UPDATE ON DIAGNOSIS AND MANAGEMENT OF FETAL GROWTH RESTRICTION

Eduard Gratacós

BCNatal – Barcelona Center of Maternal-Fetal and Neonatal Medicine Hospital Clínic and Hospital Sant Joan de Déu, Universitat de Barcelona

www.fetalmedicinebarcelona.org/
Dichorionic twins. Doppler UA N. Born 34 w
“Normal” development so far

1950 g (p45)  1200 g (p1)
Dichorionic twins. Doppler UA N. Born 34 w
“Normal” development so far

1950 g (p45) 1200 g (p1)

Lagercrantz H. Better born too soon than too small. Lancet 1997

Satchev, 2012
Figueras 2006-2011
Baschat 2009, 2011
Vohr 2004
Geva 2002-2011
Marsal 00-06
Visser 01-11
Placental insufficiency = high risk of IUFD and fetal/neonatal acidosis
Fetal Smallness = higher risk of placental insufficiency
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Fetal Smallness = higher risk of placental insufficiency

Risk of placental insufficiency

Fetal weight centile

“Small fetuses”

Placental “respiratory” smallness = risk distress + IUFD
Placental insufficiency = high risk of IUFD and fetal/neonatal acidosis
Fetal Smallness = higher risk of placental insufficiency
1. Identify small fetus

2. Identify placental insufficiency (FGR vs. SGA)

3. Determine timing of delivery
Neonatal and Fetal GA-adjusted “normal” weight in the same population
Neonatal and Fetal GA-adjusted “normal” weight in the same population
IMPROVING DETECTION: THE DEFINITION OF “RESTRICTION”

Birthweight inverse relation with perinatal outcome AND brain-cardiac remodelling
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Birthweight inverse relation with perinatal outcome AND brain-cardiac remodelling

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IMPROVING DETECTION: THE DEFINITION OF “RESTRICTION”

Birthweight inverse relation with perinatal outcome AND brain-cardiac remodelling
IMPROVING DETECTION: THE DEFINITION OF “RESTRICTION”

Birthweight inverse relation with perinatal outcome AND brain-cardiac remodelling
5-15% during 3rd trimester
30% perinatal complications; 10-15% term stillbirth

- 4% preterm delivery
- 1% stillbirth
- 25% IUGR
- 70% Normal

decrease of fetal movements
Decrease of fetal movements

- 5-15% during 3rd trimester
- 30% perinatal complications; 10-15% term stillbirth

- 25% IUGR
- 4% preterm delivery
- 1% stillbirth

- Stillbirth reduction OR 0.36
- Increase IUGR detection (IUGR > 36 w not diagnosed before)

- 70% Normal
5-15% during 3rd trimester
30% perinatal complications; 10-15% term stillbirth

- 4% preterm delivery
- 1% stillbirth
- 25% IUGR
- 70% Normal

- stillbirth reduction OR 0.36
- increase IUGR detection (IUGR > 36 w not diagnosed before)
1. Identify small fetus

2. Identify placental insufficiency (FGR vs. SGA)

3. Determine timing of delivery
Exclude primary fetal defect

Exclude extrinsic cause

ISOLATED FETAL SMALLNESS = POORER PROGNOSIS
Perinatal and Long-term Outcomes
Exclude primary fetal defect

Exclude extrinsic cause

ISOLATED FETAL SMALLNESS = POORER PROGNOSIS
Perinatal and Long-term Outcomes

Poor perinatal outcome + IUFD
(Doppler) Signs of adaptation
ISOLATED FETAL SMALLNESS = POORER PROGNOSIS
Perinatal and Long-term Outcomes

Exclude primary fetal defect

Exclude extrinsic cause

Poor perinatal outcome + IUFD
(Doppler) Signs of adaptation

Perinatal outcome normal - No IUFD
NO signs of adaptation
Exclude primary fetal defect

Exclude extrinsic cause

**ISOLATED FETAL SMALLNESS = POORER PROGNOSIS**

**Perinatal and Long-term Outcomes**

- Poor perinatal outcome + IUFD
  - (Doppler) Signs of adaptation

- Perinatal outcome normal - No IUFD
  - NO signs of adaptation

**FGR**
- Placental insufficiency

**SGA**
- Unknown (constitutional + others)
ISOLATED FETAL SMALLNESS = POORER PROGNOSIS
Perinatal and Long-term Outcomes

exclude primary fetal defect
exclude extrinsic cause

Poor perinatal outcome + IUFD
(Doppler) Signs of adaptation
FGR
Placental insufficiency

Perinatal outcome normal - No IUFD
NO signs of adaptation
SGA
Unknown (constitutional + others)

www.fetalmedicinebarcelona.org/
Exclude primary fetal defect

Exclude extrinsic cause

**ISOLATED FETAL SMALLNESS = POORER PROGNOSIS**

**Perinatal and Long-term Outcomes**

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FGR vs. SGA: DIFFERENT MANAGEMENT

www.fetalmedicinebarcelona.org/
The discovery of UA and hemodynamics of FGR

- Constitutionally small
  - SGA
- Placental insufficiency
  - FGR
- Extrinsic cause
- Primary fetal defect

www.fetalmedicinebarcelona.org/
The discovery of UA and hemodynamics of FGR

- Constitutionally small
- Placental insufficiency
- Extrinsic cause

Primary fetal defect

SGA
FGR

The graph shows the distribution of cases (N) over gestational weeks (20 to 40). The x-axis represents gestational weeks, and the y-axis represents the number of cases (N cases).
The discovery of UA and hemodynamics of FGR

Constitutionally small ➔ SGA

Placental insufficiency ➔ FGR

Extrinsic cause ➔ Primary fetal defect

UA Doppler + (EARLY-ONSET)

www.fetalmedicinebarcelona.org/
The discovery of UA and hemodynamics of FGR

Constitutionally small  Placental insufficiency  Extrinsic cause

SGA  FGR

Primary fetal defect

UA Doppler + (EARLY-ONSET)

UA Doppler N (LATE-ONSET)

Savchev 2013

www.fetalmedicinebarcelona.org/
The discovery of UA and hemodynamics of FGR

Constitutionally small ➔ SGA
Placental insufficiency ➔ FGR
Extrinsic cause ➔ Primary fetal defect

FGR = abnormal UA Doppler

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FGR = abnormal UA Doppler?
FGR = abnormal UA Doppler?

not anymore
FGR = abnormal UA Doppler?

