Timing of delivery – When should you think about induction of labour?

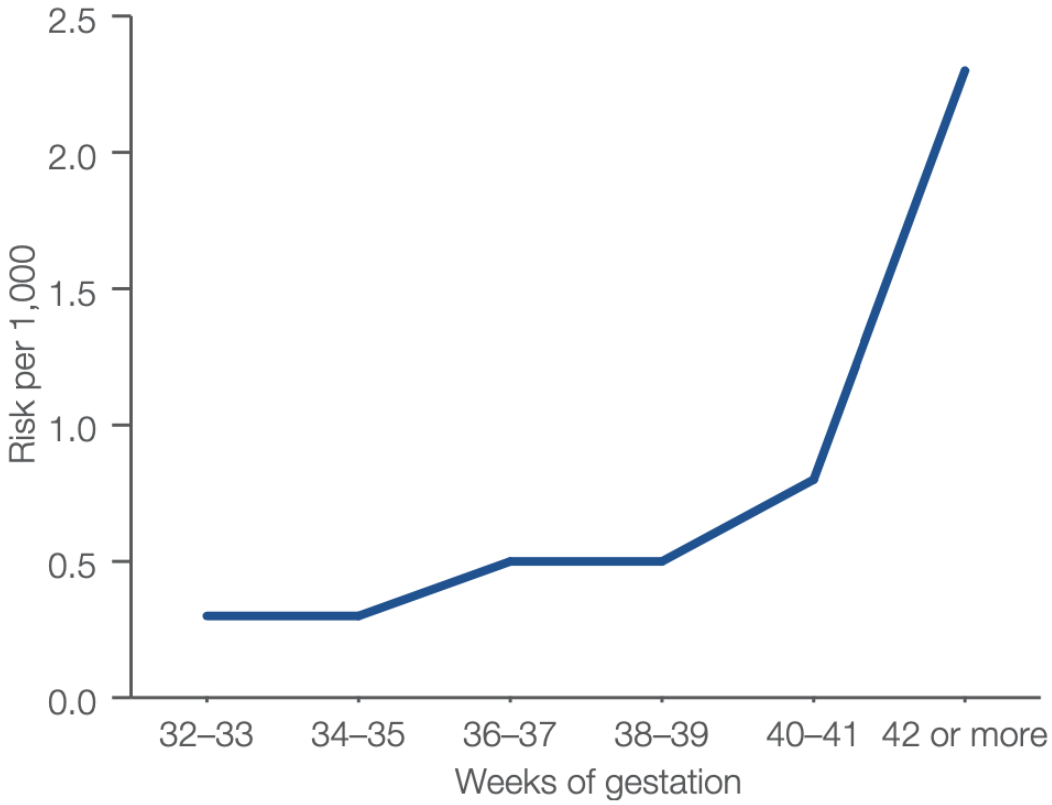
Lindsay Kindinger/Sonia Kua
King Edward Memorial Hospital
June 2025

Weighing up the risk of Stillbirth against neonatal morbidity

Risk of stillbirth

- At 38-39w: 0.5 per 1,000
- At 40–41w 0.8 per 1,000
- At 42w: 2.3 per 1,000 - rising more steeply!

Figure 1.2: Risk of stillbirth per 1,000 fetuses remaining in utero, by gestational age, Australia, 2015 and 2016



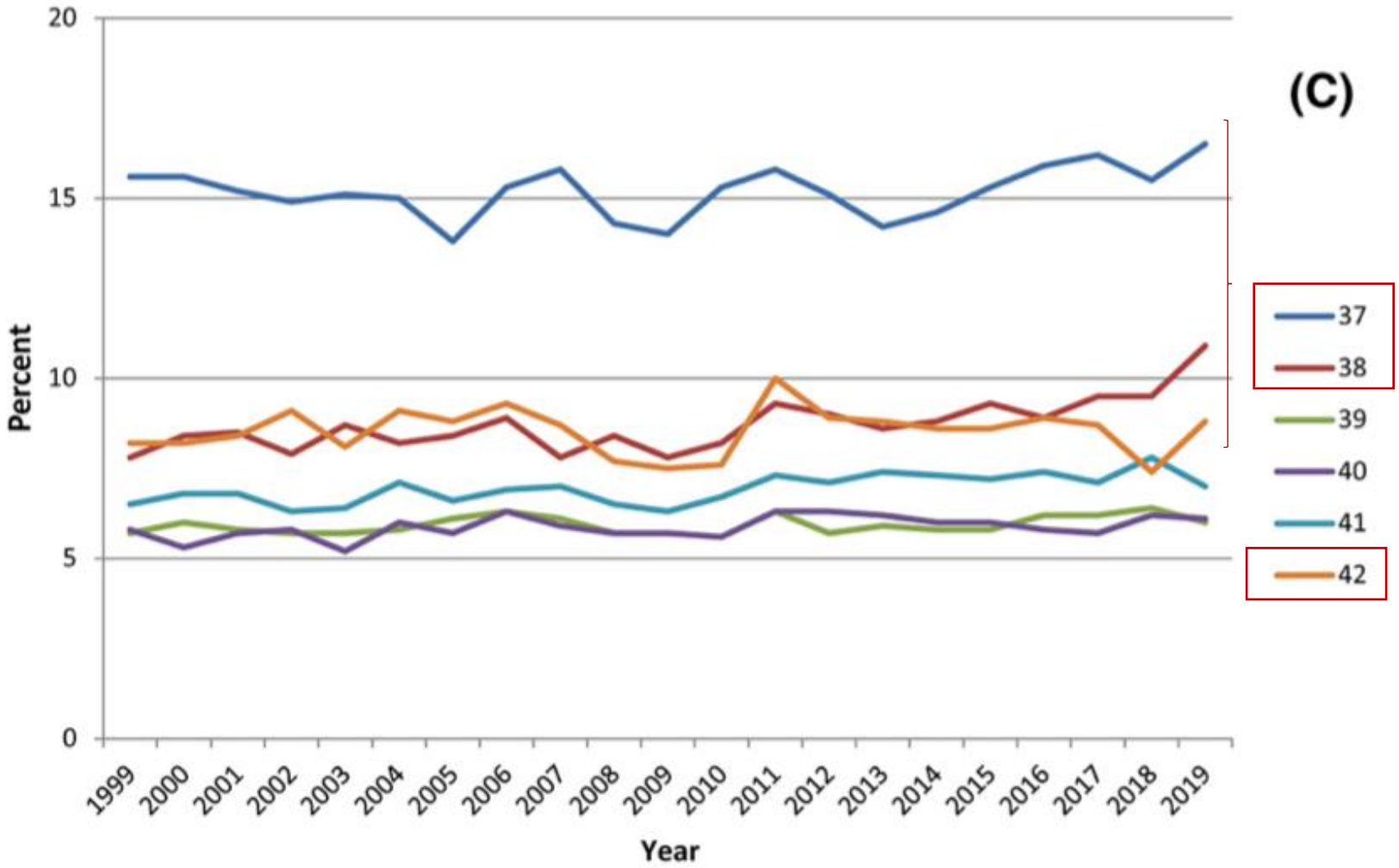
Source: *Stillbirths and Neonatal Deaths in Australia 2015 and 2016: In brief.*[19]

Admission to NICU

Is the increasing prevalence of labor induction accompanied by changes in pregnancy outcomes? An observational study of all singleton births at gestational weeks 37–42 in Norway during 1999–2019

Camilla Haavaldsen, Nils-Halvdan Morken, Ola Didrik Saugstad, Anne Eskild

First published: 09 December 2022 | https://doi.org/10.1111/aogs.14489 | Citations: 1



