Maternal sleep practices and risk of late pregnancy stillbirth

Professor Lesley McCowan
On behalf of the New Zealand Multi-centre Stillbirth Study group
June 2017

New Zealand information
- 5 million people
- 64,000 births per annum
  - 48% European/other
  - 27% Maori
  - 11% Pacific
  - 14% Asian/South Asian
- Late stillbirth rate 2.5/1000 births
- Maternity care is free & midwifery led

Late stillbirth - a silent & common problem
- Late stillbirth = death of unborn baby at ≥28 weeks’
- Intact survival usual for liveborn infants ≥28 weeks’
- 163 NZ babies died after 28 weeks’ in 2014
  - 5-6 empty classrooms in NZ each year
  - Huge emotional cost for families
  - Cost per SB $43,200 - does not include loss of QALY
HOW COMMON IS STILLBIRTH IN NZ?

NZ Deaths in 2014

- 328 Stillbirths >20 wks
- 5.5/1000 births
- 328 Stillbirths >28 wks
- 163 Late Stillbirths
- 38 SUDI
- 160 people died in a car accident

Stillbirth rates - variation between Western countries

Stillbirths: the way forward in high-income countries

Classification of stillbirth NZ 2014

PMMRC report 2016 - adapted from figure 1.14
Maternal sleep & stillbirth risk

- Approximately a third of life is spent sleeping
- Reports of babies dying after maternal sleep
  - Midnight to 7am and after daytime sleep
- Maternal supine position associated with changes in maternal blood flow & fetal oxygen levels
- No previous studies had reported sleep habits and stillbirth risk

The Auckland Stillbirth Study-TASS

**Hypothesis:**
Supine sleep position and sleep disordered breathing would be independent risk factors for stillbirth at or after 28 weeks’

**The cases:**
All stillbirths ≥28 weeks in Auckland July 2006 - June 2009
- Single baby
- No major fetal abnormality

**The controls:**
Each case matched with 2 on-going pregnancies with same:
- gestation and hospital

**THE AUCKLAND STILLBIRTH STUDY**

<table>
<thead>
<tr>
<th>Going to sleep position last night</th>
<th>Stillbirth Cases n=155</th>
<th>Pregnant Controls n=310</th>
<th>aOR 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left side</td>
<td>27.1%</td>
<td>42.6%</td>
<td>1.00</td>
</tr>
<tr>
<td>Right side</td>
<td>31.6%</td>
<td>27.1%</td>
<td>1.74</td>
</tr>
<tr>
<td>Supine/Back</td>
<td>9.7%</td>
<td>4.8%</td>
<td>2.54 1.04 to 6.18</td>
</tr>
<tr>
<td>Other</td>
<td>31.6%</td>
<td>25.5%</td>
<td>2.32 1.28 to 4.19</td>
</tr>
</tbody>
</table>

*Adjusted for age, BMI, social deprivation, parity, ethnicity, smoking, gestation & DHB*
TASS RESULTS: OTHER SLEEP HABITS

<table>
<thead>
<tr>
<th></th>
<th>Cases %</th>
<th>Controls %</th>
<th>Adjusted Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to toilet - last night</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than once</td>
<td>55.5</td>
<td>66.8</td>
<td>1.00 (1.46-4.0)</td>
</tr>
<tr>
<td>Once or less</td>
<td>45.5</td>
<td>33.2</td>
<td>2.42 (1.46-4.0)</td>
</tr>
<tr>
<td>Regular Daytime sleep - last month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>49.7</td>
<td>62.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Yes</td>
<td>50.3</td>
<td>37.4</td>
<td>2.64 (1.26-3.30)</td>
</tr>
<tr>
<td>Night-time sleep - last month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8 hours</td>
<td>52.9</td>
<td>66.1</td>
<td>1.00</td>
</tr>
<tr>
<td>&gt; 8 hours</td>
<td>27.7</td>
<td>19.0</td>
<td>1.71 (0.99-2.95)</td>
</tr>
<tr>
<td>&lt; 6 hours</td>
<td>19.4</td>
<td>14.8</td>
<td>1.89 (0.98-3.65)</td>
</tr>
</tbody>
</table>

OTHER LATE STILLBIRTH RISK FACTORS IN TASS

- Increased BMI- dose dependent
- Nulliparity
- High parity ≥4
- SGA baby especially if not recognised
- No relationship found with self reported sleep disordered breathing