UA Doppler + (EARLY-ONSET)

UA Doppler N (LATE-ONSET)

Savchev 2013

www.fetalmedicinebarcelona.org/
Prognostic criteria for poor outcome among small fetuses with normal UA Doppler

- CPR <p5
- UtA >p95
- EFW CENTILE <3

Risk of CS for distress and/or neonatal acidosis
N=509 SGA + 509 controls

www.fetalmedicinebarcelona.org/
Risk of CS for distress and/or neonatal acidosis
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Figueras 2012
Prognostic criteria for poor outcome among small fetuses with normal UA Doppler

- CPR <p5
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Risk of CS for distress and/or neonatal acidosis
N=509 SGA + 509 controls

- 50%
- 40%
- 30%
- 20%
- 10%
- 8%
- 0%

Controls | All normal | Any abnormal

Figueras 2012

www.fetalmedicinebarcelona.org/
Prognostic criteria for poor outcome among small fetuses with normal UA Doppler

- CPR <p5
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Risk of CS for distress and/or neonatal acidosis
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- 40%
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- 10%
- 0%

Controls 8%
All normal 11%
Any abnormal

www.fetalmedicinebarcelona.org/

Figueras 2012
Prognostic criteria for poor outcome among small fetuses with normal UA Doppler

- CPR <p5
- UtA >p95
- EFW CENTILE <3

Risk of CS for distress and/or neonatal acidosis
N=509 SGA + 509 controls

- Controls: 8%
- All normal: 11%
- Any abnormal: 40%
Cerebroplacental ratio is more sensitive than UA or MCA alone

IPUA = p80

IPMCA = p20

CPR < p5

Sensitivity (95% CI)

- Bahado-Singh RO: 0.41 (0.30 - 0.52)
- Obido AO: 0.61 (0.49 - 0.72)
- Arias F: 0.49 (0.32 - 0.65)
- Gramellini D: 0.86 (0.42 - 1.00)
- Makhseed M: 0.63 (0.42 - 0.81)
- Habek D: 0.39 (0.17 - 0.64)
- Sterne G: 0.58 (0.39 - 0.75)
- Yalti S: 0.86 (0.57 - 0.98)
- Ebrashy A: 1.00 (0.89 - 1.00)

Pooled Sensitivity = 0.59 (0.53 to 0.64)
Chi-square = 57.86, df = 8 (p = 0.0000)
Inconsistency (I-square) = 86.2 %
FGR = EFW <p10 + any of

- CPR <p5
- UtA >p95
- EFW CENTILE <3
Distribution of cases when FGR = abnormal UA Doppler

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Distribution of cases when FGR = abnormal CPR or UtA or EFW<p3
Excluding primary fetal defect and extrinsic cause.

**ISOLATED FETAL SMALLNESS = POORER PROGNOSIS**

**Perinatal and Long-term Outcomes**

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**FGR vs. SGA: DIFFERENT MANAGEMENT**

[www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
1. Identify small fetus
2. Identify placental insufficiency (FGR vs. SGA)
3. Determine timing of delivery
FGR = abnormal CPR or UtA or EFW < p3

Savchev 2013
FGR = abnormal CPR or UtA or EFW <p3

Savchev 2013

www.fetalmedicinebarcelona.org/
FGR = abnormal CPR or UtA or EFW < p3

www.fetalmedicinebarcelona.org/
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Savchev 2013

www.fetalmedicinebarcelona.org/
FGR = abnormal CPR or UtA or EFW <p3
FGR = abnormal CPR or UtA or EFW

Management = when should we deliver?

Savchev 2013
FGR = abnormal CPR or UtA or EFW<p3
Management = when should we deliver?

PROBLEM: DETECTION
Q: Is it FGR or SGA?

Late-mild
No IUFD <37w (risk at term)

www.fetalmedicinebarcelona.org/
FGR = abnormal CPR or UtA or EFW<\text{p3}

Management = when should we deliver?

Early-severe
High risk IUFD preterm

PROBLEM: TIMING DELIVERY
Q: Delivery? Next exam?

Late-mild
No IUFD <37w (risk at term)

PROBLEM: DETECTION
Q: Is it FGR or SGA?

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RATIONALE FOR AN INTEGRATED STAGE-BASED APPROACH TO THE MANAGEMENT OF FGR

PLACENTAL DISEASE

HYPOXIA

ACIDOSIS

SERIOUS INJURY

DEATH

Increment placental impedance

Centralization

cardiac ischemia
Diastolic failure

Systolic cardiac failure

Risks of prematurity

MINIMAL

MILD

HIGH

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RATIONALE FOR AN INTEGRATED STAGE-BASED APPROACH TO THE MANAGEMENT OF FGR

- PLACENTAL DISEASE
- HYPOXIA
- ACIDOSIS
- SERIOUS INJURY
- DEATH

**Risks of prematurity**
- Minimal
- MILD
- HIGH

- Increment placental impedance
- Centralization
- Diastolic failure
- Systolic cardiac failure

BPP < 4

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RATIONALE FOR AN INTEGRATED STAGE-BASED APPROACH TO THE MANAGEMENT OF FGR

**PLACENTAL DISEASE**
- Diagnostic/chronic markers
- Increment placental impedance

**HYPOXIA**
- Centralization

**ACIDOSIS**
- Diastolic failure
- cCTG: reduced STV

**SERIOUS INJURY**
- Systolic cardiac failure

**DEATH**

Risks of prematurity
- MINIMAL
- MILD
- HIGH

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RATIONALE FOR AN INTEGRATED STAGE-BASED APPROACH TO THE MANAGEMENT OF FGR