Lowest NICU admission**:**
39 and 40w

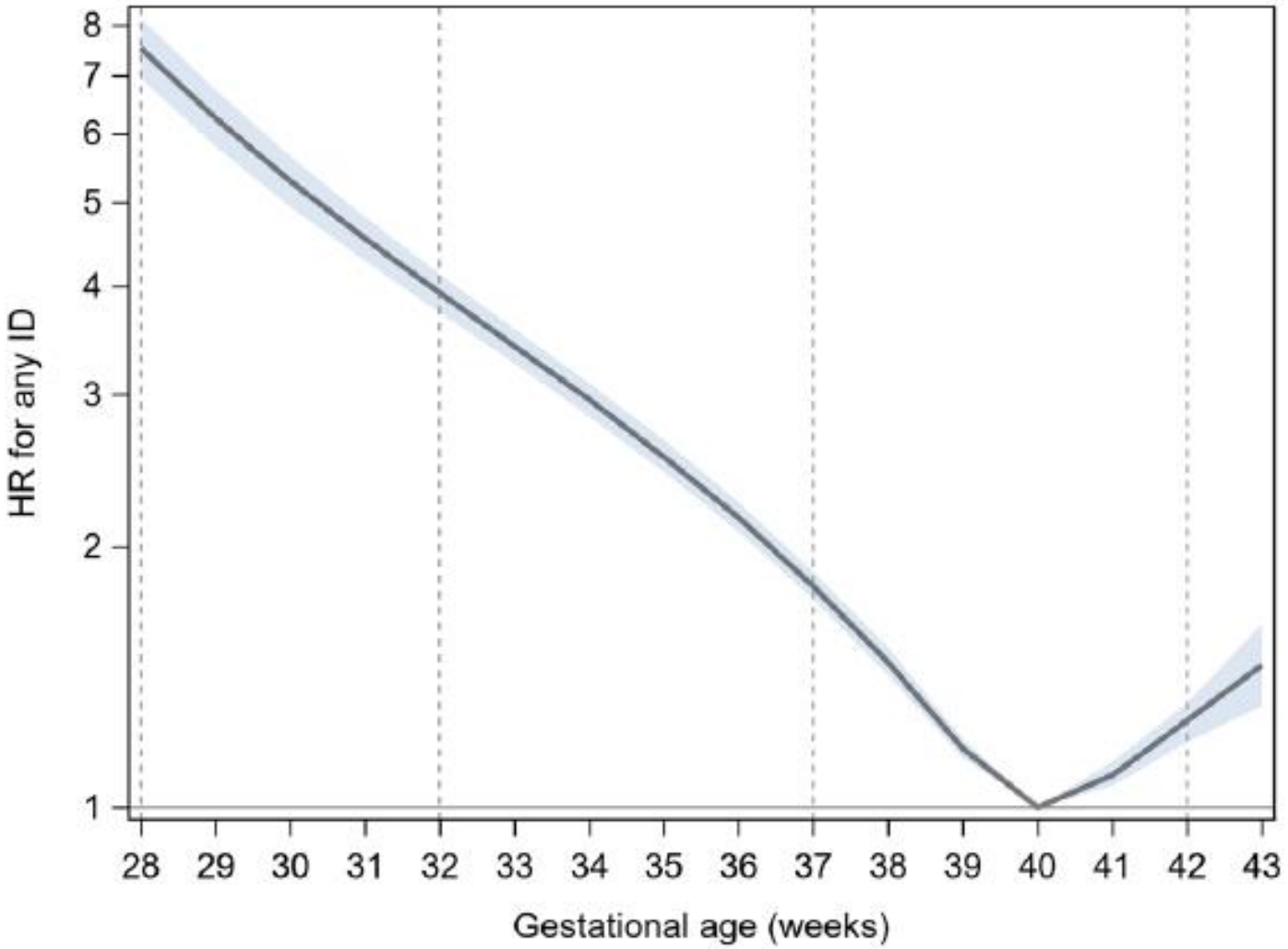
Highest NICU admission:
37w, 38w and 42w

Long term outcomes of early term birth: <39w

Swedish popn study,
n = 3.5 million

Risk of intellectual disability increases weekly before 40w

- **↑17% ADHD scores at early term (37-38)** (Lingasubramanian et al)



Original research

BMJ

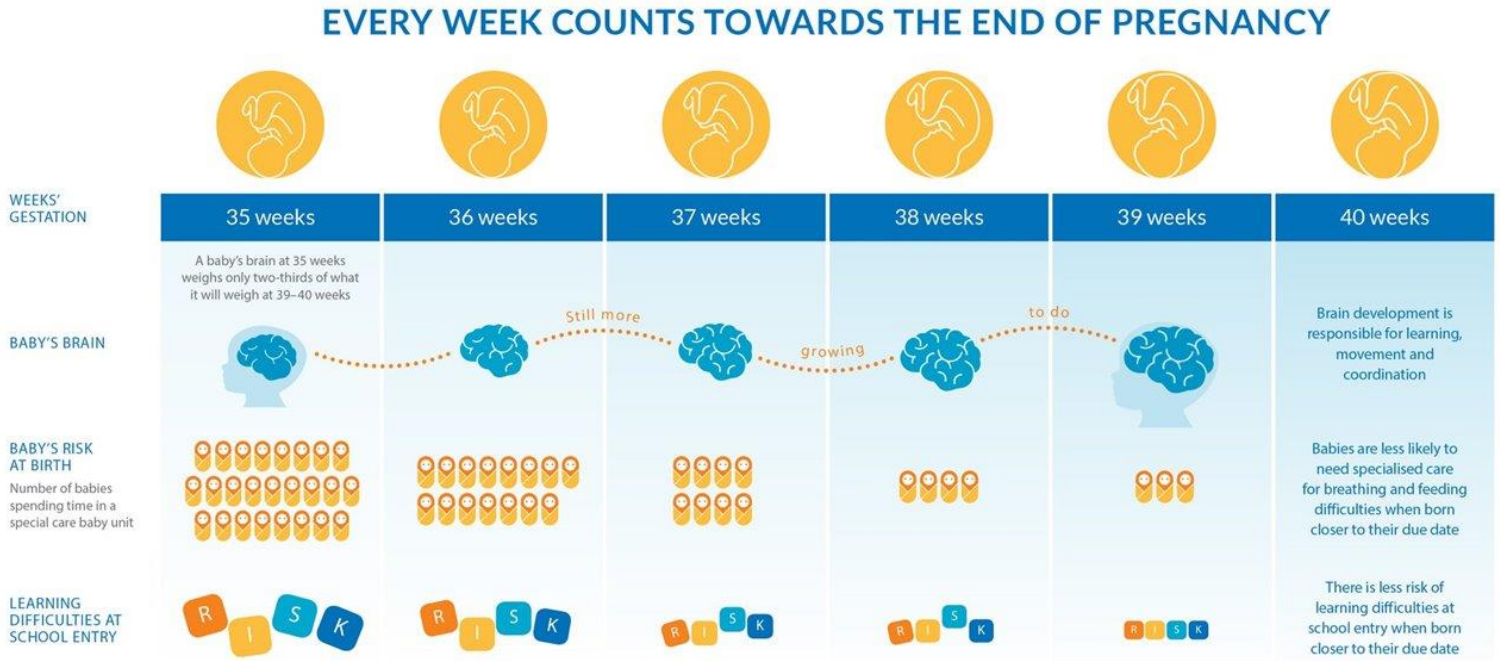
Gestational age and risk of intellectual disability: a population-based cohort study

2022;**0**:1–7.

Weiyao Yin [1,2] Nora Döring,[1] Monica S M Persson,[1] Martina Persson,[3] Kristina Tedroff,[4] Ulrika Ädén,[3] Sven Sandin [1,5]

AUSTRALIAN
Preterm Birth
Prevention
ALLIANCE

Every Week Counts for the neonate!



So how to find a balance…
…when is an IOL really indicated?

Common indications for induction

Low risk

Advanced maternal age

Assisted conception (IVF)

High BMI

Small for gestational age

LGA / macrosomia

Hypertension and Pre-eclampsia

Intrahepatic cholestasis of pregnancy (OC)

PPROM and PROM

~~Diabetes / GDM~~

Low risk nulliparous

‘ARRIVE trial’, *2018*

The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 AUGUST 9, 2018 VOL. 379 NO. 6

Labor Induction versus Expectant Management in Low-Risk Nulliparous Women

Primary outcome: **Composite perinatal death & severe neonatal morbidity**

→No significant difference

4.3% IOL vs **5.4% expectant** (RR 0.80; 0.64 - 1.00)

Secondary outcome: **Multiple neonatal and maternal outcomes**

→ Significant ↓ **in Caesareans.** NNT =28

19% IOL vs **22% expectant** (RR 0.84; 0.76 - 0.93)

Maternal secondary outcomes

The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 AUGUST 9, 2018 VOL. 379 NO. 6

