ISUOG Basic Training

Management of Abnormal Growth

Learning objectives

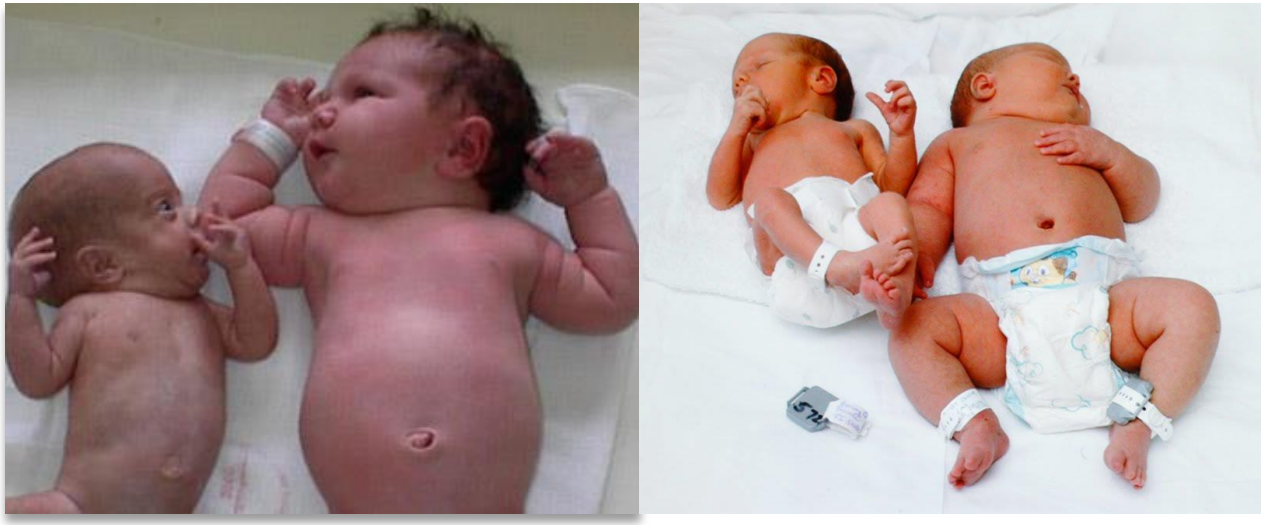
At the end of the lecture you will be able to:

- Describe the role of ultrasound imaging in the management of abnormal fetal growth
- Describe the role of doppler studies in the management of abnormal fetal growth

Fetal growth

Growth patterns

- Macrosomia
- Fetal growth restriction (FGR)



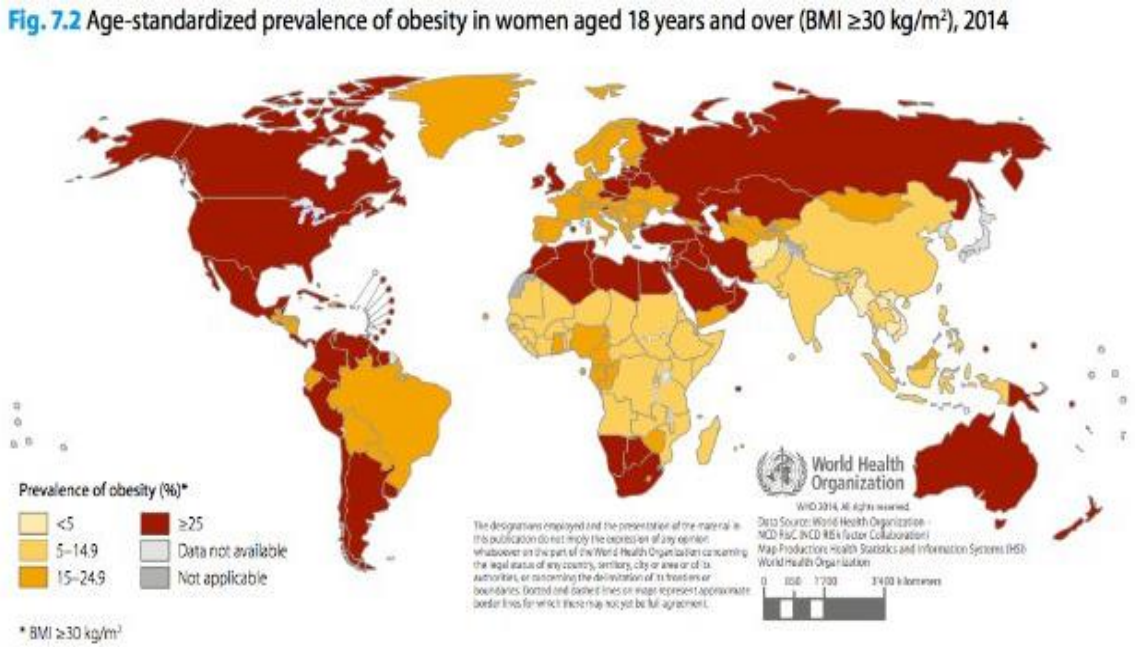
Macrosomia

Definition	Cut-off	Prevelence
Neonate at term	> 4.5 kg	1.3 – 1.5%
Gestational age dependent	> 97th centile	
Birth weight at term	> 4 kg	7%
Gestational age dependent	> 90th centile	

Campbell S. UOG 2014; 43: 3–10

Macrosomia risk factors

- Maternal diabetes
- Gestational diabetes
- Maternal obesity
- Family history
- Genetic syndromes:
  - Beckwith-wiedemann,
  - Simpson-golabi-behmel,
  - Sotos…

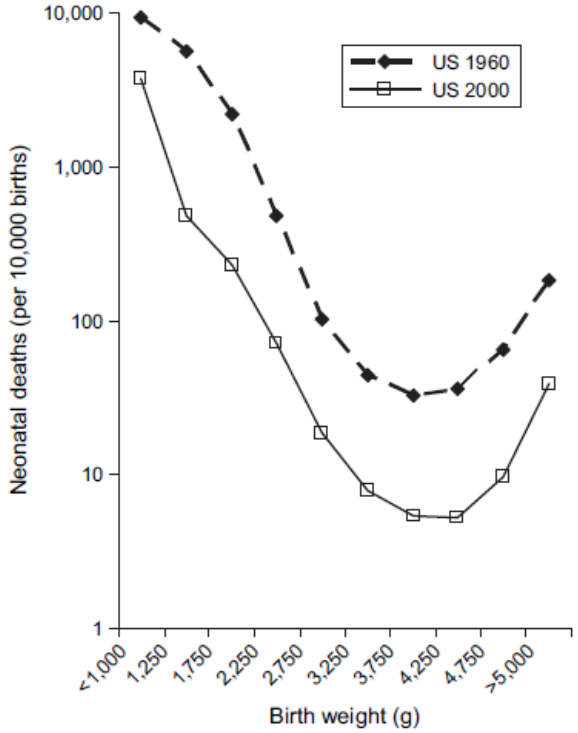


Okun et al. J Matern Fetal Med 1997;6:285–290

Macrosomia

Risk for mother

- Emergency CS
- Instrumental delivery
- Shoulder dystocia
- Trauma to birth canal
- Bladder, perineum and sphincter injury



Risk for infant

- Mortality
- Brachial plexus injury
- Facial nerve injury
- Fracture humerus / clavicle
- Birth asphyxia

Basso et al Am J Epidemiol 2006;164:303–311

Cochrane Library

Cochrane Database of Systematic Reviews

Induction of labour at or near term for suspected fetal macrosomia (Review)

Boulvain M, Irion O, Dowswell T, Thornton JG

Why do we care about SGA?