Placental Disease

Diagnostic/chronic markers
- DIFFERENCE
- FGR VS SGA

Diagnostic markers
- Impedance
- Centralization

Hyoxia

Prognostic/Acute markers
- INDICATION ABOUT THE SHORT-TERM RISK
  OF IUFD/brain injury

Acidosis

Serious Injury Death

- Cardiac ischemia
- Diastolic failure
- Systolic cardiac failure
- BPP < 4

Risks of prematurity

- MINIMAL
- MILD
- HIGH

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RATIONALE FOR AN INTEGRATED STAGE-BASED APPROACH TO THE MANAGEMENT OF FGR

PLACENTAL DISEASE

Diagnostic/chronic markers
DIFFERENCE
FGR VS SGA

HYPOXIA

ACIDOSIS

SERIOUS INJURY

DEATH

Diagnostic/chronic markers
DIFFERENCE
FGR VS SGA

Prognostic/Acute markers
INDICATION ABOUT THE SHORT-TERM RISK
OF IUFD/Brain injury

Increment placental impedance

Centralization

Systolic cardiac failure

Diastolic failure

cCTG: reduced STV

BPP < 4

Stage fetal deterioration

I

II

III

IV

Risks of prematurity

MINIMAL

MILD

HIGH

deliver when risks are:

www.fetalmedicinebarcelona.org/
## Protocol FGR

First step: UtA + CPR + EFW = SGA or FGR

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**CPR**
- <p5

**Ut A**
- >p95

**EFW**
- <p3
Protocol FGR
First step: UtA + CPR + EFW = SGA or FGR

I  low EFW (<p3) or mild placental resistance / redistribution

II Severe placental resistance / redistribution

III Severe hemodynamic adaptation
   - Low suspicion acidosis

IV High suspicion of acidosis
   - High risk of death

www.fetalmedicinebarcelona.org/
Protocol FGR
First step: UtA + CPR + EFW = SGA or FGR

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- **CPR <p5**
- **Ut A >p95**
- **EFW <p3**
- **AEDV**
- **Aol >p95**
- **DV >p95**
- **REDV**
## Protocol FGR

First step: UtA + CPR + EFW = SGA or FGR

### I. Low EFW (<p3) or mild placental resistance / redistribution

- **CPR**: <p5
- **UtA**: >p95
- **EFW**: <p3

### II. Severe placental resistance / redistribution

- **AEDV**
- **Aol**: >p95

### III. Severe hemodynamic adaptation - Low suspicion acidosis

- **DV**: >p95
- **REDV**

### IV. High suspicion of acidosis - High risk of death

- **DV**: (a rev)
- **CGT decelerations of reduced short-term variability**

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# FGR

Management protocol according to severity stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mort.</th>
<th>Morb.</th>
<th>Risk of IUFD/brain injury</th>
<th>Deliver at</th>
<th>Follow-up</th>
<th>Mode</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>&lt;26w</td>
<td>&gt;90%</td>
<td>EFW&lt;p3, CPR &lt;p5, UtA&gt;95</td>
<td>37</td>
<td>1/w</td>
<td>LI</td>
</tr>
<tr>
<td>II</td>
<td>26-28</td>
<td>50%</td>
<td>LOW</td>
<td>37</td>
<td>1/w</td>
<td>LI</td>
</tr>
<tr>
<td>III</td>
<td>28-30</td>
<td>&lt;10%</td>
<td>LOW</td>
<td>37</td>
<td>1/w</td>
<td>LI</td>
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<tr>
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Risk of IUFD/brain injury

- MODERATE: AEDV, AoI>95
- LOW: EFW<p3, CPR <p5, UtA>95

Deliver at

- 34 weeks
- 37 weeks

Follow-up

- 2/w
- 1/w

Mode

- CS or LI
- LI

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## FGR

Management protocol according to severity stages

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<td>HIGH</td>
<td>30</td>
<td>1-2 d</td>
<td>CS</td>
</tr>
<tr>
<td>II</td>
<td>MODERATE</td>
<td>34</td>
<td>2/w</td>
<td>CS or LI</td>
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Visit our website: [www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
# FGR

**Management protocol according to severity stages**

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<td>Hours/Daily</td>
<td>1-2 d</td>
<td>2/w</td>
<td>1/w</td>
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<tr>
<td>Mode</td>
<td>CS</td>
<td>CS</td>
<td>CS or LI</td>
<td>LI</td>
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- **Mode**:
  - CS: Caesarean section
  - LI: Low intervention

- **Follow-up**:
  - Hours/Daily: Hours of daily monitoring
  - 2/w: Twice weekly monitoring
  - 1/w: Once weekly monitoring

- **Risk of IUFD/brain injury**:
  - VERY HIGH
  - HIGH
  - MODERATE
  - LOW

- **Deliver at**:
  - Any time
  - 30
  - 34
  - 37

- **Follow-up**:
  - Hours/Daily
  - 1-2 d
  - 2/w
  - 1/w

- **Mode**:
  - CS: Caesarean section
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## FGR Management Protocol According to Severity Stages

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- **Risk of IUFD/brain injury**:
  - VERY HIGH
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  - MODERATE
  - LOW

- **Deliver at**:
  - Any time
  - 30
  - 34
  - 37

- **Follow-up**:
  - Hours/Daily
  - 1-2 d
  - 2/w
  - 1/w

- **Mode**:
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## Mortality and Morbidity

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- **Mortality**:
  - >90%
  - 50%
  - <10%
  - 50%