Labor Induction versus Expectant Management in Low-Risk Nulliparous Women

Maternal				
Cesarean delivery — no. (%)	569 (18.6)	674 (22.2)	0.84 (0.76–0.93)	<0.001‡
Operative vaginal delivery — no. (%)	222 (7.3)	258 (8.5)	0.85 (0.72–1.01)	0.07
Hypertensive disorder of pregnancy — no. (%)	277 (9.1)	427 (14.1)	0.64 (0.56–0.74)	<0.001‡
Chorioamnionitis — no. (%)	407 (13.3)	429 (14.1)	0.94 (0.83–1.07)	0.35
Third-degree or fourth-degree perineal laceration — no. (%)	103 (3.4)	89 (2.9)	1.15 (0.87–1.52)	0.33
Postpartum hemorrhage — no. (%)	142 (4.6)	137 (4.5)	1.03 (0.82–1.29)	0.81
Postpartum infection — no. (%)	50 (1.6)	65 (2.1)	0.76 (0.53–1.10)	0.15
Admission to ICU — no. (%)	4 (0.1)	8 (0.3)	0.50 (0.13–1.55)	0.26
Death — no. (%)	0	0	NA	NA
Median duration of stay in labor and delivery unit (IQR) — hr§	20 (13–28)	14 (9–20)		<0.001‡
Postpartum hospital stay — no. (%)				0.01‡¶
<2 days	322 (10.5)	317 (10.4)		
2 days	2191 (71.6)	2084 (68.6)		
3 days	399 (13.0)	452 (14.9)		
4 days	130 (4.2)	166 (5.5)		
>4 days	17 (0.6)	18 (0.6)		
Median scores on Labor Agentry Scale (IQR)‖				
At 6–96 hr after delivery	168 (148–183)	164 (143–181)		<0.001‡
At 4–8 wk after delivery	176 (157–189)	174 (154–188)		0.01‡
Median labor pain scores (IQR)**				
Worst score	8 (7–10)	9 (8–10)		<0.001‡
Overall score	7 (5–8)	7 (5–9)		<0.001‡

IOL at 39w:

- 16%↓ Caesar rate
- 36% ↓ Hypertensive disorders

BUT Longer duration on LW

20hrs (IOL) vs 14hrs (expectant)

Einerson et al; for the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD)
Obstetrics & Gynecology 136(1):p 19-25, July 2020.

Is There a Difference in Cost?

Economic analysis:

Comparison the actual health-system costs amongst ARRIVE Utah study sites

Outpatient costs: **47% lower** in IOL group

Inpatient labour delivery costs: **17% higher** in IOL group

No difference in
- Postpartum care (Inpatient or outpatient)
- Neonatal care

Overall: **No significant difference between groups.**

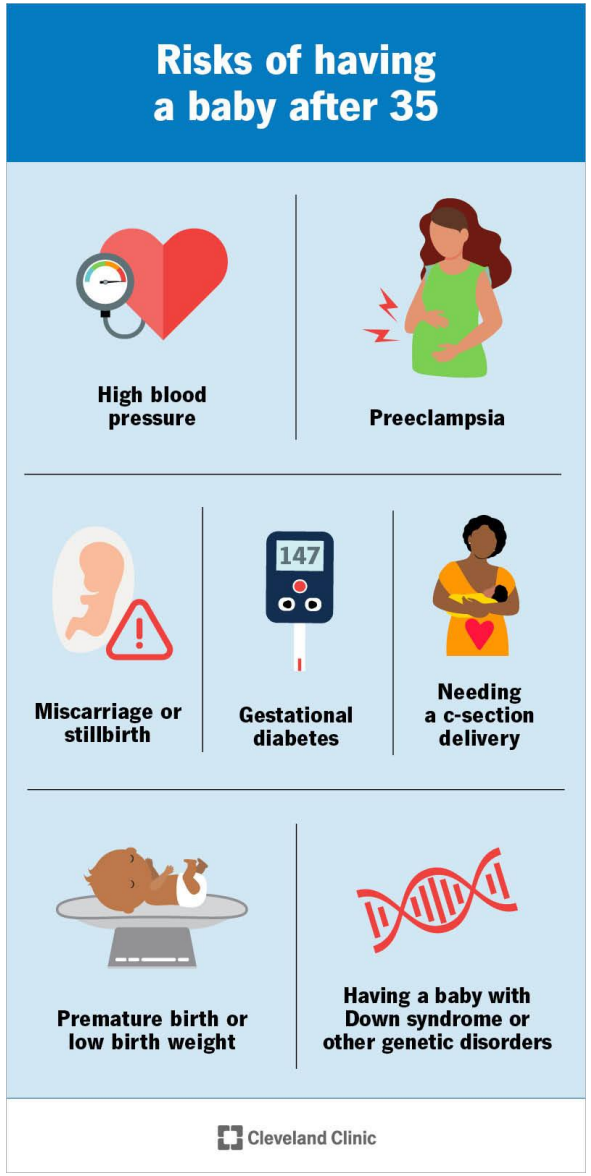
Perinatal mortality and other severe adverse outcomes following planned birth at 39 weeks versus expectant management in low-risk women: a population based cohort study

Kylie Crawford,[a,b] Waldemar A. Carlo,[d] Anthony Odibo,[e] Aris Papageorghiou,[f] William Tarnow-Mordi,[g,h] and Sailesh Kumar[a,b,c,h,*]

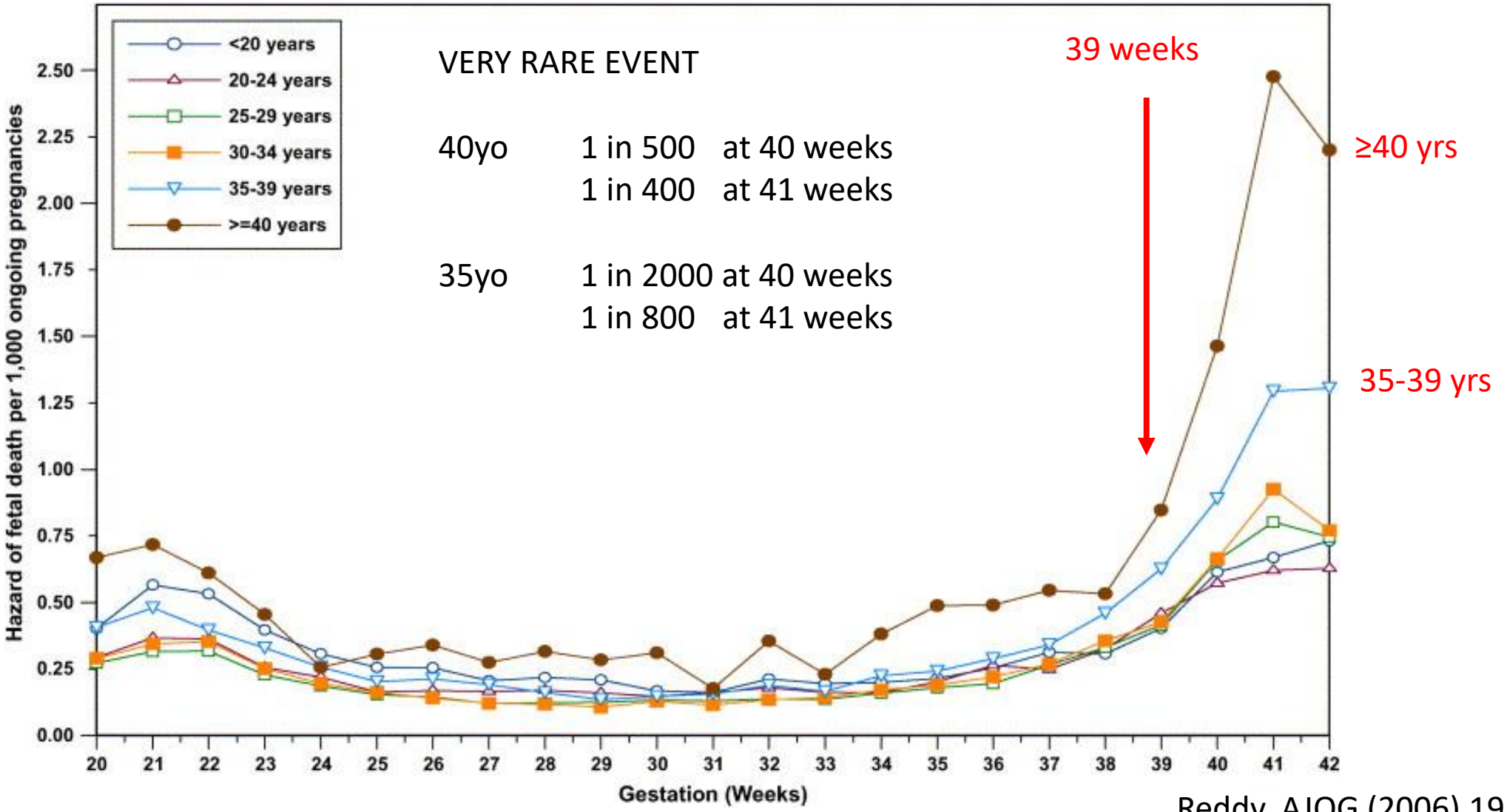
- 2025 Lancet
- 472 520 low risk pregnancies Qld
- Planned birth 39+0-39+6 (40% IOL, 60% planned CS)
  - ↓52% perinatal mortality
  - ↓54% severe neurological morbidity and ↓35% severe non neurological morbidity
- However – risk reduction greatest for planned CS
- Planned birth by IOL - ↓CS, severe perineal trauma and shoulder dystocia

- NNT to prevent one case of perinatal death was 2278 (!)