Potential Significance

- Biologically plausible findings re sleep position
- Hypothesis generating
- Further data are required to confirm or refute these findings
- Encouraging women to go to sleep on the left side in late pregnancy has potential to reduce late stillbirth in the future
NEED FOR CONFIRMATION ABOUT MATERNAL SLEEP POSITION & LATE STILLBIRTH RISK

TASS led to:
1. NZ Multicentre Stillbirth Study
2. South Auckland Maternal Sleep Survey
3. Physiological Studies of Maternal Sleep Position in Pregnancy

FURTHER STUDIES ON SUPINE SLEEP & LATE STILLBIRTH CONSISTENT

1. Ghana: Owusu et al. (2013)
   aOR 8.0 95% CI 1.5-43.2
   aOR 6.26 95% CI 1.2-34

NZ MULTICENTRE STILLBIRTH STUDY (MCSS) 2012-2015
LESLEY MCCOWAN, ED MITCHELL, JOHN THOMPSON, GEMASHA STACEY, ALEC EREROMA, BEV LAWTON, ROBIN CRENNIN
NZ Multicentre Stillbirth Study

**Aims**
- To confirm or refute the findings in the Auckland Stillbirth Study related to sleep position

**Primary Hypothesis:**
- Supine going-to-sleep position would be associated with ↑ risk of late stillbirth

**Expected numbers of late stillbirths less than projected on previous numbers**
- Reduction in NZ late stillbirth after 37 weeks
  - Going-to-sleep position changed:
    - left side 43% in TASS controls vs 58% in MCSS controls
    - supine 5% in TASS 3.8% in MCSS controls

**Education**
- Child birth educators & midwives recommending left sided going-to-sleep position following TASS publicity

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Classification of Death by PSANZ criteria in MCSS

<table>
<thead>
<tr>
<th>PSANZ Classification</th>
<th>Total cases (n = 164)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexplained</td>
<td>36 (22.1%)</td>
</tr>
<tr>
<td>Perinatal infarction</td>
<td>5 (3.0%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>8 (4.9%)</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>13 (7.9%)</td>
</tr>
<tr>
<td>Maternal conditions</td>
<td>12 (7.3%)</td>
</tr>
<tr>
<td>Specific perinatal condition</td>
<td>25 (15.2%)</td>
</tr>
<tr>
<td>Hypoxic postpartum death</td>
<td>14 (8.5%)</td>
</tr>
<tr>
<td>Fetal growth restriction</td>
<td>8 (4.9%)</td>
</tr>
<tr>
<td>Spontaneous preterm</td>
<td>1 (0.6%)</td>
</tr>
</tbody>
</table>
Two thirds of stillbirths in MCSS occurred at ≥36 weeks of gestation.
# Going to Sleep Position Last Night

## Multivariable Analysis

<table>
<thead>
<tr>
<th></th>
<th>Cases (N=164)</th>
<th>Controls (N=569)</th>
<th>Univariable OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going-to-sleep position last night</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left side</td>
<td>48%</td>
<td>58%</td>
<td>1.00</td>
</tr>
<tr>
<td>Right side</td>
<td>27%</td>
<td>33%</td>
<td>0.99 (0.66 to 1.49)</td>
</tr>
<tr>
<td>Supine/Back</td>
<td>12%</td>
<td>4%</td>
<td>3.67 (1.74 to 7.78)</td>
</tr>
<tr>
<td>Propped</td>
<td>2.4%</td>
<td>1.6%</td>
<td>1.10 (0.30 to 4.06)</td>
</tr>
</tbody>
</table>

Adjusted for: ethnicity, age, BMI, smoking, social deprivation, parity, SGA, gestation and DHB

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# Going to Sleep Position Last Week

## Multivariable Analysis

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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left side</td>
<td>52%</td>
<td>53%</td>
<td>1.00</td>
</tr>
<tr>
<td>Right side</td>
<td>26%</td>
<td>30%</td>
<td>0.62 (0.52 to 1.30)</td>
</tr>
<tr>
<td>Supine/Back</td>
<td>9%</td>
<td>3%</td>
<td>3.46 (1.49 to 8.03)</td>
</tr>
<tr>
<td>Variable side</td>
<td>9%</td>
<td>13%</td>
<td>0.85 (0.44 to 1.65)</td>
</tr>
<tr>
<td>Propped</td>
<td>3%</td>
<td>1%</td>
<td>2.10 (0.57 to 7.71)</td>
</tr>
</tbody>
</table>