- **Morbidity**:
  - >90%
  - 50%

---

[www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
# FGR

## Management protocol according to severity stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>IV</th>
<th>III</th>
<th>II</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of IUFD/brain injury</td>
<td>VERY HIGH</td>
<td>HIGH</td>
<td>MODERATE</td>
<td>LOW</td>
</tr>
<tr>
<td>Deliver at</td>
<td>Any time</td>
<td>30</td>
<td>34</td>
<td>37</td>
</tr>
<tr>
<td>Follow-up</td>
<td>Hours/Daily</td>
<td>1-2 d</td>
<td>2/w</td>
<td>1/w</td>
</tr>
<tr>
<td>Mode</td>
<td>CS</td>
<td>CS</td>
<td>CS or LI</td>
<td>LI</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;26w</td>
<td>26-28</td>
<td>28-30</td>
<td>30-34</td>
</tr>
<tr>
<td>&gt;90%</td>
<td>50%</td>
<td>&lt;10%</td>
<td>50%</td>
</tr>
</tbody>
</table>

[www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
### Fetal Growth

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational Age</td>
<td>34</td>
</tr>
<tr>
<td>Fetal Age</td>
<td>1</td>
</tr>
<tr>
<td>Last Menstrual period</td>
<td>1/1/2014</td>
</tr>
<tr>
<td>EFW</td>
<td>1850</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
</tr>
</tbody>
</table>

**Percentile:** 5
UA Doppler PI: 1.26 Percentile: 70

UA Diastolic flow: Present

MCA Doppler M.CA PI: 1.15

Ut.A Right Doppler: 1.4

Ut.A Left Doppler: 1.1

CPR (Percentile: 1) 0.91

Ao Isthmus Diastolic Flow: Present

DV PI: 0.91 Percentile: 50

D.V. Atrial Flow: Present

Gender: Female

Gestational Age: 34

Last Menstrual period: 1/1/2014

EFW: 1850

Weight: 1

BCNATAL

www.fetalmedicinebarcelona.org/
UA Doppler PI: 1.26 Percentile: 70

UA Diastolic flow Present

MCA Doppler M.CA PI: 1.15

Ut.A Right Doppler: 1.4

Ut.A Left Doppler: 1.1

CPR (Percentile:1) 0.91

Ao Isthmus Diastolic Flow: Present

DV PI: 0.91 Percentile: 50

D.V. Atrial Flow: Present

Fetal Growth restriction: Stage 1
Recommended management: Follow-up in 1 week
Fetal Growth

- Gestational Age
  - 37
  - 1

- Last Menstrual period
  - 1/1/2014

EFW:
- 2310
  - Percentile: 4

Gender:
- Female
- Male

Calculate

www.fetalmedicinebarcelona.org/
### UA Doppler PI:

<table>
<thead>
<tr>
<th>Value</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.26</td>
<td>70</td>
</tr>
</tbody>
</table>

### UA Diastolic flow

- **Present**

### MCA Doppler M.CA PI:

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15</td>
</tr>
</tbody>
</table>

### Ut.A Right Doppler:

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
</tr>
</tbody>
</table>

### Ut.A Left Doppler:

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
</tr>
</tbody>
</table>

### Ao Isthmus Diastolic Flow:

- **Present**

### DV PI:

<table>
<thead>
<tr>
<th>Value</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.91</td>
<td>50</td>
</tr>
</tbody>
</table>

### D.V. Atrial Flow:

- **Present**

### CPR (Percentile:1)

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.91</td>
</tr>
</tbody>
</table>

### Stage 1

**Recommended management:**

- **Delivery**

[www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
First goal:
First goal:
Identify small fetus (EFW<p10)
First goal:
Identify small fetus (EFW<p10)

Second goal:
First goal:
Identify small fetus (EFW<p10)

Second goal:
Classify as FGR vs SGA using CPR, UtA and EFW<3.
First goal:
Identify small fetus (EFW < p10)

Second goal:
Classify as FGR vs SGA using CPR, UtA and EFW < 3.

Third goal:
First goal:
Identify small fetus (EFW<p10)

Second goal:
Classify as FGR vs SGA using CPR, UtA and EFW<3.

Third goal:
Decide timing of delivery and follow-up scheme:
First goal:
Identify small fetus (EFW<p10)

Second goal:
Classify as FGR vs SGA using CPR, UtA and EFW<3.

Third goal:
Decide timing of delivery and follow-up scheme: use a stage-based integrated protocol.
Early vs. Late onset FGR
<table>
<thead>
<tr>
<th>EARLY-ONSET</th>
<th>LATE-ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

www.fetalmedicinebarcelona.org/
EARLY-ONSET

LATE-ONSET

PREECLAMPSIA

www.fetalmedicinebarcelona.org/
EARLY-ONSET

1 %

LATE-ONSET

PREECLAMPSIA

1 %

FGR

PREECLAMPSIA + FGR

www.fetalmedicinebarcelona.org/
EARLY-ONSET

LATE-ONSET

1 %

1 %

FGR

PREECLAMPSIA

PREECLAMPSIA + FGR

4-8 %

4-8 %
FGR = low CPR or high UtA or EFW < p3 or low PI GF
FGR = low CPR or high UtA or EFW < p3 or low PI GF
FGR = low CPR or high UtA or EFW < p3 or low PlGF

**EARLY FGR (1-2%)**

**LATE FGR (5-6%)**

32w @ diagnosis
FGR = low CPR or high UtA or EFW < p3 or low PI GF

EARLY FGR (1-2%) | LATE FGR (5-6%)
---|---
PROBLEM: MANAGEMENT | PROBLEM: DIAGNOSIS

32w @diagnosis
FGR = low CPR or high UtA or EFW<p3 or low PI GF

EARLY FGR (1-2%)  LATE FGR (5-6%)

PROBLEM: MANAGEMENT  PROBLEM: DIAGNOSIS

Placental disease: high (UA+, PE high)  Placental disease: low (UA-, PE low)
FGR = low CPR or high UtA or EFW < p3 or low PIGF

EARLY FGR (1-2%)

PROBLEM: MANAGEMENT

Placental disease: high (UA+, PE high)

Hypoxia ++: systemic CV adaptation

LATE FGR (5-6%)

PROBLEM: DIAGNOSIS

Placental disease: low (UA-, PE low)

Hypoxia +/-: central CV adaptation

www.fetalmedicinebarcelona.org/
FGR = low CPR or high UtA or EFW < p3 or low PI GF

EARLY FGR (1-2%)

PROBLEM: MANAGEMENT
Placental disease: high (UA+, PE high)
Hypoxia ++: systemic CV adaptation
Tolerance to hypoxia. Natural history

LATE FGR (5-6%)

PROBLEM: DIAGNOSIS
Placental disease: low (UA-, PE low)
Hypoxia +/-: central CV adaptation
Low tolerance: no natural history

www.fetalmedicinebarcelona.org/
EARLY FGR (1-2%)

**PROBLEM: MANAGEMENT**
- Placental disease: high (UA+, PE high)
- Hypoxia ++: systemic CV adaptation
- Tolerance to hypoxia. Natural history
- High mortality and morbidity

**PROBLEM: DIAGNOSIS**
- Placental disease: low (UA-, PE low)
- Hypoxia +/-: central CV adaptation
- Low tolerance: no natural history
- Low mortality but poor long outcome.