Advanced Maternal age



Advanced Maternal age



VERY RARE EVENT

40yo 1 in 500 at 40 weeks
1 in 400 at 41 weeks

35yo 1 in 2000 at 40 weeks
1 in 800 at 41 weeks

39 weeks

≥40 yrs

35-39 yrs

Reddy, AJOG (2006) 195, 764–70

Advanced Maternal age

Randomized Controlled Trial > N Engl J Med. 2016 Mar 3;374(9):813-22.
doi: 10.1056/NEJMoa1509117.

Randomized Trial of Labor Induction in Women 35 Years of Age or Older

Kate F Walker [1], George J Bugg [1], Marion Macpherson [1], Carol McCormick [1], Nicky Grace [1], Chris Wildsmith [1], Lucy Bradshaw [1], Gordon C S Smith [1], James G Thornton [1]; 35/39 Trial Group

‘>35yo, IOL at 39w’ trial, NEJM 2016

No evidence of harm

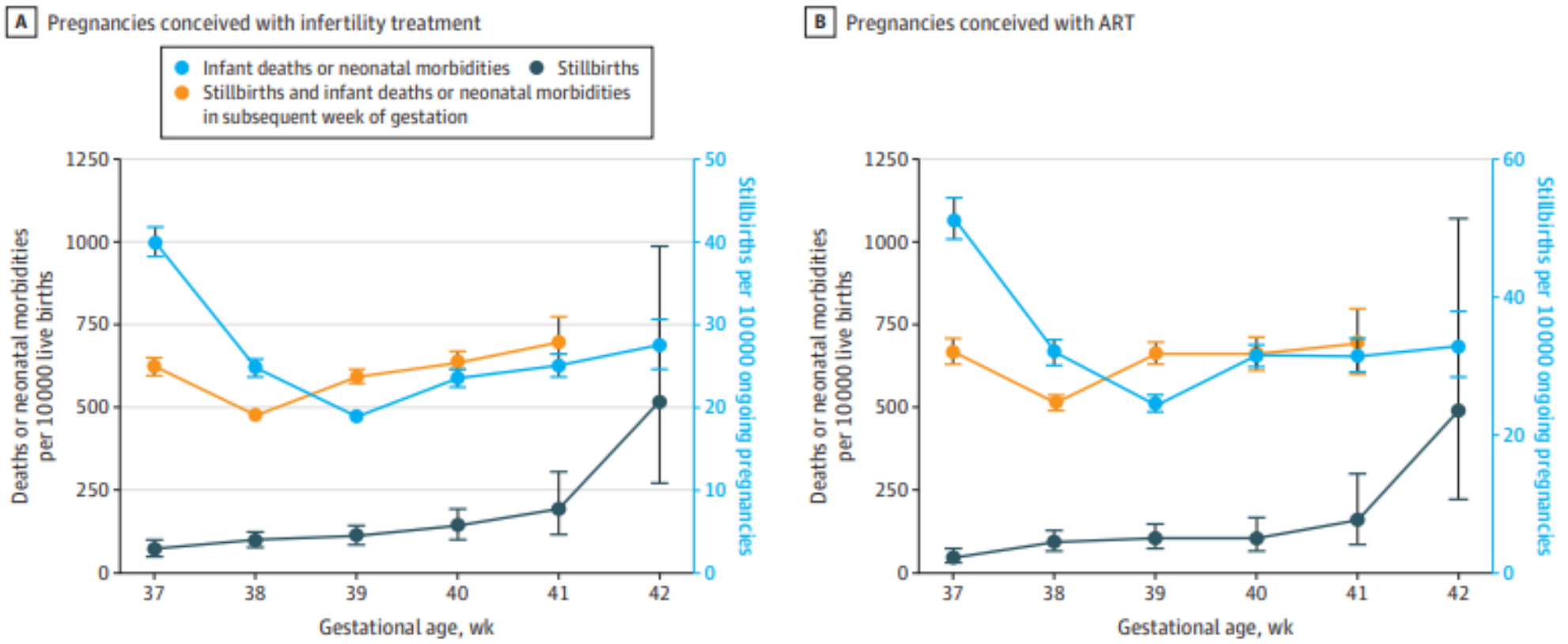
No reduction in
- adverse perinatal outcome
- neonatal morbidity

No impact on CS rates

Under powered for stillbirth

IVF / assisted reproductive techniques

IVF / assisted reproductive techniques



Hamilton et al. JAMA, 2023

Study demonstrating the balance of stillbirth vs neonatal death and/or morbidity – lowest at 39w

NNT = 63 to prevent 1 excess death

Obesity


Under weight
Normal weight
Over weight
Obese (Class I)
Obese (Class II)
Obese (Class III)
<18.5
18.5 – 24.9
25.0 – 29.9
30.0 – 34.9
35.0 – 39.9
>40.0

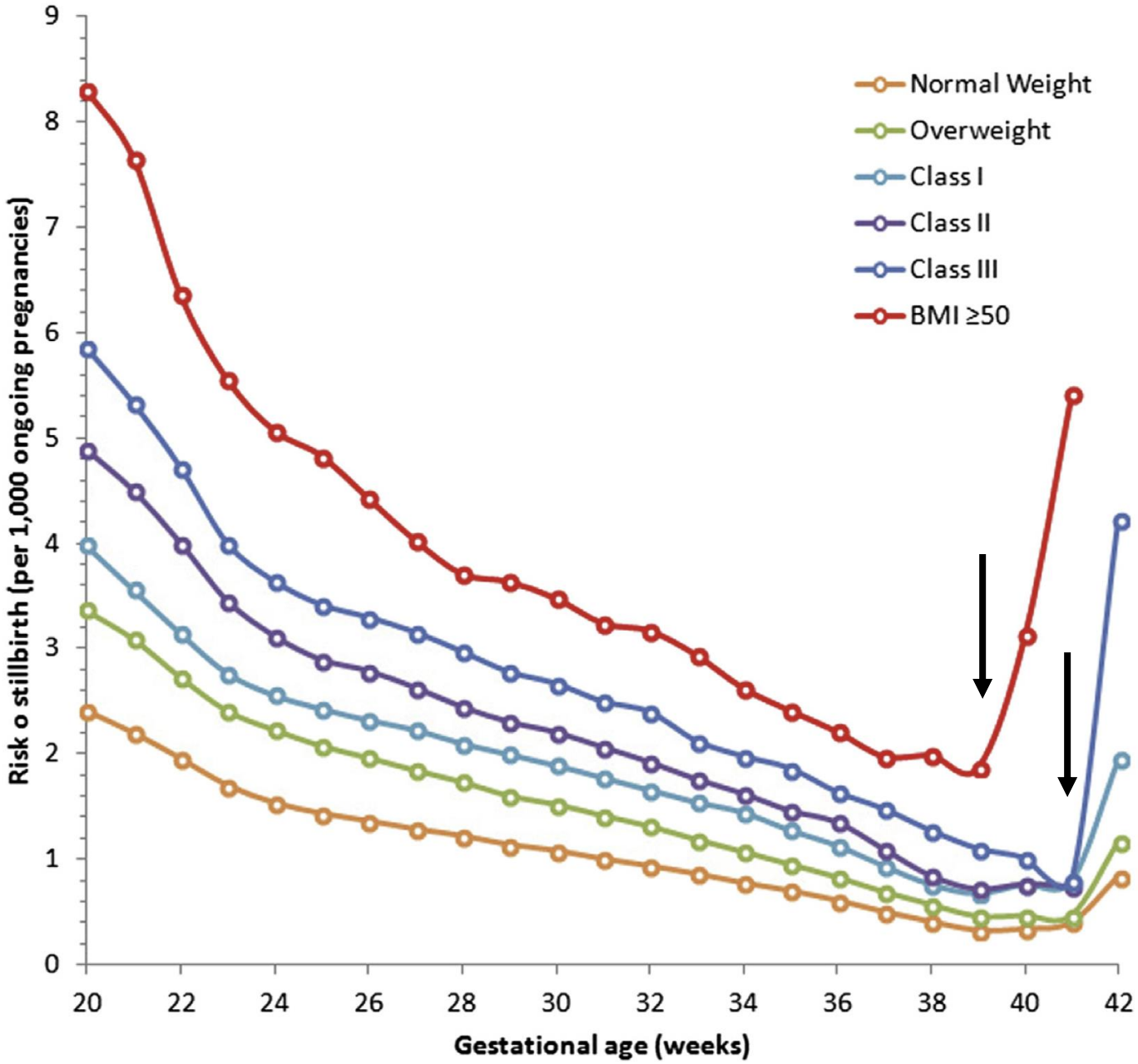
Obesity

BMI 30 to 49:

Stillbirth risk ↑ **from 41w**.