- We don't care about SGA …
- Most SGA babies display perinatal outcomes similar to those of normally grown fetuses…
- We care about fgr fetuses which have:
  - Poorer perinatal outcomes
  - Abnormal dopplers, suggesting fetal adaptation to undernutrition/hypoxia
  - Signs of placental disease
  - Higher risk of preeclampsia

  and long term poorer outcomes

Table 7. Birth weight percentiles among preterm and term stillbirths and live births.

Birth Weight Norms and Percentiles	Preterm SB and All LB			Term SB and LB		
Ultrasound norms, percent[d]	Preterm SB	All LB	Crude OR for Preterm SB (95% CI)[a]	Term SB	Term LB	Crude OR for Term SB (95% CI)[a]
<5th percentile	39	10	7.30 (5.53–9.63)	21	10	3.08 (1.77–5.39)
5th–<10th	8	7	2.22 (1.44–3.45)	13	6	2.88 (1.42–5.86)
10th–90th	41	77	Reference	55	78	Reference
>90th–95th	5	3	2.96 (1.65–5.30)	2	3	0.92 (0.21–3.95)
>95th	8	3	4.49 (2.76–7.31)	9	3	4.69 (2.12–10.41)
<10th	47	17	5.22 (4.06–6.72)	34	16	3.00 (1.86–4.85)
>90th	12	6	3.76 (2.55–5.55)	11	6	2.74 (1.35–5.55)

OPEN ACCESS Freely available online PLOS | MEDICINE

Fetal Growth and Risk of Stillbirth: A Population-Based Case–Control Study

Radek Bukowski[1]*, Nellie I. Hansen[2], Marian Willinger[3], Uma M. Reddy[3], Corette B. Parker[2], Halit Pinar[4], Robert M. Silver[5], Donald J. Dudley[6], Barbara J. Stoll[7], George R. Saade[1], Matthew A. Koch[2], Carol J. Rowland Hogue[8], Michael W. Varner[5], Deborah L. Conway[6], Donald Coustan[4], Robert L. Goldenberg[9], for the Eunice Kennedy Shriver National Institute of Child Health and Human Development Stillbirth Collaborative Research Network[¶]

Fetal growth impacts late in our lives

Screening for abnormal growth

- Clinical assessment
  - Maternal risk factors
  - Measurement of fundal height

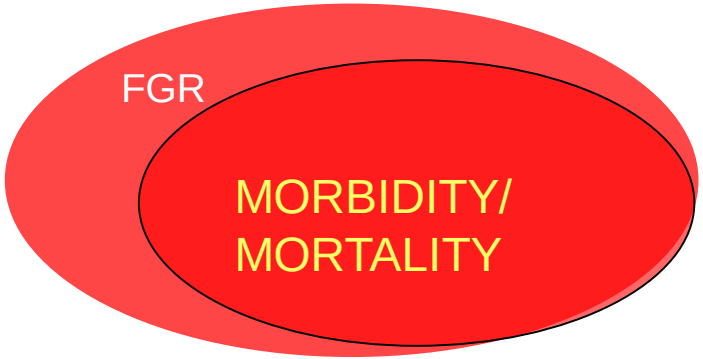
- Ultrasound
  - Biometry (HC and AC)
  - Estimation of fetal weight (BPD, HC, AC, FL)
  - Measurement of amniotic fluid (AFI or MVP)