LATE FGR (5-6%)

FGR = low CPR or high UtA or EFW < p3 or low PI GF

EARLY FGR (1-2%) & LATE FGR (5-6%)
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- UMBILICAL A. >p95
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA

DECOMPENSATED HYPOXIA
- cardiac ischemia
- Diastolic failure
- Systolic cardiac failure

SERIOUS INJURY
- DEATH

CTG ABNORMAL

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- UMBILICAL A. >p95
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA
- growth

DECOMPENSATED HYPOXIA
- cardiac ischemia
- Diastolic failure
- DUCTUS VENOSUS >p95 and a-

SERIOUS INJURY DEATH
- Systolic cardiac failure
- CTG ABNORMAL

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- UMBILICAL A. >p95
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA
- growth

DECOMPENSATED HYPOXIA
- cardiac ischemia
- Diastolic failure
- DUCTUS VENOSUS >p95 and a-
- cCTG: reduced short-term variability
- CTG ABNORMAL
- Systolic cardiac failure

SERIOUS INJURY
- DEATH

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- UMBILICAL A. >p95
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA
- growth

DECOMPENSATED HYPOXIA
- cardiac ischemia
- Diastolic failure
- DUCTUS VENOSUS >p95 and a-

SERIOUS INJURY
- DEATH

Systolic cardiac failure

CTG / BPP ABNORMAL

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE

- Increment placental impedance

UTERINE A. >p95

- CPR <p5

UMBILICAL A. >p95

Centralization

- MIDDLE CEREBRAL A. <p5

growth

COMPENSATED HYPOXIA

Placental injury <30%

DECOMPENSATED HYPOXIA

cardiac ischemia

Diastolic failure

- DUCTUS VENOSUS >p95 and a-

CTG / BPP ABNORMAL

SERIOUS INJURY

DEATH

Systolic cardiac failure

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE

- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA

- Placental injury <30%
- UMBILICAL A. >p95
- DUCTUS VENOSUS >p95 and a-
- cardiac ischemia
- Diastolic failure
- CTG / BPP ABNORMAL

DECOMPENSATED HYPOXIA

- Systolic cardiac failure

SERIOUS INJURY DEATH

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

- PLACENTAL DISEASE
  - Increment placental impedance
  - UTERINE A. >p95
  - CPR <p5
  - Centralization
  - MIDDLE CEREBRAL A. <p5

- COMPENSATED HYPOXIA
  - Placental injury <30%
  - Growth

- DECOMPENSATED HYPOXIA
  - cardiac ischemia
  - Diastolic failure
  - DUCTUS VENOSUS >p95 and a-

- SERIOUS INJURY
  - DEATH
  - Casual injury
  - MILD HYPOXIA
  - no cardiovascular adaptation
  - Systolic cardiac failure

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- Centralization
- MIDDLE CEREBRAL A. <p5

COMPENSATED HYPOXIA
- Placental injury <30%

DECOMPENSATED HYPOXIA
- UMBILICAL A. >p95

SERIOUS INJURY/DEATH
- CTG / BPP ABNORMAL
- mild hypoxia
- no cardiovascular adaptation

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

**PLACENTAL DISEASE**

- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- Centralization
- MIDDLE CEREBRAL A. <p5

**COMPENSATED HYPOXIA**

- minimal tolerance to hypoxia
- Placental injury <30%

**DECOMPENSATED HYPOXIA**

- UMBILICAL A. >p95
- MIDDLE CEREBRAL A. <p5

**SERIOUS INJURY DEATH**

- CTG / BPP ABNORMAL

**growth**

- mild hypoxia
- no cardiovascular adaptation

[www.fetalmedicinebarcelona.org/](http://www.fetalmedicinebarcelona.org/)
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE

INCREMENT PLACENTAL IMPEDANCE

UTERINE A. >p95

CPR <p5

CENTRALIZATION

MIDDLE CEREBRAL A. <p5

DECOMPENSATED HYPOXIA

MINIMAL TOLERANCE TO HYPOXIA

SERIOUS INJURY

DEATH

PLACENTAL INJURY <30%

UMBILICAL A. >p95

CTG / BPP ABNORMAL

MILD HYPOXIA

NO CARDIOVASCULAR ADAPTATION

GROWTH

www.fetalmedicinebarcelona.org/
FETAL DETERIORATION IN PLACENTAL INSUFFICIENCY
EARLY VS LATE FGR (>34s)

PLACENTAL DISEASE
- Increment placental impedance
- UTERINE A. >p95
- CPR <p5
- Centralization
- MIDDLE CEREBRAL A. <p5
- Ao ISTHMUS >p95

DECOMPENSATED HYPOXIA
- minimal tolerance to hypoxia
- Placental injury <30%

SERIOUS INJURY
- DEATH
- UMBILICAL A. >p95

growth

mild hypoxia
- no cardiovascular adaptation

CTG / BPP ABNORMAL

www.fetalmedicinebarcelona.org/
FGR = low CPR or high UtA or EFW < p3 or low PIGF