BMI >50:

Stillbirth risk ↑ **from 39w**.



Yao, Perinatal Research Consortium. Obesity and the risk of stillbirth: a population-based cohort study. *AJOG 2014*

High(er) risk indications for early delivery

Advanced maternal age

Assisted conception (IVF)

High BMI

Small for gestational age

LGA / macrosomia

Intrahepatic cholestasis of pregnancy (OC)

PPROM

Hypertension and Pre-eclampsia

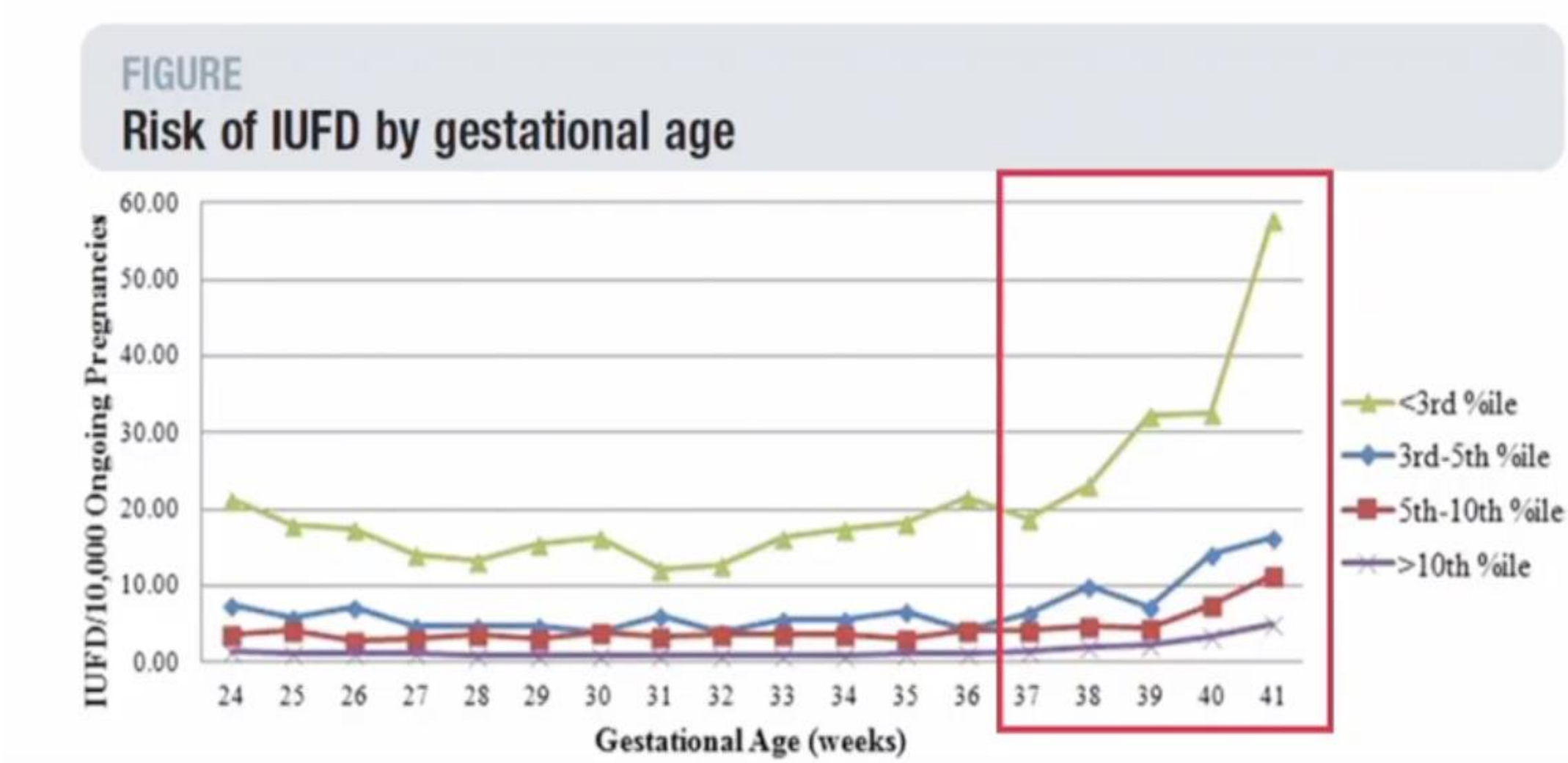
Small for gestational age
&
Fetal growth restriction

KEMH

SGA vs FGR…things to consider

Centile:	*<3rd, 3rd-10th, 10th*
Growth trajectory	*forward vs slowing*
Dopplers	*UA PI >95th centile* *(MCA should not be used to time birth)*
Amniotic fluid	*oligo <2cm*
Risk factors	*HTN / PET, comorbidities, Low PAPPA,* *Congenital infection, drugs, alcohol…etc etc*

Risk of stillbirth and neonatal death for SGA fetus



Pilliod AJOG, 2012;207:318.e1-6.

Timing of delivery:

US findings	Recommended GA at delivery
Normal UA Doppler	Aim > 37w
10th centile (good trajectory, no risk factors = SGA)	39w
3rd to 10th centile	38w
<3rd centile (‘severe FGR’)	37w
Abnormal UA Doppler	By 37w
Raised UA PI	36w

OR CTG ABNORMALITIES

Fetal macrosomia

Newborn baby

Fetal macrosomia

IOL <40w vs expectant Mx:

Cochrane Library

Cochrane Database of Systematic Reviews

Cochrane Database of Systematic Reviews 2023

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

Boulvain M, Thornton JG

Outcome or subgroup title	No. of studies	No. of partici-pants	Statistical method	Effect size
1.1 Caesarean section	4	1190	Risk Ratio (M-H, Fixed, 95% CI)	0.91 [0.76, 1.09]
1.2 Instrumental delivery	4	1190	Risk Ratio (M-H, Fixed, 95% CI)	0.86 [0.65, 1.13]
1.3 Shoulder dystocia ↓ 40%	4	1190	Risk Ratio (M-H, Fixed, 95% CI)	0.60 [0.37, 0.98]
1.4 Brachial plexus injury	4	1190	Risk Ratio (M-H, Fixed, 95% CI)	0.21 [0.01, 4.28]
1.5 Fracture (any) ↓ 80%	4	1190	Risk Ratio (M-H, Fixed, 95% CI)	0.20 [0.05, 0.79]
1.6 Low Apgar score (5 minutes)	2	858	Risk Ratio (M-H, Fixed, 95% CI)	1.51 [0.25, 9.02]
1.7 Low arterial cord blood pH (< 7.10)	1	818	Risk Ratio (M-H, Fixed, 95% CI)	1.01 [0.46, 2.22]