Screening for abnormal growth

FGR: Failure to achieve the anticipated growth potential

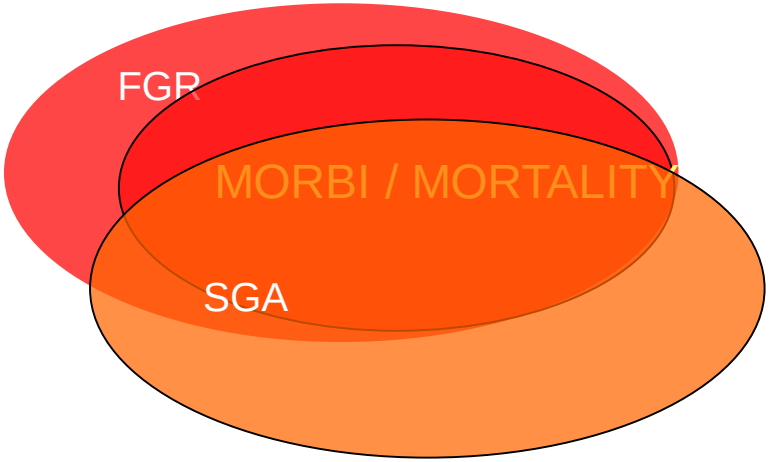
Screening for abnormal growth

Restriction in growth is associated with morbidity and mortality

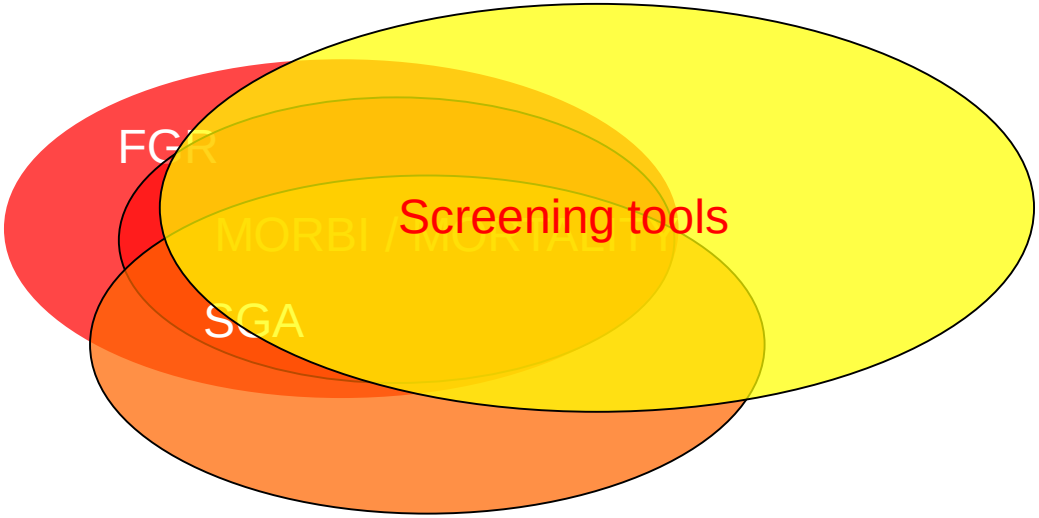


Screening for abnormal growth

Different from SGA and constitutionally small



Screening for abnormal growth

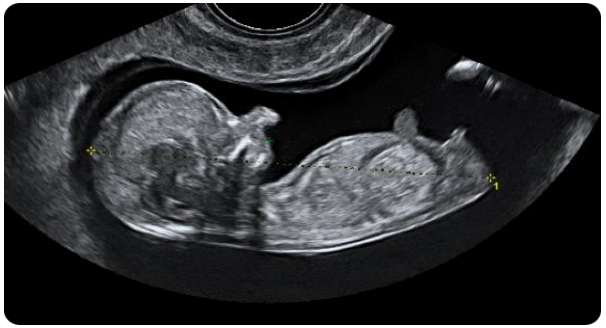


Correct recognition of SGA and FGR

- Correct dating
- Correct use of measurements
- Correct tools to assess biometry
- Appropriate management of clinical situation

Correct dating

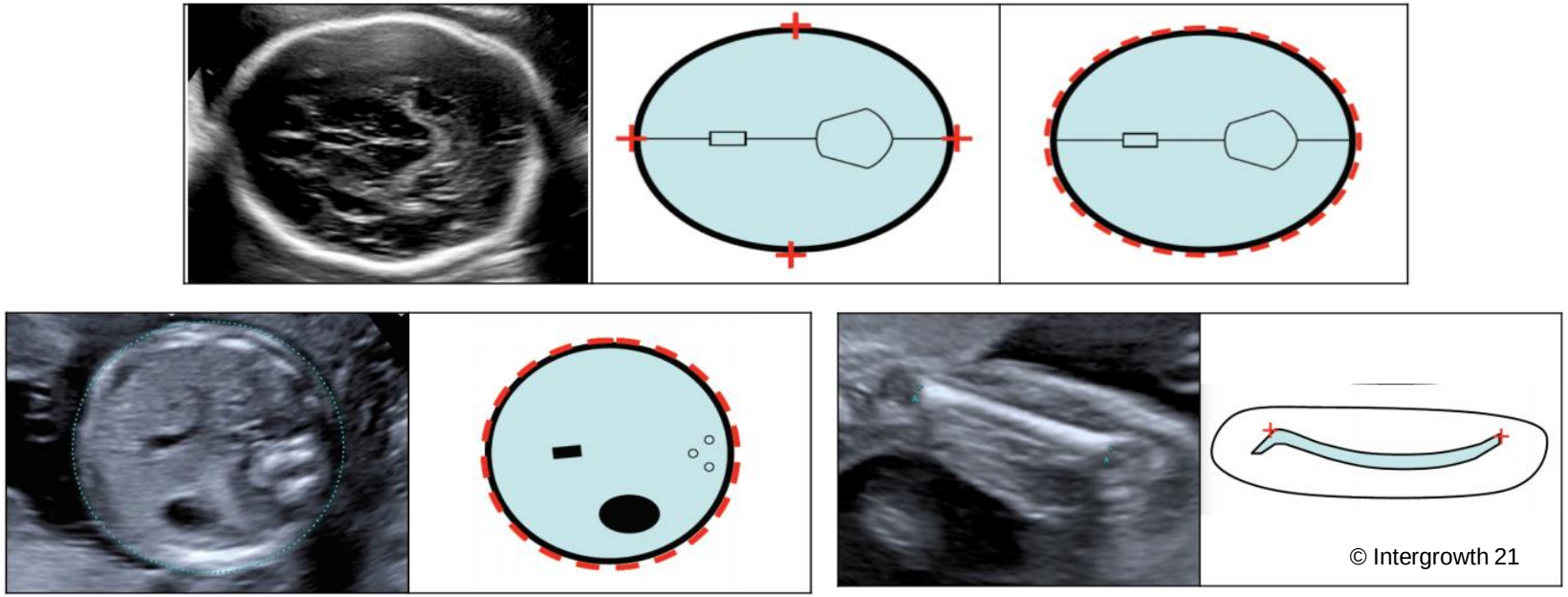
- Pregnant women should be offered an early US scan between 10 weeks 0 days and 13 weeks 6 days to determine gestational age
- CRL measurement appears to be the most precise, allowing an accurate determination of the day of conception, to within 5 days either way in 95% of cases



ISUOG Practice Guidelines: performance of first-trimester fetal ultrasound scan

Ultrasound Obstet Gynecol 2013:41:102-113

Correct use of measurements



ISUOG Practice guidelines for performance of the routine mid-trimester fetal ultrasound scan

Ultrasound Obstet Gynecol 2011:37:116-126

Correct tools to assess biometry

- Biometric assessment - central role in the identification of fetuses at risk of FGR and related adverse outcomes

- Multiple tools to assess the likelihood of fgr prenatally, using biometric measurements:
  - Biometry charts
  - Estimated fetal weight (EFW) and related charts