<table>
<thead>
<tr>
<th>EARLY FGR (1-2%)</th>
<th>LATE FGR (5-6%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROBLEM: MANAGEMENT</strong></td>
<td><strong>PROBLEM: DIAGNOSIS</strong></td>
</tr>
<tr>
<td>Placental disease: high (UA+, PE high)</td>
<td>Placental disease: low (UA-, PE low)</td>
</tr>
<tr>
<td>Hypoxia ++: systemic CV adaptation</td>
<td>Hypoxia +/-: central CV adaptation</td>
</tr>
<tr>
<td>Tolerance to hypoxia. Natural history</td>
<td>Low tolerance: no natural history</td>
</tr>
<tr>
<td>High mortality and morbidity</td>
<td>Low mortality but poor long outcome.</td>
</tr>
</tbody>
</table>
Parameters for fetal follow up in FGR
umbilical artery
normal and anormal hemodynamics

Cardiac pump
normal function
umbilical artery
normal and anormal hemodynamics

Cardiac pump
normal function
umbilical artery
normal and anormal hemodynamics

Cardiac pump
normal function

<30%
umbilical artery
normal and abnormal hemodynamics

Cardiac pump normal function

Cardiac pump abnormal function

<30%
umbilical artery
normal and anormal hemodynamics

Cardiac pump
normal function

Cardiac pump
abnormal function

Placental status
<30%
umbilical artery
normal and abnormal hemodynamics

Cardiac pump
normal function

Cardiac pump
abnormal function

Placental status
<30%

placenta + cardiac ischemia
middle cerebral artery
normal and abnormal hemodynamics

Normal oxygenation

hypoxia
middle cerebral artery
normal and abnormal hemodynamics

Normal oxygenation
[normal waveform]

hypoxia
middle cerebral artery
normal and abnormal hemodynamics

Normal oxygenation
[normal waveform]

[mild vasodilation]

hypoxia
middle cerebral artery
normal and abnormal hemodynamics

Normal oxygenation
[normal waveform]

[mild vasodilation]

[marked vasodilation]

hypoxia
Cerebroplacental ratio is more sensitive than UA or MCA alone.

IPUA = p80 + IPMCA = p20 = CPR < p5

Sensitivity (95% CI)
- Bahado-Singh RO: 0.41 (0.30 - 0.52)
- Obido AO: 0.61 (0.49 - 0.72)
- Arias F: 0.49 (0.32 - 0.65)
- Gramellini D: 0.86 (0.42 - 1.00)
- Makhseed M: 0.63 (0.42 - 0.81)
- Habek D: 0.39 (0.17 - 0.64)
- Sterne G: 0.58 (0.39 - 0.75)
- Yalit S: 0.86 (0.57 - 0.98)
- Ebrashy A: 1.00 (0.89 - 1.00)

Pooled Sensitivity = 0.59 (0.53 to 0.64)
Chi-square = 57.86, df = 8 (p = 0.0000)
Inconsistency (I-square) = 86.2%
30 % venous return

REFLECTS DIASTOLIC PRESSURE IN RIGHT (AND LEFT) HEART

www.fetalmedicinebarcelona.org/
ductus venosus
normal and abnormal
hemodynamics
ductus venosus
normal and abnormal
hemodynamics

Venous vessel: pulsation due to retrograde pressure
ductus venosus

normal and abnormal hemodynamics

Venous vessel: pulsation due to retrograde pressure
ductus venosus
normal and abnormal hemodynamics

Venous vessel: pulsation due to retrograde pressure
ductus venosus
normal and abnormal hemodynamics

Venous vessel: pulsation due to retrograde pressure
ductus venosus
normal and abnormal hemodynamics

Venous vessel: pulsation due to retrograde pressure
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

no Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

no Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

Myocardial ischemia
compliance right chambers: effect sobre on venous return

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect sobre on venous return

Myocardial ischemia

compliance
ductus venosus
normal and abnormal hemodynamics

compliance right chambers: effect on venous return

Myocardial ischemia

compliance
IFI

VTI sistole + VTI diástole
VTI sistole

Fouron AJOG 2001, Del Río UOG 2006
When and how to deliver
FGR = abnormal CPR or UtA or EFW<p3
Management = when should we deliver?

- Early-severe
  High risk IUFD preterm

- Late-mild
  Low risk IUFD (high at term)

PROTOCOL

- Stage II to IV

- Stage I
  >37w

Savchev 2013

www.fetalmedicinebarcelona.org/
Early-onset FGR

PROBLEM #1: MORTALITY

<table>
<thead>
<tr>
<th>Perinatal Mortality</th>
<th>&lt;26</th>
<th>26-28</th>
<th>29-30</th>
<th>31-34</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;90%</td>
<td>30-40%</td>
<td>&lt;10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

www.fetalmedicinebarcelona.org/

Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
Early-onset FGR
PROBLEM #1: MORTALITY

Perinatal Mortality
<26: >90%
26-28: 30-40%
29-30: <10%
31-34: 

DVa (rev)
Yes: 19%
No: 60%

www.fetalmedicinebarcelona.org/
Early-onset FGR

PROBLEM #1: MORTALITY

Pathological CGT

DVa (rev)

Perinatal Mortality

<26  26-28  29-30  31-34

>90%  30-40%  <10%

www.fetalmedicinebarcelona.org/

Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
Early-onset FGR

PROBLEM #1: MORTALITY

Perinatal Mortality

Pathological CGT

DVa (rev)

<26

26-28

29-30

31-34

<90%

30-40%

<10%

www.fetalmedicinebarcelona.org/

Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
Early-onset FGR

PROBLEM #1: MORTALITY

- Perinatal Mortality:
  - <26: >90%
  - 26-28: 30-40%
  - 29-30: <10%
  - 31-34:

- Pathological CGT
- DVa (rev)

- cCTG-STV<3 ms:
  - Reassuring
  - Attention
  - Suspicious
  - Very Suspicious
  - Pathological