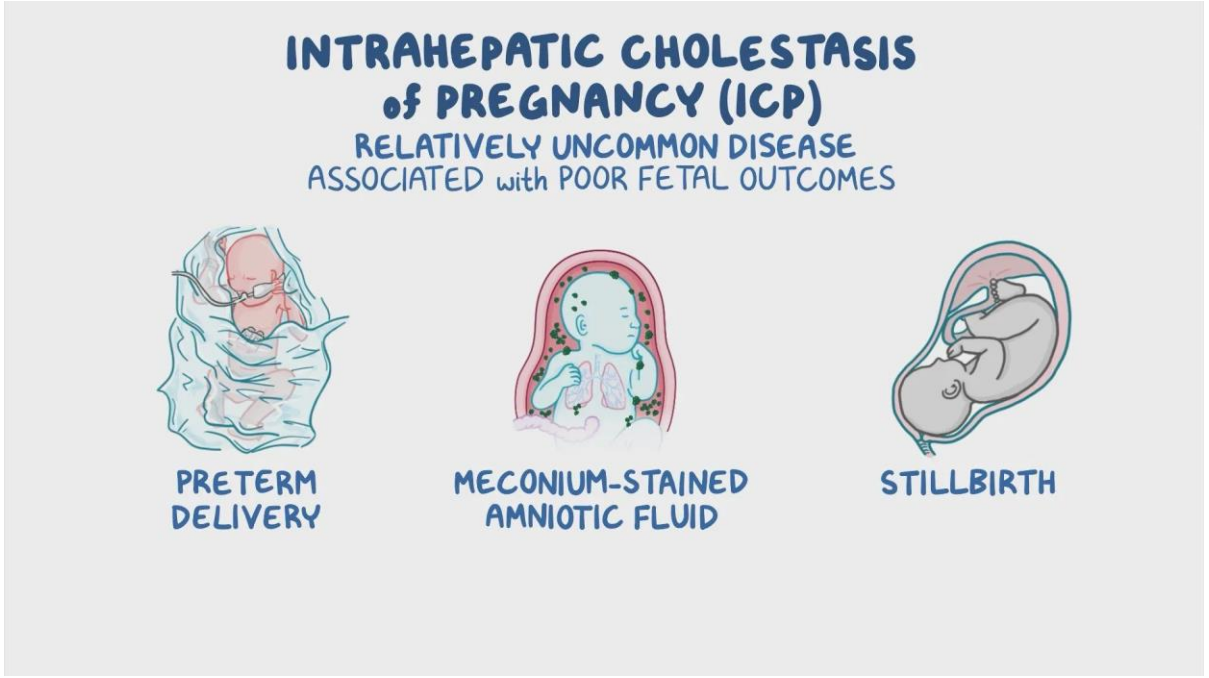
Big Baby

Induction of labour versus standard care to prevent shoulder dystocia in fetuses suspected to be large for gestational age in the UK (the Big Baby trial): a multicentre, open-label, randomised controlled trial

Jason Gardosi, Lauren Jade Ewington, Katie Booth, Debra Bick, George Bouliotis, Emily Butler, Sanjeev Deshpande, Hanna Ellson, Joanne Fisher, Adam Gornall, Ranjit Lall, Hema Mistry, Seyran Naghdi, Stavros Petrou, Anne-Marie Slowther, Sara Wood, Martin Underwood, Siobhan Quenby

- Women with suspected LGA (>90th centile) recruited 35-38 weeks
- IOL 38+0 – 38+4 vs standard management
- Primary outcome – shoulder dystocia
- Intention to treat analysis – no significant difference
  - 24.6% in standard care group were induced/delivered <38+4
- Per protocol analysis – shoulder dystocia ↓(RR 0.62, 98%CI 0.41-0.92, p=-.019)
- No ↑in maternal trauma (3rd or 4th), ↓PPH by 10%, and NELUSCS 20%
- No change in adverse neonatal outcomes

Intrahepatic Cholestasis of Pregnancy



Intrahepatic Cholestasis of Pregnancy
Quick recap

SOMANZ
SOCIETY OF OBSTETRIC MEDICINE OF AUSTRALIA AND NEW ZEALAND

Intrahepatic Cholestasis of Pregnancy – Diagnosis and Management:

Dx:	**Non fasting**	**BA *≥19 µmol/L***
	Severe OC	**BA *≥40 µmol/L***
	Very severe OC	**BA *≥100 µmol/L***

Obstetric Cholestasis
Timing of delivery

Association of adverse perinatal outcomes of intrahepatic cholestasis of pregnancy with biochemical markers: results of aggregate and individual patient data meta-analyses

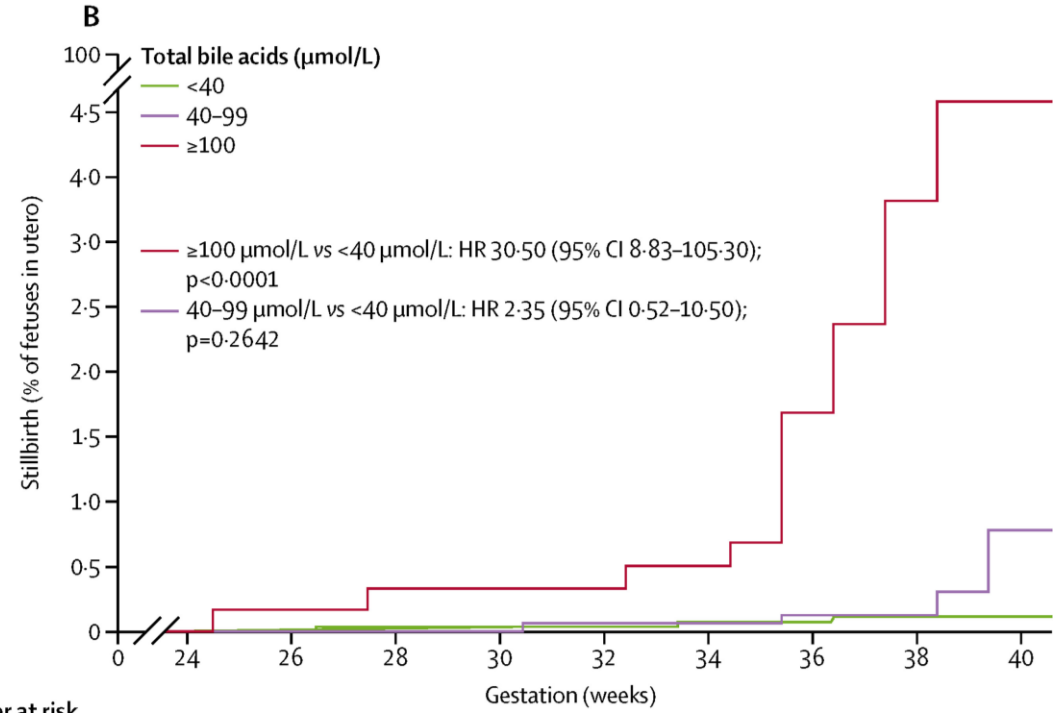
Caroline Ovadia, BCh • Paul T Seed, MSc • Alexandros Sklavounos, BSc • Victoria Geenes, PhD • Chiara Di Ilio, MD • Jenny Chambers, BPhil • et al. Show all authors • Show footnotes

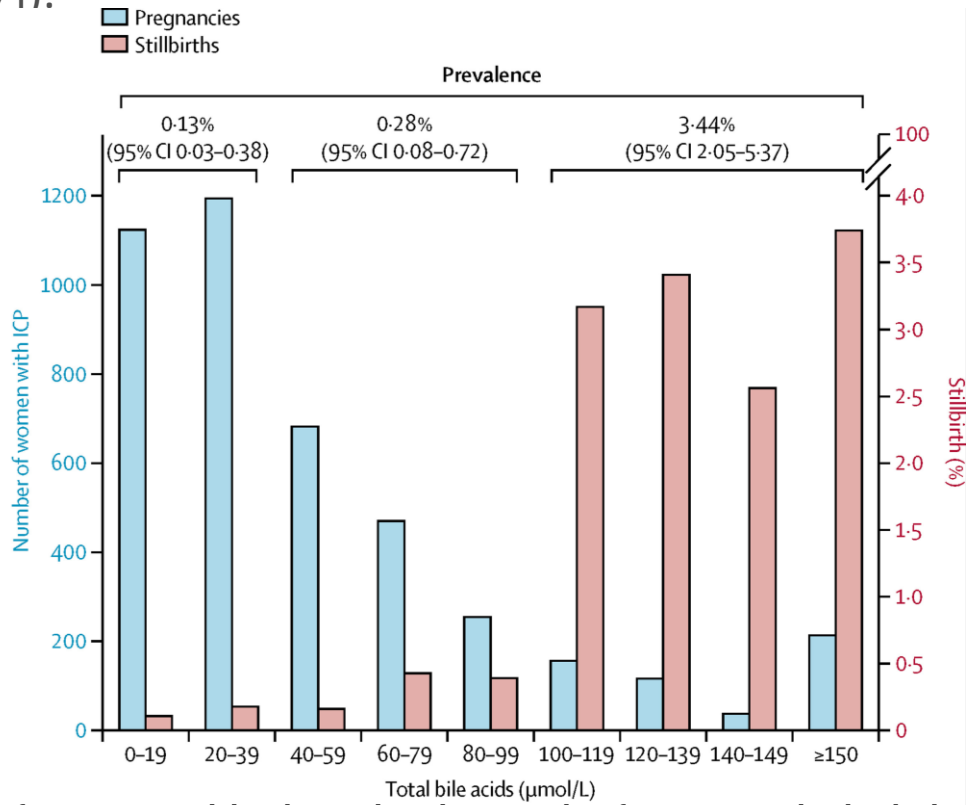
Open Access • Published: February 14, 2019 • DOI: https://doi.org/10.101

THE LANCET

Lancet 2019, 'the Ovadia study': meta-analysis of 23 studies: 5557 ICP cases vs 165,136 controls

- **BA >100** **highly predictive of stillbirth**
- **LFTS and ALT** **NOT predictive of stillbirth** (AUC 0·46 [0·35–0·57]).