Appropriate choice of charts

DOI: 10.1111/j.1471-0528.2012.03451.x
www.bjog.org

Systematic review

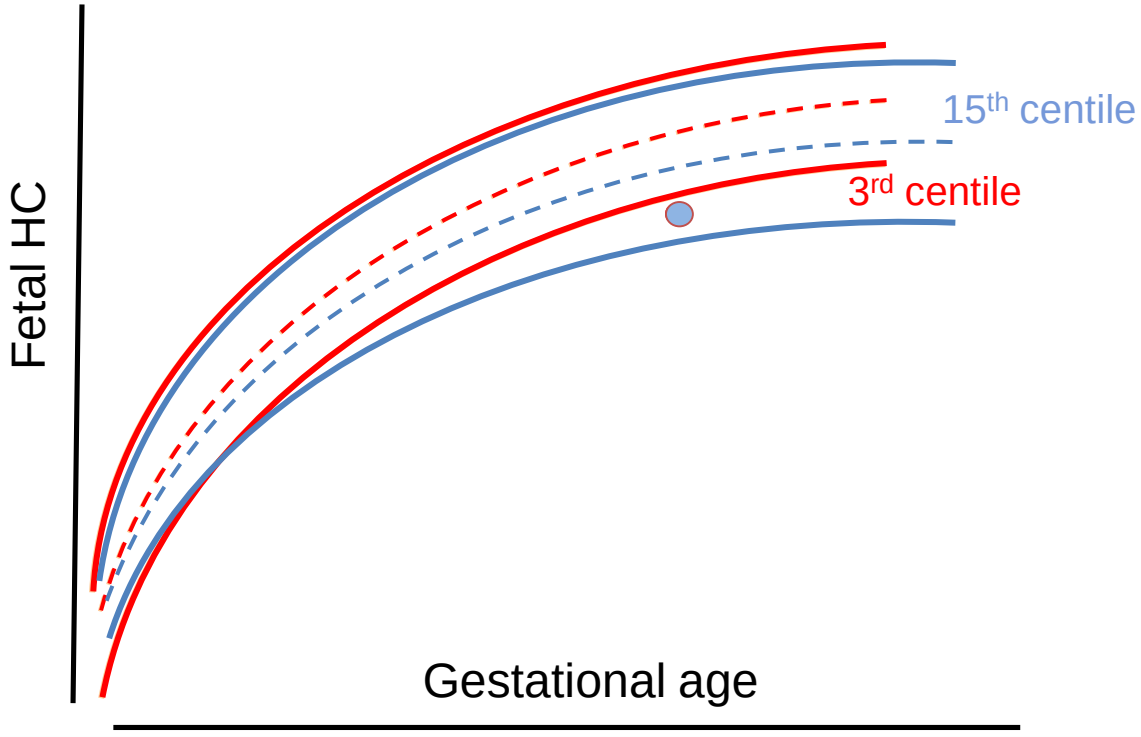
Systematic review of methodology used in ultrasound studies aimed at creating charts of fetal size

C Ioannou,[a] K Talbot,[a] E Ohuma,[a] I Sarris,[a] J Villar,[a,b] A Conde-Agudelo,[c] AT Papageorghiou[a,b]

[a] Nuffield Department of Obstetrics and Gynaecology, University of Oxford, UK [b] Oxford Maternal and Perinatal Health Institute, Green Templeton College, University of Oxford, UK [c] Perinatology Research Branch, Eunice Kennedy Shriver National Institute of Child Health and Human Development/National Institutes of Health/Department of Health and Human Services, Bethesda, MD and Detroit, MI, USA
Correspondence: Dr AT Papageorghiou, Nuffield Department of Obstetrics and Gynaecology, John Radcliffe Hospital, Oxford, OX3 9DU, UK. Email aris.papageorghiou@obs-gyn.ox.ac.uk

Accepted 13 June 2012. Published Online 13 August 2012.

Clinical implications

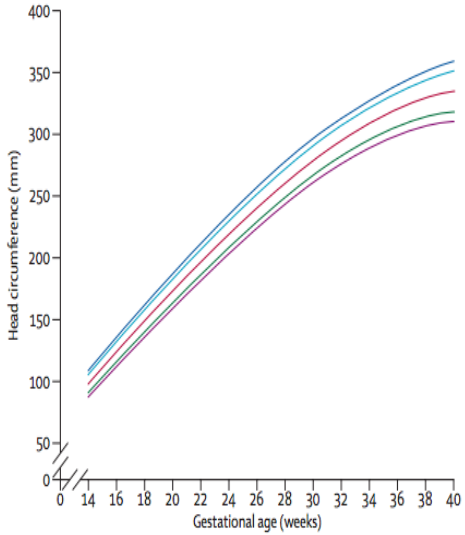


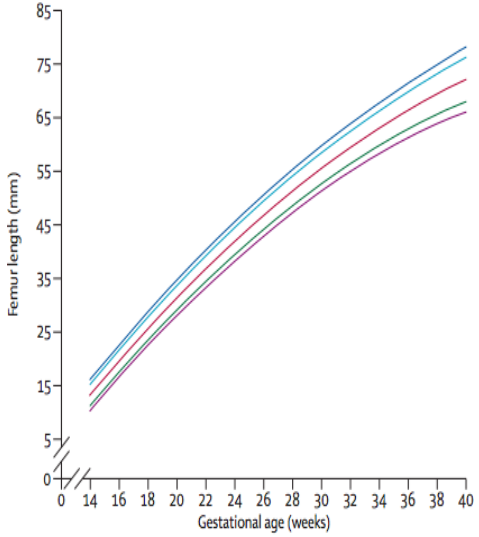
International standards for fetal growth based on serial ultrasound measurements: the Fetal Growth Longitudinal Study of the INTERGROWTH-21st Project

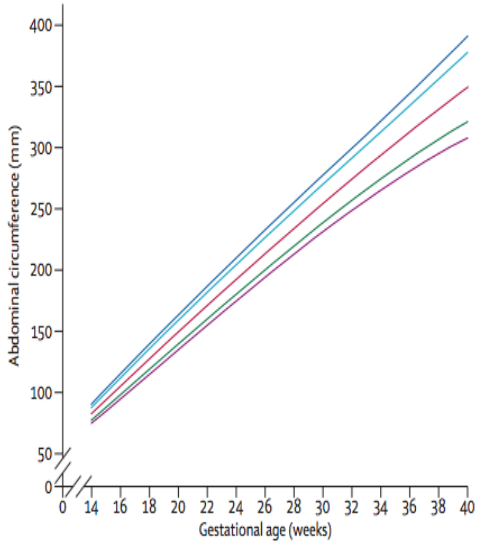
Aris T Papageorghiou, Eric O Ohuma, Douglas G Altman, Tullia Todros, Leila Cheikh Ismail, Ann Lambert, Yasmin A Jaffer, Enrico Bertino, Michael G Gravett, Manorama Purwar, J Alison Noble, Ruyan Pang, Cesar G Victora, Fernando C Barros, Maria Carvalho, Laurent J Salomon, Zulfiqar A Bhutta*, Stephen H Kennedy*, José Villar*, for the International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st)†

Intergrowth charts

- Provide prescriptive standards
- Represent ‘healthy’ growth of a normal population
- Suggest the targets to achieve