Adjusted for: ethnicity, age, BMI, smoking, social deprivation, parity, SGA, gestation and DHB

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# Supine Going to Sleep - Term vs Preterm

**Last night**
- Risk greater for term pregnancies (≥37 wks): aOR 10.3 (3.01 to 35)
- vs preterm (28-36 wks) aOR 3.1 (0.97 to 10)

**Last week**
- Term aOR 12.7 (2.9 to 55)
- Preterm aOR 2.3 (0.65 to 7.8)
NZ MULTICENTRE STILLBIRTH STUDY
2012-2015
MULTIVARIABLE MODEL

<table>
<thead>
<tr>
<th>Sleep factors last night</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine/Back going-to-sleep position</td>
<td>3.67 (1.74 to 7.78)</td>
<td></td>
</tr>
<tr>
<td>Sleep duration &lt; 6 hours</td>
<td>1.81 (1.14 to 2.88)</td>
<td></td>
</tr>
<tr>
<td>Other late stillbirth risk factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGA Bwt &lt;10th centile</td>
<td>2.76 (1.59 to 4.80)</td>
<td></td>
</tr>
<tr>
<td>BMI 4% increase per unit of BMI</td>
<td>1.04 (1.01 to 1.08)</td>
<td></td>
</tr>
<tr>
<td>Age ≥40</td>
<td>2.88 (1.31 to 6.32)</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted for: ethnicity, age, BMI, smoking, social deprivation, parity, SGA, gestation and DHB
Smoking, deprivation, ethnicity NOT significant after adjustment for BMI

BMI & late stillbirth risk in MCSS

POPULATION ATTRIBUTABLE RISK

<table>
<thead>
<tr>
<th>Risk factors for Stillbirth</th>
<th>Prevalence controls</th>
<th>Population Attributable Risk</th>
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<tbody>
<tr>
<td>SGA</td>
<td>12.8%</td>
<td>24.7%</td>
</tr>
<tr>
<td>BMI ≥30</td>
<td>23.7%</td>
<td>20.4%</td>
</tr>
<tr>
<td>BMI 25-29.9</td>
<td>25.3%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Supine/Back going-to-sleep</td>
<td>3.8%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Age ≥40</td>
<td>3.5%</td>
<td>5.4%</td>
</tr>
</tbody>
</table>
OTHER FINDINGS IN MCSS VS TASS

- Marginal effect of not getting up to toilet on last night aOR 1.55 (0.93 to 2.56)
- Similar effect of short (<6 hours) sleep duration to TASS aOR 1.81 (1.14 to 2.88)
- In contrast to TASS no effect of:
  - Long sleep duration at night
  - Day time sleep

Conclusions

- 4 published studies show association between supine going-to-sleep position & late stillbirth risk
- Risk of supine position ? greater for term babies
- No effect of right side in MCSS
- IPD with data from TASS, Sydney study, MCSS & MINESS (UK study) – funding obtained

NEXT STEPS

IPD COLLABORATION

- Confirm association between supine going-to-sleep & late stillbirth
- Test Rt side vs Lt side—is one better?
- Term vs preterm effect
- Test interaction between going-to-sleep position and fetal vulnerability (SGA, smoking, obesity)
Physiological studies

- Examine effect of maternal position on fetal activity state in healthy late third trimester pregnancies
- When most stillbirths occur and fetal behavioural states are mature


Methods

- 29 healthy singleton pregnancies
- 35-38 weeks and awake
- Ambulatory fetal ECG
- 4 positions randomly selected:
  - supine, right & left lateral (30° tilt),
  - semi-recumbent

Fetal Behavioural States

- Visual analysis of derived CTG
- 1F, 2F or 4F (or undetermined)
- States ≥ 3 minutes
- 2 independent scorers
- Fetal behavioural state analysed in relation to maternal position

Summary

In healthy 3rd trimester pregnancies:
- Maternal position affects time fetus spends in each activity state
- State 4F is rare when mother supine
- State 1F (fetal quiescence & ↓oxygen consumption) more common in supine position
- Suggests that supine position is associated with lower oxygen fetal behavioural state even in healthy pregnancy