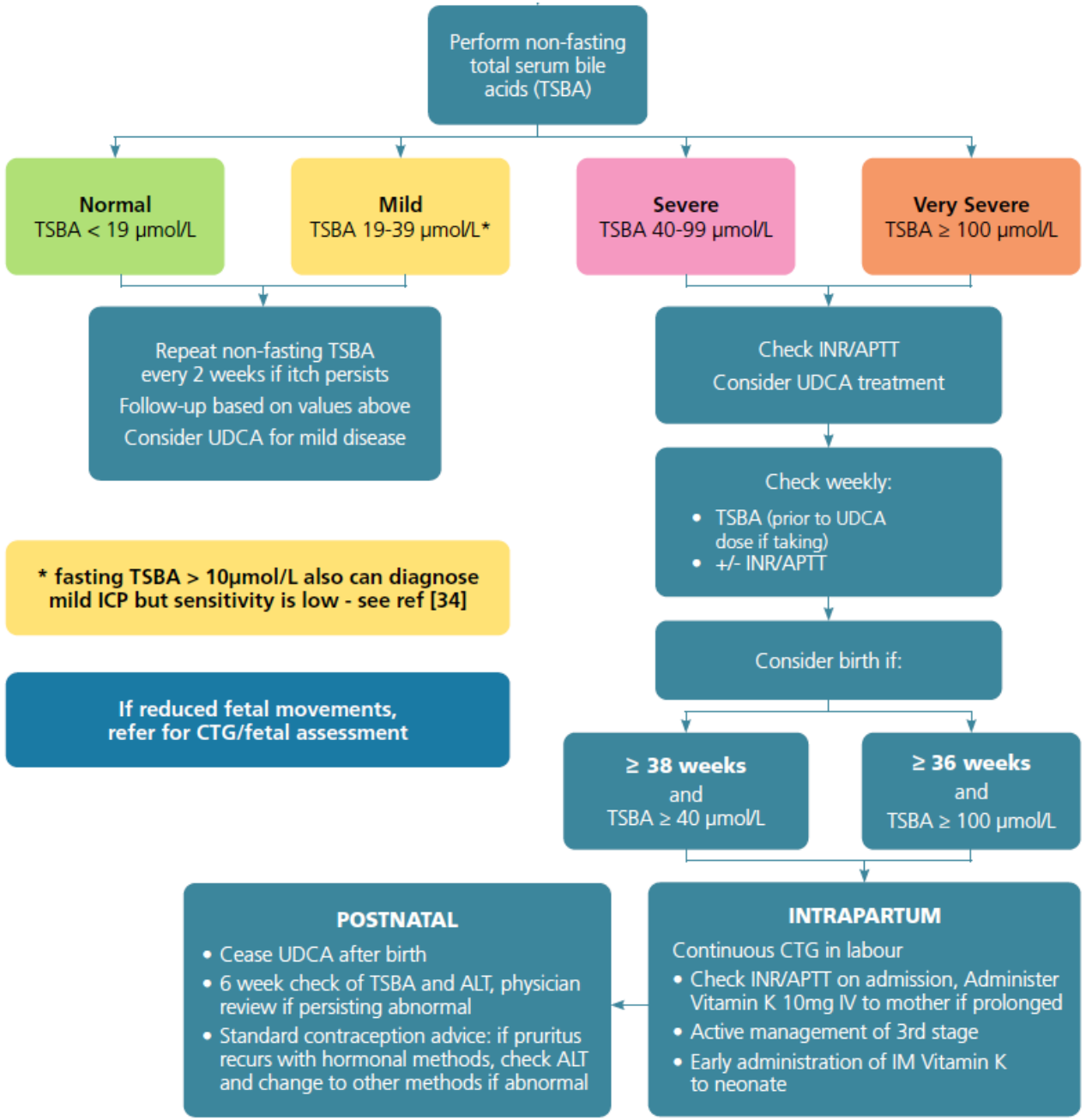
Ovadia C, Seed PT, Sklavounos A, *et al.* (2019) Association of adverse perinatal outcomes of intrahepatic cholestasis of pregnancy with biochemical markers: results of aggregate and individual patient data meta-analyses. *Lancet* 393:899-909.

Obstetric Cholestasis
Timing of delivery

SOMANZ
SOCIETY OF OBSTETRIC MEDICINE OF AUSTRALIA AND NEW ZEALAND

Intrahepatic Cholestasis of Pregnancy – Diagnosis and Management:

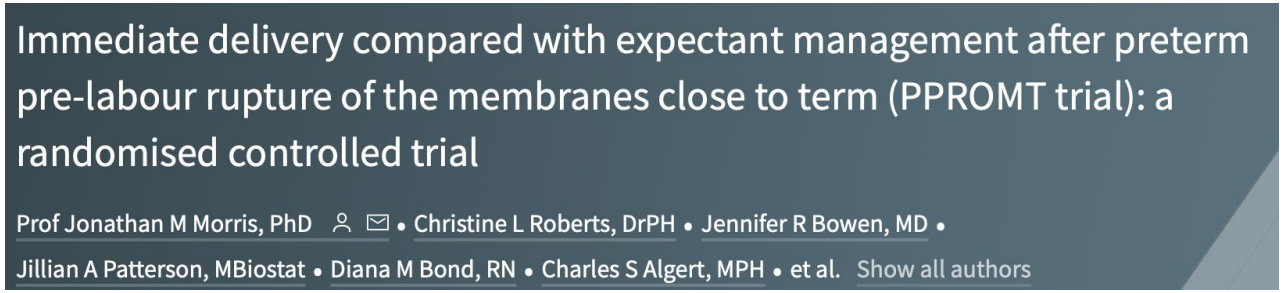
- BA < 40 aim for **40w**
- BA ≥ 40 aim for **38w**
- BA ≥ 100 aim for **36w**



PPROM

Flickr

PPROM
Timing of delivery



PROMPT trial, Lancet 2016

RCT: immediate vs expectant delivery 34 to 37w

- No difference in neonatal sepsis (2-3%) – including in the GBS +ve group
- **Immediate delivery:**
  - **↑respiratory distress and need for mechanical ventilation**
  - **↑ NICU stay**
  - **↑ Caesarean delivery**
  - **↓birthweight**

PPROM
Timing of delivery

Immediate delivery compared with expectant management after preterm pre-labour rupture of the membranes close to term (PPROMT trial): a randomised controlled trial

Prof Jonathan M Morris, PhD • Christine L Roberts, DrPH • Jennifer R Bowen, MD • Jillian A Patterson, MBiostat • Diana M Bond, RN • Charles S Algert, MPH • et al. Show all authors

PROMPT trial, Lancet 2016

RCT: immediate vs expectant delivery 34 to 37w

- No difference in neonatal sepsis (2-3%)
- **Immediate delivery: greater RDS, ventilation, longer NICU, higher CS**

Cochrane review, 2017

3617 women, Expectant vs expedited delivery.

- No difference in infection
- **Expedited delivery increased rates of RDS and neonatal death**

Cochrane Library

Planned early birth versus expectant management for women with preterm prelabour rupture of membranes prior to 37 weeks' gestation for improving pregnancy outcome (Review)

Bond DM, Middleton P, Levett KM, van der Ham DP, Crowther CA, Buchanan SL, Morris J

PPROM
Timing of delivery

RCOG, Greentop 2019

'offer expectant management

until 37+0 weeks, *as this is*

associated with better outcomes

compared with early birth'

Royal College of Obstetricians & Gynaecologists

Green-top Guideline No 73: Care of Women Presenting with Suspected Preterm Prelabour Rupture of Membranes from 24+0 Weeks of Gestation

Diagnosis

The diagnosis of spontaneous rupture of the membranes is made by maternal history followed by a sterile speculum examination.

If, on speculum examination, no amniotic fluid is observed, clinicians should consider performing an insulin-like growth factorbinding protein 1 (IGFBP-1) or placental alpha microglobulin-1(PAMG-1) test of vaginal fluid to guide further management.

Antibiotics, corticosteroids and magnesium sulfate

An antibiotic (preferably erythromycin) should be given for 10 days or until the woman is in established labour (whichever is sooner) following the diagnosis of PPROM, and corticosteroids and magnesium sulfate, considered or offered.

Assessments

A combination of clinical assessment, maternal blood tests (C-reactive protein and white cell count) and fetal heart rate should be used to diagnose chorioamnionitis in women with PPROM; these parameters should not be used in isolation.