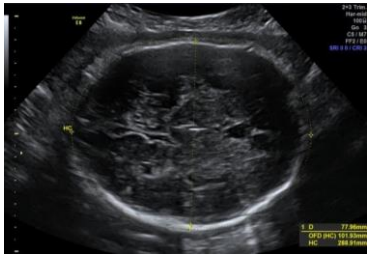


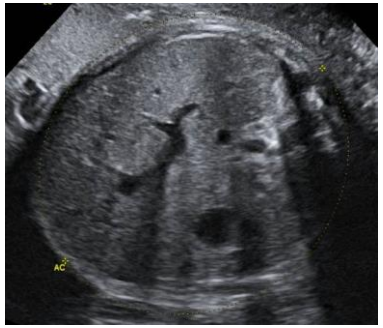


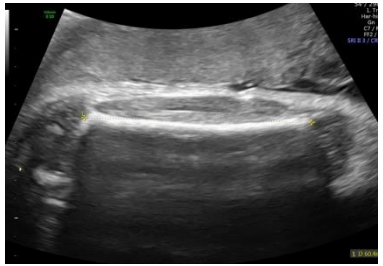


Estimated fetal weight (EFW)

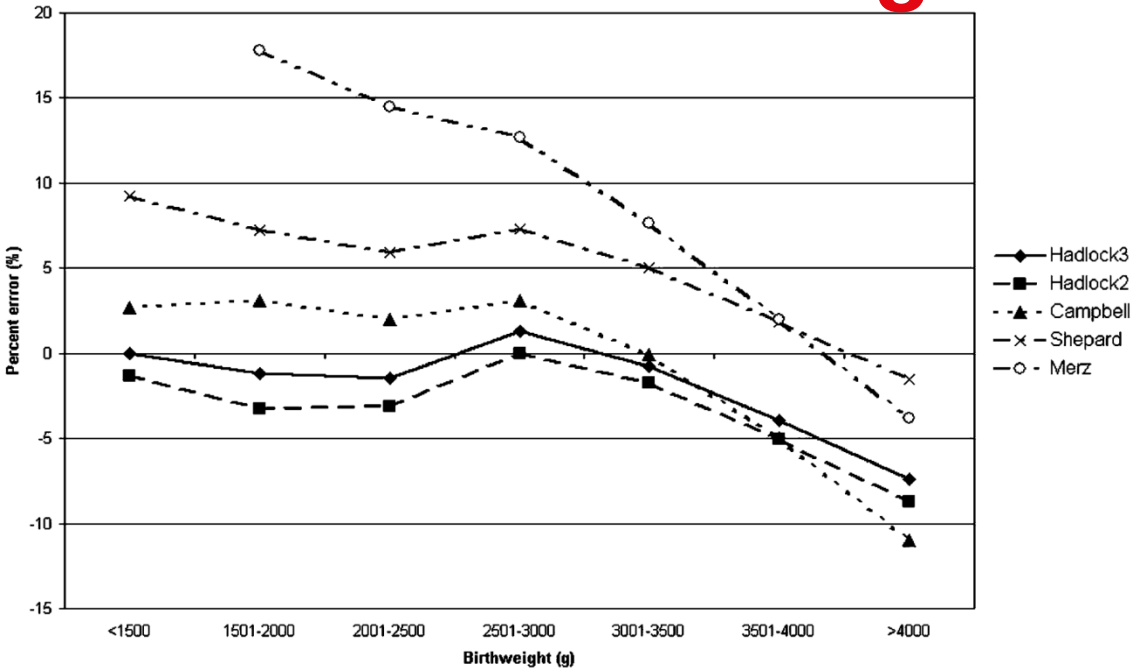
- Ultrasound superior to clinical estimate before 37 weeks
- Clinical estimate has accuracy similar to that of ultrasound at term
- 80% of EFW are within 10% of actual birthweight, remainder are within 20% actual bw (Chauhan ajog 1998)
- Hadlock (Ajog 1985) - EFW calculated from HC, AC, and FL
  (Log EFW = 1.326 + 0.0107 hc + 0.0438 ac + 0.158 fl – 0.00326 AC x FL)
- Intergrowth estimated fetal weight standards
  (Stirnemann et al, ultrasound obstet gynecol 2017;49:478-486)







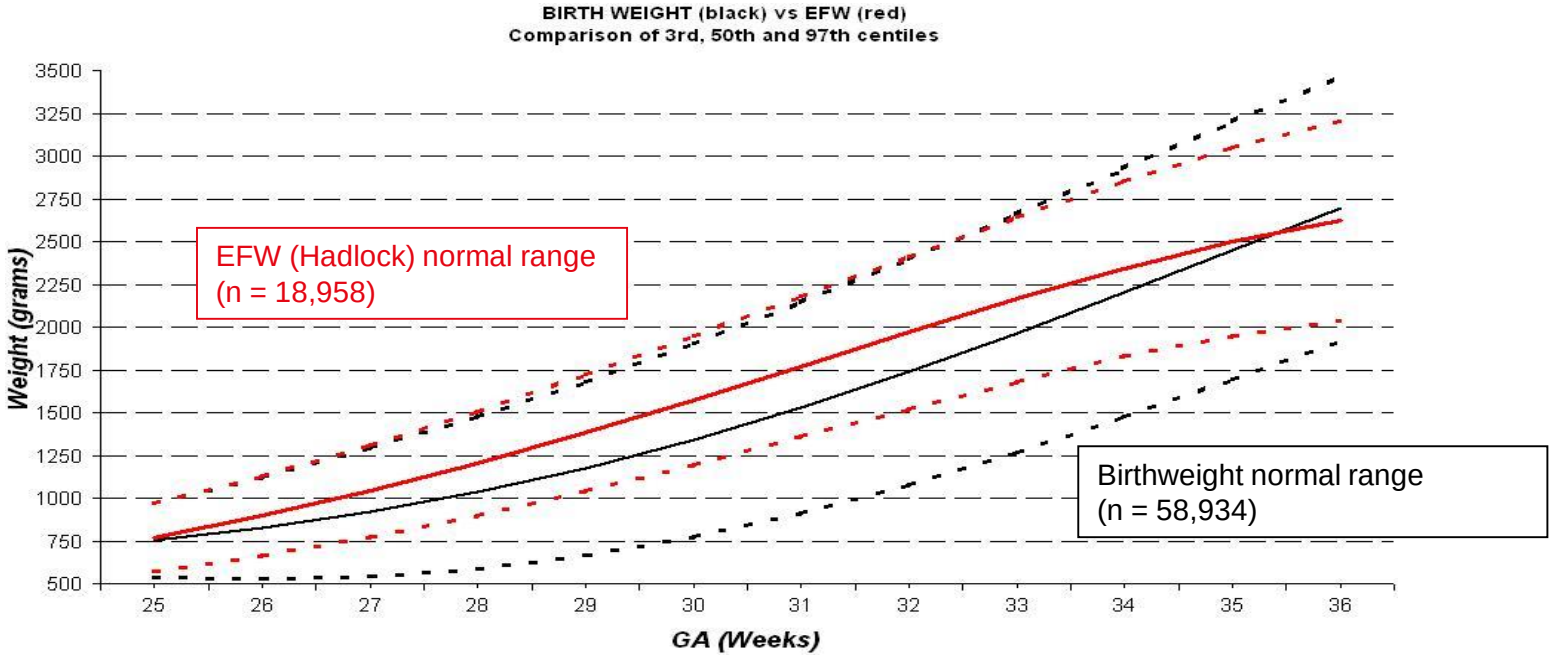
Estimated fetal weight



- Most reliable formula – hadlock 3

Kurmanavicius et al J Perinat Med 2004;32:155-61

Birth weight versus EFW



- BW charts reflect a significant proportion of premature FGR neonates, reporting EFW from BW charts therefore misleading at 28-32 wks, 50th centile for BW = 10th centile for EFW!