- Baschat 2003
- Hecher 2003
- Grivell 2009
- Cruz-Lemini 2012

www.fetalmedicinebarcelona.org/
Early-onset FGR
PROBLEM #1: MORTALITY

Perinatal Mortality

<26 | 26-28 | 29-30 | 31-34

>90% | 30-40% | <10% |

Stage IV | Stage III | Stage II

Pathological CGT

DVa (rev)

Yes | No

19% | 60%

www.fetalmedicinebarcelona.org/

Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
Early-onset FGR
PROBLEM #2: (NEUROLOGICAL) MORBIDITY

Neurological Morbidity

- <29: >90%
- 29-32: 30-40%
- >32.0: <10%

Fouron 2004
Del Rio 2008
Cruz-Martinez 2012

www.fetalmedicinebarcelona.org/
Early-onset FGR

PROBLEM #2: (NEUROLOGICAL) MORBIDITY

Neonatal brain US anomalies in 30-34w FGR

- Controls
- IUGR ant AoI
- IUGR REV AoI

Neurological Morbidity

- >90%
- 30-40%
- <10%

Fouron 2004
Del Rio 2008
Cruz-Martinez 2012

www.fetalmedicinebarcelona.org/
Late-onset FGR
PROBLEM #1: WHEN AND HOW TO DELIVER

37-38 w (+/- check lung maturity)
Do not use prostaglandins (Foley/Balloon)
Select high risk cases (MCA Doppler)

www.fetalmedicinebarcelona.org/
Cesarean section for fetal distress after labor induction in term SGA according to MCA Doppler (N=202)

(OVERALL RISK OF CS AFTER INDUCTION 80 %)

Cruz et al, 2010
RISK RESPIRATORY MORBIDITY

Risk of Respiratory Distress Syndrome (%) vs Gestational Age (weeks)

- 30 weeks: 59.1%
- 31 weeks: 45.4%
- 32 weeks: 34.2%
- 33 weeks: 22%
- 34 weeks: 17.7%
- 35 weeks: 11.4%
- 36 weeks: 6.1%
- 37 weeks: 4%
- 38 weeks: 3.1%
- 39 weeks: 2.9%
- 40 weeks: 1.2%

JAMA Pediatrics 2013

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- N=144
- Singleton pregnancies
- 29.0 - 38.6 w
- Axial thoracic section
• N=144
• Singleton pregnancies
• 29.0 - 38.6 w
• Axial thoracic section

Bonet, UOG 2014

Neonatal Respiratory Morbidity (*):
• Respiratory Distress Syndrome
• Transient tachypnea of newborn

(*) RDS: Respiratory symptoms (eg, grunting, flaring, tachypnea, retractions), O2 requirement + chest Rx + NICU admission
TT: chest Rx impression + clinical diagnosis by clinician in charge.
JAMA 2010
Performance of Quantus FLM and comparison with currently used lab

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>L/S Ratio</td>
<td>72%</td>
<td>84%</td>
<td>37%</td>
<td>95%</td>
</tr>
<tr>
<td>PG</td>
<td>88%</td>
<td>65%</td>
<td>24%</td>
<td>97%</td>
</tr>
<tr>
<td>Lamellar body</td>
<td>88%</td>
<td>66%</td>
<td>19%</td>
<td>98%</td>
</tr>
<tr>
<td>QuantusFLM®</td>
<td><strong>86%</strong></td>
<td><strong>86%</strong></td>
<td><strong>62%</strong></td>
<td><strong>96%</strong></td>
</tr>
</tbody>
</table>

*L/S: Lecithin / Sphingomyelin
PG: Phosphatidol Glycerol

*QuantusFLM® ha sido validado mediante 144 muestras ciegas.
Late FGR with MCA<p5
Planned delivery at 37.0 weeks
Late FGR with MCA<p5
Planned delivery at 37.0 weeks

RISK RESPIRATORY MORBIDITY
Late FGR with MCA<p5
Planned delivery at 37.0 weeks

RISK RESPIRATORY MORBIDITY

BASELINE GA-ADJUSTED = 4%
Late FGR with MCA<p5
Planned delivery at 37.0 weeks

RISK RESPIRATORY MORBIDITY

BASELINE GA-ADJUSTED = 4%

PERSONALIZED: FETAL LUNG MATURITY
Late FGR with MCA<p5
Planned delivery at 37.0 weeks

RISK RESPIRATORY MORBIDITY

BASELINE GA-ADJUSTED = 4%

PERSONALIZED: FETAL LUNG MATURITY

LOW RISK =1.5%

Deliver

www.fetalmedicinebarcelona.org/
Late FGR with MCA<\textless;p5
Planned delivery at 37.0 weeks

**RISK RESPIRATORY MORBIDITY**

- **BASELINE GA-ADJUSTED** = 4%
- **PERSONALIZED: FETAL LUNG MATURITY**
  - **LOW RISK** = 1.5%
  - **HIGH RISK** = 25%

- Deliver
- Wait and follow-up until 37.6-38.0

www.fetalmedicinebarcelona.org/
Early and late-onset determines different severity, fetal response and natural history

Doppler is the main tool for follow-up and timing of delivery in stage II to IV

Stage I: challenge is to determine best timing and mode of delivery
BEING SMALL EARLY IN PREGNANCY IS A PROBLEM

PROBLEM #1: MORTALITY

Perinatal Mortality

<table>
<thead>
<tr>
<th>&lt;26</th>
<th>26-28</th>
<th>&gt;28</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;90%</td>
<td>30-40%</td>
<td>&lt;10%</td>
</tr>
</tbody>
</table>

www.fetalmedicinebarcelona.org/

Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
BEING SMALL EARLY IN PREGNANCY IS A PROBLEM

PROBLEM #1: MORTALITY

- <26: >90%
- 26-28: 30-40%
- >28: <10%

DVa (rev)
- Yes: 19%
- No: 60%

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BEING SMALL EARLY IN PREGNANCY IS A PROBLEM
PROBLEM #1: MORTALITY

Perinatal Mortality

- <26: >90%
- 26-28: 30-40%
- >28: <10%

Pathological CGT
DVa (rev)