Biological plausibility

Supine position also associated with:
- ↓ fetal middle cerebral artery pulsatility index - reflection of relative hypoxia
- ↓ fetal pulse oximetry in labour
- ↓ uterine blood flow
- ↓ cardiac output

Milson & Forssman AMJOG 1984,148:764
Khatib et al.
British Journal of Obstetrics & Gynaecology and Reproductive Biology 175 (2014) 132–134
Carbonne et al, O&G 1996,88:797

Sleep disturbed breathing & pregnancy outcomes

- Sleeping on the back increases SDB & sleep apnea
- SDB/sleep apnea associated with oxidative stress, inflammation, endothelial dysfunction & hormonal dysregulation
- SDB associated with hypertension in pregnancy, gestational diabetes & FGR
- Does sleep apnea/SDB also contribute to the relationship between supine position and stillbirth risk??
Survey of maternal sleep practices in late pregnancy in a multi-ethnic sample in South Auckland, NZ

South Auckland Maternal Sleep Study

<table>
<thead>
<tr>
<th>Usual 'going-to-sleep' position (last wk)</th>
<th>n=377 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Either side</td>
<td>146 (38.7)</td>
</tr>
<tr>
<td>Left side</td>
<td>114 (30.2)</td>
</tr>
<tr>
<td>Right side</td>
<td>82 (21.8)</td>
</tr>
<tr>
<td>Sitting</td>
<td>22 (5.8)</td>
</tr>
<tr>
<td>Supine</td>
<td>12 (3.2)</td>
</tr>
<tr>
<td>Prone</td>
<td>1 (0.3)</td>
</tr>
</tbody>
</table>

[Image: https://www.google.co.nz/search?q=sleep+in+pregnancy,+russia&rlz=1T4ADRA_enNZ493NZ493&tbm=isch&tbo=u&source=univ&sa=X&ei=BNaNVebwAtP28QXx4E4&ved=0CBwQsA]

Conclusion

Our findings suggest that public health education to achieve optimal 'going-to-sleep' position is likely to be feasible in a socioeconomically disadvantaged, multicultural setting.
When baby is inside, best to settle on your side and avoid going-to-sleep lying on your back from 28 weeks.

TAKE HOME MESSAGE

Great media interest in MCSS

- Daily Mail: http://www.dailymail.co.uk/femail/article-4601596/Researchers-urging-pregnant-women-sleep-sides.html

Responses to FAQs re going to sleep position

1. Should I go to sleep on my back in late pregnancy?
   Results from four separate studies show that going to sleep on your back in the last three months of pregnancy is associated with an increased risk of having a stillbirth.

2. What is the reason for the increased risk of stillbirth if I go to sleep on my back in late pregnancy?
   We are not sure exactly but when women lie on their back in late pregnancy the large pregnant womb can put pressure on major blood vessels which reduces blood flow to the uterus and the baby. This can result in lower levels of oxygen in the baby. Lying on the back is also associated with sleep disturbed breathing (snoring) and sleep apnea, both of which can be associated with pregnancy complications.

3. Is it best to go to sleep lying on my left side rather than my right side?
   Many pregnancy web sites suggest that sleeping on the left side is best. One study reported that the left side may be better for baby than the right but two further studies have shown no difference between left and right sides. Therefore we recommend that you can settle to sleep on either side.
Responses to FAQs re going to sleep position

4. What do I do if I wake up on my back in the night?
Don’t worry - this is normal. Just settle back to sleep on your side.

5. Why is it that going to sleep position is important rather than the position I wake up in?
The position that you fall asleep in is the one in which you have the longest and soundest sleep and may therefore have more impact on the baby.

6. What can I do to increase my chance of staying on my side during the night?
A pillow behind your back may be helpful.

7. What about having a sleep during the day?
A lot of pregnant women have a day time nap. If you nap during the day settle to sleep on your side.