Salomon, Bernard and Ville. Ultrasound Obstet Gynecol 2007:29;550-555

FGR risk factors

FETAL
- Chromosomal anomaly
- Genetic syndrome
- Congenital anomaly

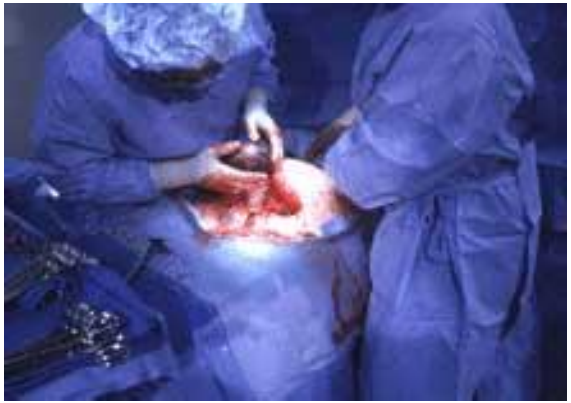
MATERNAL
- Idiopathic
- Chronic disease
- Abnormal implantation (PE, HELLP, antiphospholipid, FGR)

SGA / FGR

PLACENTA
- Mosaicism
- Uterine anomaly
- Velamentous cord insertion

EXTERNALFACTORS
- Smoking
- Infection
- Psycho/social

Placental insufficiency



Mother

Fetus/newborn

Pre-eclampsia, HELLP syndrome, Eclampsia, Increased risk of C-section

Short term

FGR brain remodelling

Increased prenatal mortality, Increased risk of C-section

Born SGA, increased perinatal morbidity and mortality

Medium term

Impaired neurodevelopment, poorer school performance, Accelerated gain in fat

Long term sequelae of per partum complications

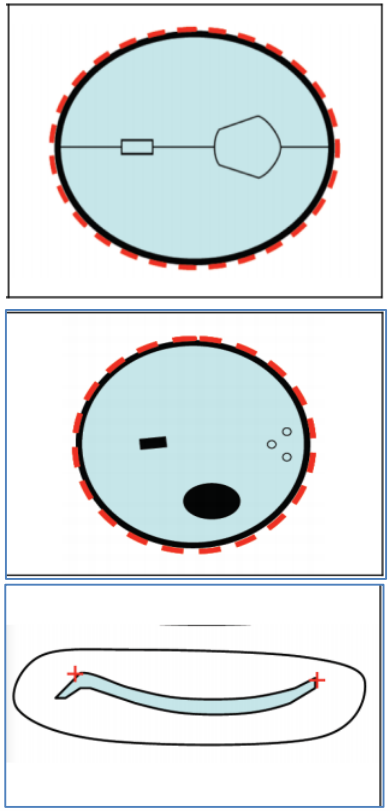
Long term

Obesity, diabetes, hypertension Cardiac diseases, stroke

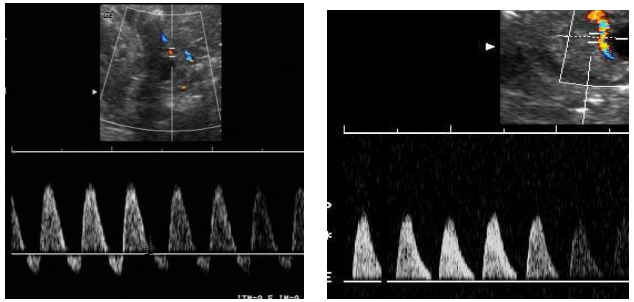
Appropriate diagnosis of FGR in SGA fetuses

- Diagnosis of FGR currently performed by means of combination of biometric measurements and other parameters:
  - Umbilical artery (UA) Doppler historically used to distinguish FGR from SGA - identifies severe placental disease but fails to pick up mild placental disease, I.E. Majority of FGR
  - UA should always be used in combination with cerebroplacental ratio (CPR)
  - Uterine artery doppler PI (uta PI) and very low estimated fetal weight (<p3) independently predict poorer outcome in small fetuses
  - Maternal symptoms
  - Crossing centiles
- Abnormal biometry (EFW and/or AC <10th centile)
  - → UA, CPR, UtA PI, amniotic fluid etc

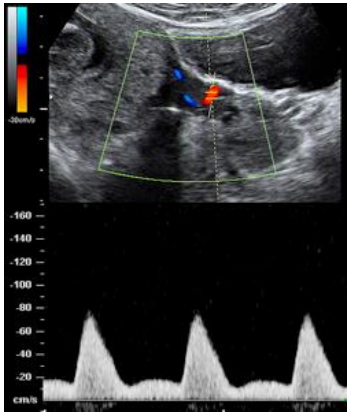
Distinguishing between FGR and SGA



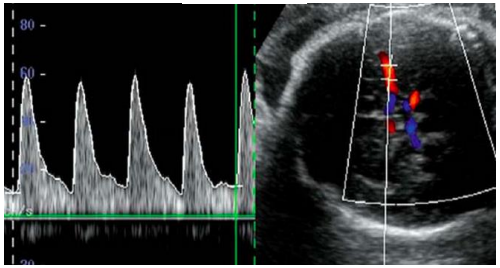
Umbilical artery



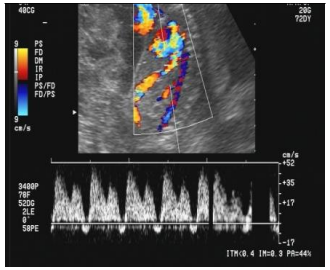
Uterine artery



MCA



Ductus venosus



Appropriate recognition of late FGR / prevention of stillbirth

- Appropriate dating
- Appropriate use of biometry
- Appropriate tools to diagnose late FGR
- Appropriate management of situations

How to manage SGA

Delivery

Neonatal death
RDS
Hypoglycemia
Sepsis
NICU complications..