- cCTG-STV<3 ms
- REASSURING
- ATTENTION
- SUSPICIOUS
- PATHOLOGICAL

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Baschat 2003
Hecher 2003
Grivell 2009
Cruz-Lemini 2012
Early-onset FGR

PROBLEM #2: (NEUROLOGICAL) MORBIDITY

Neurological Morbidity

- <29: >90%
- 29-32: 30-40%
- >32.0: <10%

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Fouron 2004
Del Rio 2008
Cruz-Martinez 2012
Early-onset FGR

PROBLEM #2: (NEUROLOGICAL) MORBIDITY

Neonatal brain US anomalies in 30-34w FGR

- Controls
- IUGR ant AoI
- IUGR REV AoI

Neurological Morbidity
- >90%
- 30-40%
- <10%

Fouron 2004
Del Rio 2008
Cruz-Martinez 2012

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BEING SMALL LATE IS ALSO A PROBLEM

SGA = constitutionally small?
BEING SMALL LATE IS ALSO A PROBLEM

**SGA**

- Significant increase in the risk of adverse perinatal outcome
  - Hershkovitz et al. Ultrasound Obstet Gynecol 2000
  - Severi et al. Ultrasound Obstet Gynecol 2002

**SGA = constitutionally small?**

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BEING SMALL LATE IS ALSO A PROBLEM

SGA = constitutionally small?

Significant increase in the risk of adverse perinatal outcome

Hershkovitz et al. Ultrasound Obstet Gynecol 2000
Severi et al. Ultrasound Obstet Gynecol 2002

Significant increase in the risk of adverse neurodevelopment

Eixarch et al. Ultrasound Obstet Gynecol 2008
Severi et al. Ultrasound Obstet Gynecol 2002

www.fetalmedicinebarcelona.org/
SGA: proportion of perinatal adverse outcomes in 376 consecutive cases

Neonatal acidosis
CS for distress
Abnormal NBAS
Any

Figueras 2011

www.fetalmedicinebarcelona.org/
IMPACT OF NON-DETECTED FGR ON LATE FETAL MORTALITY
Barcelona
2005-2010

![Bar chart showing percentages of FGR, Unknown, and Others categories](chart.png)

- FGR: 45%
- Unknown: 30%
- Others: 25%
Classification of stillbirth by relevant condition at birth (ReCoDe): population-based cohort study
Gardosi et al. BMJ 2005 and 2013

FGR as relevant condition identified in 43-60%

Overall stillbirth rate (/ 1000 births) 4.2, but only 2.4 in non-SGA pregnancies, increasing to 9.7 with antenatally detected FGR and 19.8 in not detected FGR.
Neurobehavioral performance of term SGA newborns

N=120
SGA vs 100 AGA

* p <0.05
Adjusted for GA, maternal age, socioeconomic status and smoking

www.fetalmedicinebarcelona.org/
Neurobehavioral performance of term SGA newborns

\[ N=120 \]
SGA vs 100 AGA

* \( p < 0.05 \)
Adjusted for GA, maternal age, socioeconomic status and smoking

Bayley Score

- **cognitive**
- **language**
- **motor**
- **socio-emotional**
- **adaptive behavior**

* Satchev, 2012
* Geva 2008
* Figueras 2008
* Eixarch 2010

www.fetalmedicinebarcelona.org/
Cardiovascular programming in SGA / late-FGR

Crispi 2010
Cardiovascular programming in SGA / late-FGR

Fetuses EFW<p10 evaluated at 5 years

*Classified by CPR, p3 and UtA Doppler:*
- All normal: SGA
- Any abnormal: late-FGR

Crispi 2010
Cardiovascular programming in SGA / late-FGR

Fetuses EFW<p10 evaluated at 5 years

Classified by CPR, p3 and UtA Doppler:
- All normal: SGA
- Any abnormal: late-FGR

Crispi 2010
US Dating

<14.0 w: CRL (Robinson)

14-24 w: BPD (Mul)

>24 w: HC±LFL (Snijders)

US Dating

Review: Ultrasound for fetal assessment in early pregnancy
Comparison: 1 Routine/revealed versus selective/concealed ultrasound in early pregnancy
Outcome: 31 Induction of labour for any reason

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Routine scan n/N</th>
<th>Control n/N</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alesund</td>
<td>34/774</td>
<td>77/750</td>
<td></td>
<td>11.8 %</td>
<td>0.43 [0.29, 0.63]</td>
</tr>
<tr>
<td>London 1982</td>
<td>104/531</td>
<td>107/531</td>
<td></td>
<td>15.5 %</td>
<td>0.97 [0.76, 1.24]</td>
</tr>
<tr>
<td>Missouri 1990</td>
<td>91/402</td>
<td>103/413</td>
<td></td>
<td>15.4 %</td>
<td>0.91 [0.71, 1.16]</td>
</tr>
<tr>
<td>Oxford 2006</td>
<td>34/233</td>
<td>46/230</td>
<td></td>
<td>11.5 %</td>
<td>0.73 [0.49, 1.09]</td>
</tr>
<tr>
<td>RADIUS</td>
<td>1912/7617</td>
<td>1858/7534</td>
<td></td>
<td>19.1 %</td>
<td>1.02 [0.96, 1.08]</td>
</tr>
<tr>
<td>Sweden</td>
<td>140/2389</td>
<td>218/2412</td>
<td></td>
<td>16.4 %</td>
<td>0.65 [0.53, 0.80]</td>
</tr>
<tr>
<td>Trondheim 1984</td>
<td>32/496</td>
<td>38/478</td>
<td></td>
<td>10.4 %</td>
<td>0.81 [0.52, 1.28]</td>
</tr>
</tbody>
</table>

Total (95% CI) 12442 12348 100.0 % 0.78 [0.63, 0.97]

Total events: 2347 (Routine scan), 2447 (Control)
Heterogeneity: Tau² = 0.06; Chi² = 37.57, df = 6 (P<0.00001); I² = 84%
Test for overall effect: Z = 2.24 (P = 0.025)

www.fetalmedicinebarcelona.org/