Overall conclusions

- Supine going-to-sleep position is a risk factor for late stillbirth
- IPD to investigate risk associated with other positions & interactions
- Physiological studies in healthy pregnancies demonstrate that supine position is associated with ↑ stage 1 (response to hypoxia) & ↓ stage 4 behavioral state
- Physiological studies ongoing in vulnerable pregnancies
- NZ women have changed sleep position
- Develop public health messages advising not to go to sleep supine in late pregnancy
- Planning a pillow trial to see if this reduces time supine overnight

Acknowledgements

- Funders
  - HRC, Curekids & Nurture, Mercia Barnes Trust
- Research midwives
- Participants!!
The Role of Fetal Growth Restriction in Late Pregnancy Stillbirth

- ≈30% of non-anomalous singleton late stillbirths in NZ are SGA (birthweight <10\textsuperscript{th} customised centile)
- No absolute cut-off defines risk
- Internationally many SGA stillbirths not identified as such before birth

Contribution of SGA to late stillbirth

- Diagnosed before birth - well
- Not diagnosed sick baby
- Not diagnosed dead baby

Population Attributable Risk of SGA for late pregnancy stillbirth in MCSS

<table>
<thead>
<tr>
<th>Risk factor for Stillbirth</th>
<th>Prevalence controls</th>
<th>Population Attributable Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGA</td>
<td>12.8%</td>
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</tr>
<tr>
<td>BMI ≥30</td>
<td>23.7%</td>
<td>20.4%</td>
</tr>
<tr>
<td>BMI 25-29.9</td>
<td>25.3%</td>
<td>8.4%</td>
</tr>
<tr>
<td>Supine/Back going-to-sleep</td>
<td>3.9%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Age ≥40</td>
<td>3.5%</td>
<td>5.4%</td>
</tr>
</tbody>
</table>

McCowan et al. Plos one June 2017
Stillbirth risk in BWT centile & stillbirth >28wks in MCSS

Stillbirth risk in BWT centile & stillbirth >28wks in MCSS

**SGA in MCSS**
- 30% of stillbirths
- 12.8% controls
- Optimum BWT %ile = 80
- Risk >90

**Major risk factors for stillbirth in high-income countries:**
a systematic review and meta-analysis

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>odds ratio</th>
<th>95% CI</th>
<th>p-value</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication use</td>
<td>1.4 (0.3-3.9)</td>
<td>1.4</td>
<td>0.6</td>
<td>17</td>
</tr>
<tr>
<td>Cesarean section</td>
<td>1.2 (0.6-2.4)</td>
<td>0.9</td>
<td>0.4</td>
<td>10</td>
</tr>
<tr>
<td>Uterine scar</td>
<td>1.1 (0.7-1.6)</td>
<td>0.4</td>
<td>0.9</td>
<td>9</td>
</tr>
<tr>
<td>No maternal age</td>
<td>2.1 (0.4-8.0)</td>
<td>0.2</td>
<td>0.9</td>
<td>20</td>
</tr>
<tr>
<td>Maternal suboptimal growth in pregnancy</td>
<td>2.7 (0.6-1.97)</td>
<td>0.1</td>
<td>0.1</td>
<td>12</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.2 (1.0-1.5)</td>
<td>1.0</td>
<td>0.0</td>
<td>11</td>
</tr>
<tr>
<td>Pre-eclampsia</td>
<td>1.4 (1.2-1.7)</td>
<td>0.2</td>
<td>0.1</td>
<td>11</td>
</tr>
<tr>
<td>Macrosomia</td>
<td>3.4 (1.6-6.8)</td>
<td>0.0</td>
<td>0.0</td>
<td>11</td>
</tr>
<tr>
<td>Small size for gestational age</td>
<td>3.2 (1.3-6.7)</td>
<td>0.0</td>
<td>0.0</td>
<td>11</td>
</tr>
<tr>
<td>Previous stillbirth</td>
<td>3.6 (1.4-9.7)</td>
<td>0.0</td>
<td>0.0</td>
<td>11</td>
</tr>
</tbody>
</table>

*OR: odds ratio, CI: confidence interval, *p*-value: *p*-value for the meta-analysis.

**How do we define smallness?**
- IUGR/FGR = failure to reach growth potential
- Traditionally SGA = birthweight <10th %ile using sex adjusted population reference
- Misses some growth restricted babies
- Includes some babies who are "constitutionally small" and not growth restricted (20-30%)
- How to best classify size at birth still debated
Customised birthweight centiles

- Adjust for maternal physiological factors that influence fetal growth:
  - early pregnancy weight
  - height
  - ethnicity
  - parity
  - gestation
  - infant sex

- Use a fetal ultrasound standard (Hadlock)

- Creates an optimum growth potential for an individual baby after exclusion of pathology


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


Table 4. Birth weight percentiles among stillbirths and live births.