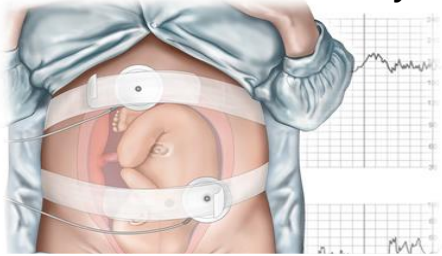
Expectant management

Stillbirth
Neurodevelopmental delay

Decisions

- Appropriate GA estimation
- Appropriate definition of SGA /FGR
- Appropriate monitoring of fetal condition

Biophysical profile

Biophysical profile variable	Normal score (2)	Abnormal score (1)
Fetal breathing movement	One episode fetal breathing 30 s	Absent or < 30 s
Gross fetal movement	Three discrete body/limb movements	Two or less
Fetal tone	One episode active extension with return to flexion of fetal limbs / trunk	Slow extension with partial flexion or limb movement without flexion or none
Fetal heart rate reactivity 	• < 26wks: two accelerations of ≥ 10 beats, two of ≥10 s • 26–36wks: two accelerations of ≥10 beats, ≥15 s • ≥ 36wks: two accelerations of ≥20 beats, ≥20 s	Less than two episodes of accelerations and durations as specified
Amniotic fluid volume	Pocket 2 x 2 cm	Pocket < 2 x 2 cm

Baschat A. UOG 2001; 18: 571–577
Manning FA. Obstet Gynecol Clin North Am 1999; 26: 557–77

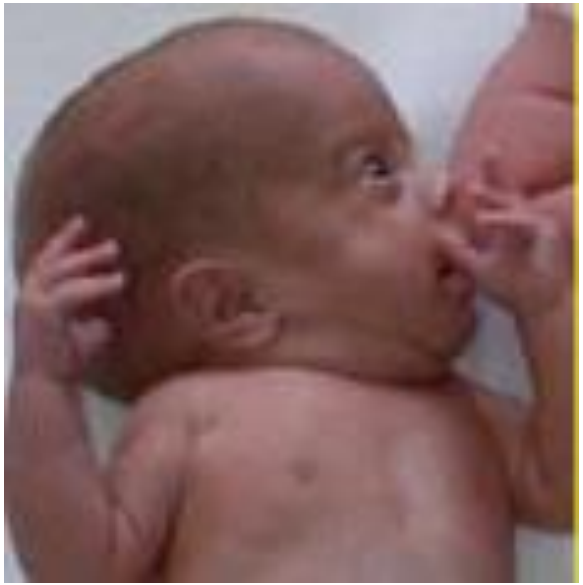
Early FGR and late FGR

Early FGR

- Easy to diagnose, difficult to treat

Late FGR

- Difficult to diagnose, easy to treat

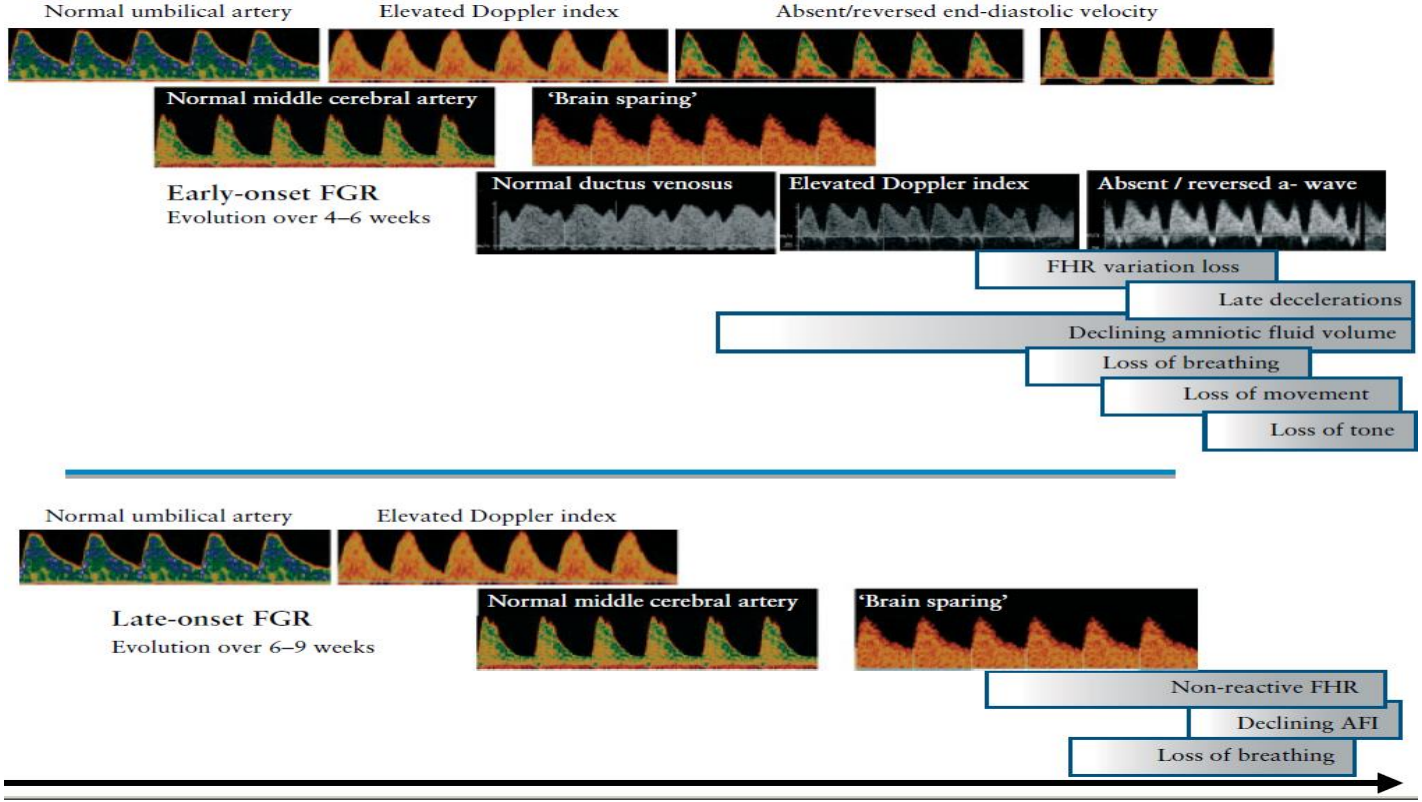


Early and late onset FGR – main differences

Early-onset FGR (1–2%)	Late-onset FGR (3–5%)
Problem: management	Problem: diagnosis
Placental disease: severe (UA Doppler abnormal, high association with preeclampsia)	Placental disease: mild (UA Doppler normal, low association with preeclampsia)
Hypoxia ++: systemic cardiovascular adaptation	Hypoxia +/–: central cardiovascular adaptation
Immature fetus = higher tolerance to hypoxia = natural history	Mature fetus = lower tolerance to hypoxia = no (or very short) natural history
High mortality and morbidity; lower prevalence	Lower mortality (but common cause of late stillbirth); poor long-term outcome; affects large fraction of pregnancies

