td>+0.00</td>
</tr>
<tr>
<td>76816</td>
<td>Follow-up*</td>
<td>0.85</td>
<td>+0.28</td>
</tr>
<tr>
<td>76801</td>
<td>1st trimester</td>
<td>0.99</td>
<td>+0.99</td>
</tr>
<tr>
<td>76802</td>
<td>1st tri multiple*</td>
<td>0.83</td>
<td>+0.83</td>
</tr>
<tr>
<td>76811</td>
<td>Comp. Fetal survey</td>
<td>1.90</td>
<td>+1.90</td>
</tr>
<tr>
<td>76812</td>
<td>Comp. Fetal survey*</td>
<td>1.78</td>
<td>+1.78</td>
</tr>
<tr>
<td>76817</td>
<td>Ob transvag</td>
<td>0.76</td>
<td>+0.07</td>
</tr>
</tbody>
</table>

*per fetus

These are all professional component (-26) assignments
ICD Codes

- Know if your carriers pay attention
- Use all that apply
- Prioritize
- Try not to use “V codes” (screening codes) as primary indication
- New ICDs fetal indications 2008, 2010
- Anthem: AMA not an indication for ultrasound/amnio etc

ICD Codes - Anatomy survey

If AMA:
1. 655.13 Suspected/known chromosome abnormality
2. Either:
   - 659.53 AMA, first pregnancy, or
   - 659.63 AMA, 2+ pregnancy
   OR
   - V23.81 Elderly primigravida, or
   - V23.82 Elderly multigravida
3. V28.81 Encounter for fetal anatomic survey

ICD Codes - Anatomy survey

For History congenital anomalies:
1. 655.23 Suspected/known hereditary disease affecting fetus
2. V19.5 Family history congenital anomalies
3. V28.81 Encounter for fetal anatomic survey

New ICD Codes 10/08

- V28.3 Encounter for routine screening for malformation using ultrasonics
- V28.82 Encounter for screening for risk of pre-term labor
- V28.89 Other specified antenatal screening (NT, CVS)

New ICD Codes 10/08

- V89.01 Suspected problem with amniotic cavity and membrane not found
- V89.02 Suspected placental problem not found
- V89.03 Suspected fetal anomaly not found
- V89.04 Suspected problem with fetal growth not found
- V88.03 Acquired absence of cervix with remaining uterus
- V89.05 Suspected cervical shortening not found
- V89.09 Other suspected maternal and fetal condition not found
New ICD Codes 10/08

• V15.21 Personal history of undergoing in utero procedure during pregnancy
• V15.22 Personal history of undergoing in utero procedure while a fetus
• V23.86 Pregnancy with history of in utero procedure during previous pregnancy

New ICD Codes 10/08

• V23.85 Pregnancy resulting from assisted reproductive technology

Coding Example 1

Patient has an increased risk for Down Syndrome or Trisomy 18. Ultrasound findings are normal. Code this as:
• 655.13 (Known or suspected chromosomal abnormality of the fetus)
• 796.5 (Abnormal finding on antenatal screening)
• V89.03 (Suspected fetal anomaly not found)
• V28.81 Encounter for fetal anatomic survey

Coding Example 2

Patient referred for suspected polyhydramnios. Consultative scan shows normal amniotic fluid volume.
• 657.03 (Polyhydramnios)
• V89.01 (Suspected problem with amniotic cavity and membrane not found)

New ICD Codes 10/08

• 649.7(0, 1, 3) Cervical shortening, unspecified as to episode of care or not applicable
• 678.0(0, 1, 3) Fetal hematologic conditions
• 678.1(0, 1, 3) Fetal conjoined twins
• 679.0X, 679.1X complications of in utero procedures

ICD Codes- Fetal diseases (655)

• 655.03 Susp/known CNS malformation
• 655.13 Susp/known chromosome anomaly
• 655.23 Susp/known hereditary disease
• 655.33 Susp/known damage from maternal viral disease
• 655.43 Susp/known damage from maternal disease (Alcohol)
ICD Codes - Fetal diseases (655)
- 655.53 Susp/known damage from drugs
- 655.63 Susp/known damage from radiation
- 655.73 Susp/known decreased fetal movement
- 655.83 Susp known fetal abnormality NEC (Not Elsewhere Classified)

ICD codes - Placenta
- 641.03 Placenta previa without hemorrhage
- 641.13 Placenta previa with hemorrhage, or Pregnancy bleeding
- 641.23 Placental abruption
- 656.73 Placenta, abnormal

ICD Codes - Fetal growth/fluid
- 656.53
  - Size < dates, or IUGR
  - Suspected oligohydramnios
- 656.63
  - Size > dates, or macrosomia
  - Suspected polyhydramnios
- 657.03 Polyhydramnios
- 658.03 Oligohydramnios
- V28.8 Dating/growth screening

ICD Codes - a few more
- 654.13 Fibroids in pregnancy
- 654.53 Incompetent cervix
- 646.13 Excessive maternal weight gain
- 646.83 Poor maternal weight gain
- V28.4 Screening for IUGR by ultrasound

ICD Codes
- Do NOT use 760 - 779.9
- Even though these have word “fetal” in description
- Neonatal/pediatric codes
- Use will result in automatic rejection of claim

New October 1, 2010
- 752.31 Agenesis of uterus
- 752.32 Hypoplasia of uterus
- 752.33 Unicorne uterus
- 752.34 Bicornuate uterus
- 752.35 Septate uterus
- 752.36 Arcuate uterus
- 752.39 Other anomalies of uterus
**New October 1, 2010**

- 752.43 Cervical agenesis
- 752.44 Cervical duplication
- 752.45 Vaginal agenesis
- 752.46 Transverse vaginal septum
- 752.47 Longitudinal vaginal septum

**New October 1, 2010**

- V85.41 BMI 40.0-44.9
- V85.42 BMI 45.0-49.9
- V85.43 BMI 50.0-59.9
- V85.44 BMI 60.0-69.9
- V85.45 BMI ≥70

**New for 2010 - Twins**

- V91.00 Unspecified # of placenta, unspecified # of amniotic sacs
- V91.01 Monochorionic/monoamniotic
- V91.02 Monochorionic/diamniotic
- V91.03 Dichorionic/diamniotic
- V91.09 Unable to determine # of placenta and # of amniotic sacs

**New for 2010- Triplets**

- V91.10 Triplet gestation, unspecified number of placenta and unspecified number of amniotic sacs
- V91.11 Two or more monochorionic
- V91.12 Two or more monoamniotic
- V91.19 Triplet gestation, unable to determine # of placenta & amniotic sacs

**New for 2010, >3 fetuses**

- V91.2X for various combinations of quads
- V91.9X for >4
- Still have 651 series for multiples in general

**New for 2011**

- 649.81 Onset (spontaneous) of labor after 37 completed weeks but before 39 completed weeks gestation, with delivery by (planned) cesarean section