Expectant management

Women whose pregnancy is complicated by PPROM who have no contraindications to continuing pregnancy should be offered expectant management until 37+0 weeks, as this is associated with better outcomes compared with early birth. Timing of birth should be discussed with each woman on a individual basis.

Remember

- Communicate with neonatologists
- Offer women and partners emotional support
- Tocolysis is not recommended
- Care at home may be appropriate for some women

Find out more at **rcog.org.uk/GTG73**

Hypertension; pre-existing, pregnancy induced

HYPITAT trial, Lancet 2009:
Mx mild PIH and PET at term

RCT: expectant vs immediate IOL at term

Immediate del associated with

- ↓in maternal complications (inc severe HTN)
- Lower CS rates
- No impact on neonatal outcome

CONCLUSION:

- IOL at term with PIH or PET improved pregnancy outcome

Severe maternal complications

	Induction (n=377)	Expectant management (n=378)	RR (95%CI) or *P*
Maternal death	0	0	
Systolic BP ≥ 170mmHg	55 (15)	85 (23)	0.64 (0.47 to 0.87)
Diastolic BP ≥ 110mmHg	61 (16)	99 (27)	0.61 (0.46 to 0.81)
Proteinuria ≥ 5 g/ 24 hours	3 (2)	4 (2)	0.91 (0.21 to 4.0)
HELLP - syndrome	3 (1)	9 (2)	0.46 (0.14 to 1.5)
Eclampsia	0	0	
Pulmonary edema	0	2	
Postpartum hemorrhage > 1 L	35 (10)	40 (11)	0.88 (0.57 to 1.3)
Thromboembolic disease	1	0	
Placental abruption	0	0	
Composite adverse maternal outcome	**116 (31)**	**159 (42)**	**0.73 (0.61 to 0.89) <0.001**

HYPITAT II trial, 2015: Mx of late preterm 34-37w mild hypertensive disease

Immediate delivery 34-37w vs expectant Mx (for non-severe HTN)

Immediate delivery <37w

- No improvement in maternal outcomes
- BUT significant increase in neonatal morbidity esp RDS (RR 3·3, 95% CI 1·4–8·2; p=0·005)

CONCLUSION:

- Expectant management until 37w in non-severe PIH/PET

PHOENIX trial, 2019:

Mx of late preterm 34-37w

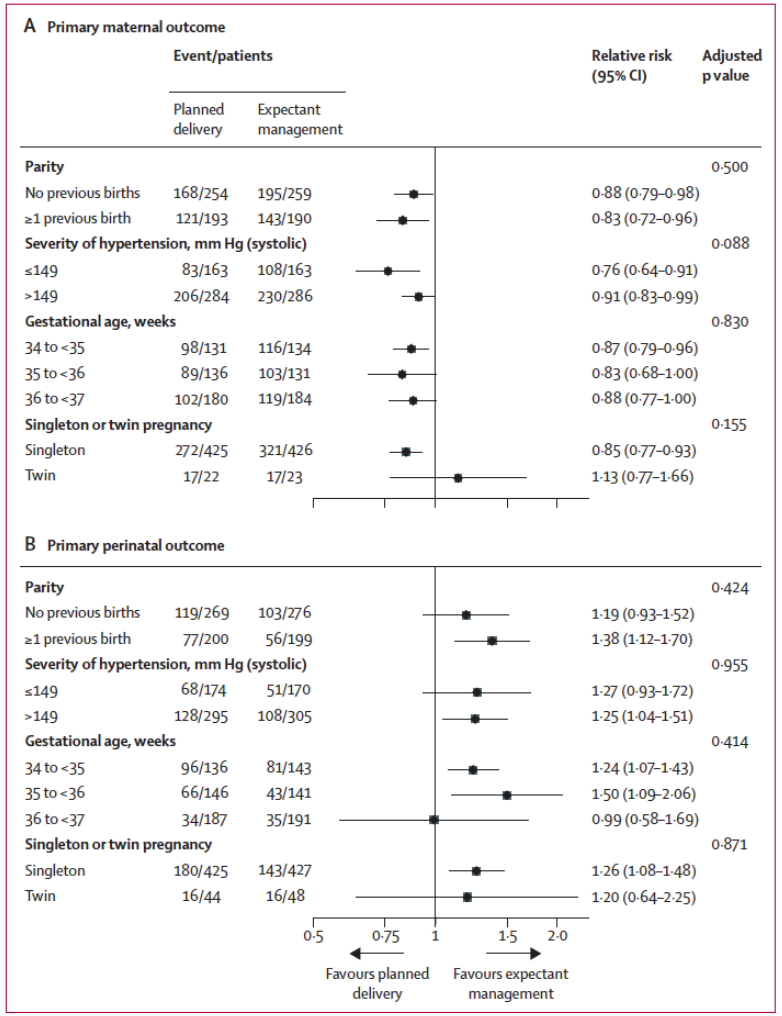
Pre-eclampsia

Planned early delivery or expectant management for late preterm pre-eclampsia (PHOENIX): a randomised controlled trial

Prof Lucy C Chappell, PhD • Prof Peter Brocklehurst, FRCOG • Marcus E Green • Rachael Hunter, MSc • Pollyanna Hardy, MSc • Edmund Juszczak, MSc • et al. Show all authors • Show footnotes

J Marko Sikkema, MD • Mallory D Woiski, MD • et al. Show all authors

THE LANCET VOLUME 394, ISSUE 10204, P1181-1190, SEPTEMBER 28, 2019



A Primary maternal outcome

	Event/patients: Planned delivery	Event/patients: Expectant management	Relative risk (95% CI)	Adjusted p value
Parity				0·500
No previous births	168/254	195/259	0·88 (0·79–0·98)	
≥1 previous birth	121/193	143/190	0·83 (0·72–0·96)	
Severity of hypertension, mm Hg (systolic)				0·088
≤149	83/163	108/163	0·76 (0·64–0·91)	
>149	206/284	230/286	0·91 (0·83–0·99)	
Gestational age, weeks				0·830
34 to <35	98/131	116/134	0·87 (0·79–0·96)	
35 to <36	89/136	103/131	0·83 (0·68–1·00)	
36 to <37	102/180	119/184	0·88 (0·77–1·00)	
Singleton or twin pregnancy				0·155
Singleton	272/425	321/426	0·85 (0·77–0·93)	
Twin	17/22	17/23	1·13 (0·77–1·66)	

B Primary perinatal outcome

Parity				0·424
No previous births	119/269	103/276	1·19 (0·93–1·52)	
≥1 previous birth	77/200	56/199	1·38 (1·12–1·70)	
Severity of hypertension, mm Hg (systolic)				0·955
≤149	68/174	51/170	1·27 (0·93–1·72)	
>149	128/295	108/305	1·25 (1·04–1·51)	
Gestational age, weeks				0·414
34 to <35	96/136	81/143	1·24 (1·07–1·43)	
35 to <36	66/146	43/141	1·50 (1·09–2·06)	
36 to <37	34/187	35/191	0·99 (0·58–1·69)	
Singleton or twin pregnancy				0·871
Singleton	180/425	143/427	1·26 (1·08–1·48)	
Twin	16/44	16/48	1·20 (0·64–2·25)	

Immediate vs expectant at 34-37w

'It's a trade off'

- Lower maternal mortality & severe HTN (aRR 0.86, p=0.0005)
- But Higher NICU admission (RR 1.24, p=0.0034)

CONCLUSION:

'Individualized'. 'Shared-decision making'

Hypertension; pre-existing, pregnancy induced

HYPITAT, Lancet 2009:

PET at term (37w+)

Immediate delivery at 37w (vs expectant)

Improved maternal outcomes

(No difference in neonatal outcome)

HYPITAT II, Lancet 2015:

HTN at late preterm (34-37w)

Aim for > 37w

Improved neonatal morbidity esp RDS

with no compromise in maternal outcome

PHOENIX, Lancet 2019:

PET at late preterm (34-37w)

'It's a trade off': Immediate delivery at 34-37w:

↓maternal mortality & severe HTN

↑ NICU admission

Summary: Timing of birth

AMA >40/ IVF / BMI >50 / large for gestational age

deliver at 39-40w

Fetal growth restriction

Elevated UA Doppler: deliver <37w

3rd centile: deliver at 37w.

10th centile, normal Doppler: deliver at 38-39w

PPROM <37w

expectant Mx between 34 to 37w (neonatal benefit)

deliver <37w if chorio

Obstetric Cholestasis

BA >40 deliver at 38w,

BA >100 deliver at 36+0w

Pre-eclampsia

Mild deliver > 37w

Severe individualise

Avoid Early term birth <39w

Poorer neurodevelopmental outcome

Thank you