Figuros F and Gratacos E. Fetal Diagn Ther. 2014; 36:86-98

Placental insufficiency, early and late response



Baschat A. UOG 2011;37:501–514

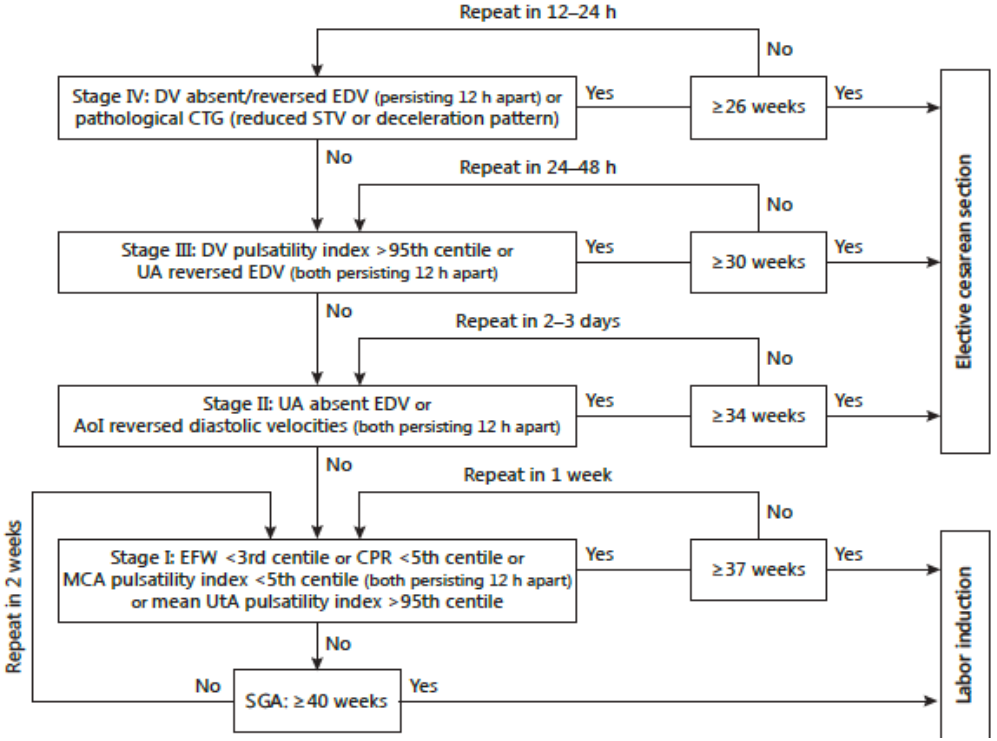
Stage based classification and management of FGR

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring*	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW <3rd centile CPR <p5 UA PI >p95 MCA PI <p5 UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV Reverse AoI	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow cCTG <3 ms FHR decelerations	12 h	26 weeks** CS

All Doppler signs described above should be confirmed at least twice, ideally at least 12 h apart. GA = Gestational age; LI = labor induction; CS = cesarean section. * Recommended intervals in the absence of severe preeclampsia. If FGR is accompanied by this complication, strict fetal monitoring is warranted regardless of the stage. ** Lower GA threshold recommended according to current literature figures reporting at least 50% intact survival. Threshold could be tailored according to parents' wishes or adjusted according to local statistics of intact survival.

Figueras F and Gratacos E. Fetal Diagn Ther. 2014; 36:86-98

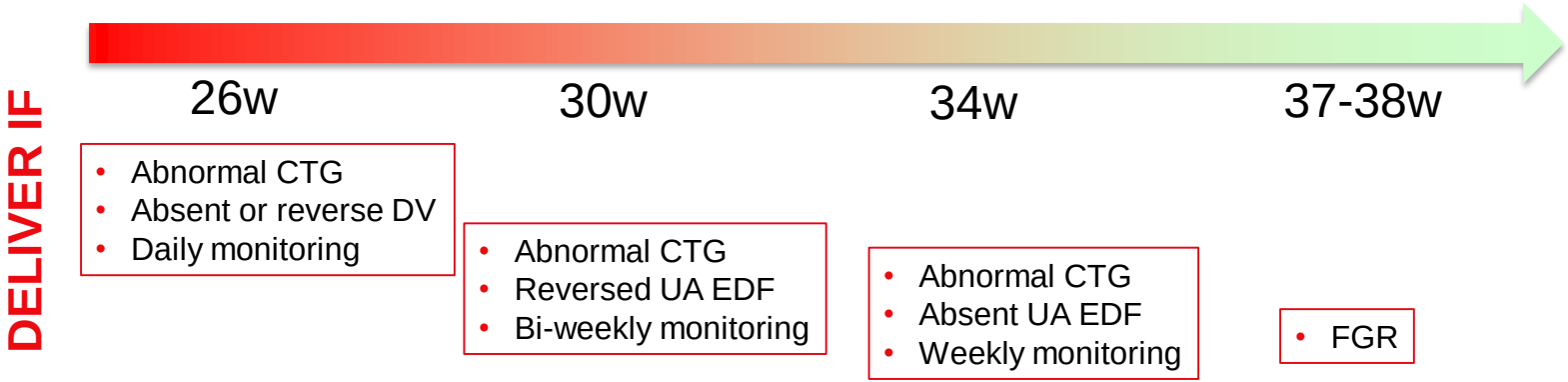
Stage based decision algorithm for FGR management



Figueras F and Gratacos E. Fetal Diagn Ther. 2014; 36:86-98

Take home messages

- Growth anomalies - public health problem responsible for mortality + short and long term morbidity
- Appropriate understanding of the differences and overlap between SGA and FGR required
- Doppler (UA, MCA and CPR) useful for improving diagnostic efficiency and management:
  - Helps distinguish between constitutionally small and FGR fetuses
  - Increases sensitivity in cases with borderline biometric anomalies



Key points

1. Use BPD, HC, AC and FL to assess fetal growth and EFW
2. Beware of the causes of impaired and increased fetal growth
3. Leave at least 10 days between scans
4. Assess amniotic fluid, fetal wellbeing and doppler to document the placental origin of fgr, and monitor the pregnancy
5. Deliver >36/37 weeks in late fgr
6. Use doppler and ctg to optimise ga at delivery in early fgr