<table>
<thead>
<tr>
<th>Birth Weight Percentile (BWT %ile)</th>
<th>Stillbirths</th>
<th>Live Births</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>2.6</td>
<td>2.7</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>20th</td>
<td>4.6</td>
<td>4.7</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>30th</td>
<td>6.7</td>
<td>6.8</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>40th</td>
<td>8.8</td>
<td>9.0</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>50th</td>
<td>10.9</td>
<td>11.1</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>60th</td>
<td>13.0</td>
<td>13.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>70th</td>
<td>15.1</td>
<td>15.3</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>80th</td>
<td>17.2</td>
<td>17.4</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>90th</td>
<td>19.3</td>
<td>19.5</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

---

BWT centile & stillbirth >28wks in MCSS

- Stillbirth risk
  - 20% of stillbirths
  - 12.3% controls
  - Optimum BWT %ile <80
  - Risk >90

---
Comparison of customised & Intergrowth 21st birthweight standards

Aim
- To compare adverse neonatal outcomes and stillbirth among SGA infants defined using INTERGROWTH 21st (IG) vs customised centiles in a multi-ethnic New Zealand population

Intergrowth vs Customised Centiles: SGA risk factors

<table>
<thead>
<tr>
<th>Maternal characteristics</th>
<th>Both non-SGA n=47,090, 88.0%</th>
<th>SGA-IG only n=172, 0.4%</th>
<th>SGA-cust only N=4015, 7.5%</th>
<th>SGA Both n=2207, 4.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>European</td>
<td>49%</td>
<td>0</td>
<td>53%</td>
<td>36%</td>
</tr>
<tr>
<td>Nulliparous</td>
<td>48%</td>
<td>89%</td>
<td>43%</td>
<td>64%</td>
</tr>
<tr>
<td>Height, cm</td>
<td>165</td>
<td>154</td>
<td>166</td>
<td>162</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>69</td>
<td>49</td>
<td>76</td>
<td>60</td>
</tr>
<tr>
<td>BMI</td>
<td>25.3</td>
<td>20.3</td>
<td>27.2</td>
<td>24.2</td>
</tr>
<tr>
<td>Smoker</td>
<td>6.9%</td>
<td>0.6%</td>
<td>14.5%</td>
<td>12.0%</td>
</tr>
<tr>
<td>PIH</td>
<td>5.4%</td>
<td>4.7%</td>
<td>9.6%</td>
<td>13.2%</td>
</tr>
<tr>
<td>Smaller for gestation</td>
<td>520</td>
<td>100</td>
<td>203</td>
<td>140</td>
</tr>
<tr>
<td>Stillbirths</td>
<td>59</td>
<td>0</td>
<td>15</td>
<td>23</td>
</tr>
</tbody>
</table>

Intergrowth vs Customised centiles: Neonatal mortality & morbidity

<table>
<thead>
<tr>
<th>Neonatal death</th>
<th>Both non-SGA n=47,031, 88.0%</th>
<th>SGA-IG only n=172, 0.3%</th>
<th>SGA-cust only n=4000, 7.5%</th>
<th>SGA Both n=2184, 4.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>NICU &gt;48hrs</td>
<td>3.0%</td>
<td>3.5%</td>
<td>7.0%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Vent &gt;4 hrs</td>
<td>2.1%</td>
<td>1.7%</td>
<td>3.4%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Apgar &lt;7@5m</td>
<td>1%</td>
<td>0.6%</td>
<td>1.5%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Composite neonatal outcome</td>
<td>4.2%</td>
<td>3.5%</td>
<td>8.4%</td>
<td>17.4%</td>
</tr>
<tr>
<td>RR 95% CI</td>
<td>Ref 0.8 [0.4-1.8]</td>
<td>2.0 [1.8-2.2]</td>
<td>4.1 [3.7-4.6]</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- In a multi-ethnic NZ context, a customised standard identified more infants with stillbirth & composite adverse neonatal morbidity than IG 21st.
- IG 21st underestimated SGA compared with the customised standard.
- Adoption of IG in NZ would miss some babies with stillbirth & immediate neonatal complications.

Antenatal identification of SGA reduces stillbirth


Growth Assessment Protocol (GAP) education - part of UK NHS Saving Baby’s Lives care bundle

- Risk assessment for SGA
- Standardised fundal height measurement
- Plotting on customised charts
- Protocols and referral pathways
- Serial scans for high risk
- Timely delivery for SGA

GAP Implemented in > 80% of NHS trusts

http://www.perinatal.org.uk/FetalGrowth/GAP/GAP.aspx
GAP Training in NZ hospitals in 2014 & 2015

- Variation in fundal height measurement usual pre & post training
- Over-measurement of SFH more common than under
- Non-standardised measurement of SFH
  - Will increase suspicion of LGA
  - Reduce suspicion of SGA

Pre-training accuracy within -1/+1 cm: 49%
Post-training accuracy within -1/+1 cm: 91.8%

Standardised measurement of fundal height

Longitudinal

Top of Fundus

Top of SymphysisPubis

SaBine- Saving babies in North of England: pre & post GAP implementation audit

Table 1: Referral and detection rates pre-and post-implementation

<table>
<thead>
<tr>
<th>Baseline Audit</th>
<th>Latest quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-training</td>
</tr>
<tr>
<td>TTP (cm)</td>
<td>TTP (cm)</td>
</tr>
<tr>
<td>N (n)</td>
<td>N (n)</td>
</tr>
<tr>
<td>Reference (low birthweight SGA (T))</td>
<td>30.5</td>
</tr>
<tr>
<td>Reference (low birthweight SGA (T))</td>
<td>1%</td>
</tr>
<tr>
<td>SGA according to BMI birthweight SGA (TP)</td>
<td>26.5</td>
</tr>
<tr>
<td>SGA according to BMI birthweight SGA (TP)</td>
<td>1.6</td>
</tr>
<tr>
<td>TP - True positive; TN - True negative</td>
<td></td>
</tr>
</tbody>
</table>

https://www.england.nhs.uk/ourwork/futurehnts/mat-transformation/saving-babies/
SaBine Saving babies in North of England 2015-16 implementation of GAP program

Fig 5: SGA referral and detection rates before and after implementation of GAP

Stillbirth rates pre & post SaBine

Fig 4: NHS stillbirth rates – England and North of England regions:

NZ national data 2017- reduced late stillbirths due to FGR

Table 3.27: Perinatal death classification (PSANZ/JDC) specific perinatal related mortality rates (per 1,000 births) using international definition (≥1000g or ≥28 weeks of gestation, weight unknown) 2007–2013

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational abnormalities</td>
<td>127</td>
<td>106</td>
<td>105</td>
<td>114</td>
<td>60</td>
</tr>
<tr>
<td>Intrauterine growth retardation</td>
<td>14</td>
<td>15</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Stillbirths</td>
<td>71</td>
<td>71</td>
<td>71</td>
<td>71</td>
<td>12</td>
</tr>
<tr>
<td>NICU mortality</td>
<td>17</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Neonatal mortality</td>
<td>23</td>
<td>16</td>
<td>16</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Neonatal non-viable births</td>
<td>33</td>
<td>49</td>
<td>49</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Neonatal non-viable births</td>
<td>33</td>
<td>49</td>
<td>49</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Neonatal non-viable births</td>
<td>33</td>
<td>49</td>
<td>49</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>

SGA guideline | GAP training
Reduction in Late stillbirths
NZ 2017

Reasons multifactorial & thought to include:
- ↓ FGR deaths: GAP program, SGA guideline & ↓ smoking
- ↓ births at 40 weeks and beyond
- Reduced pregnancies to teen parents
- NZ wide maternal quality and safety program
- Changes in maternal going to sleep position

Algorithm & SGA Risk Assessment Tool for NZ – Screening and Surveillance of fetal growth in singleton pregnancies

Major Risk for SGA
- Maternal age >40 years
- Drug misuse
- Previous SGA baby (<10th centile)
- Previous stillbirth
- Maternal Medical History
- Chronic hypertension
- Diabetes with vascular disease
- Renal impairment
- Antiphospholipid syndrome
- Women unsuitable for monitoring by fundal height measurement e.g.
  - Large fibroids
  - BMI 35+

Current Pregnancy Complications
- Early Pregnancy
  - PAPP-A <0.2 MoM
- Late Pregnancy
  - Pre-eclampsia

Low Risk of SGA
□ No known major risk factors

Low Risk Care
- Serial assessment of fundal height (FH) (not more frequently than 2 weekly) from 26-28 weeks until delivery.
- FH plotted on customised chart.

Suspected abnormal growth:
- FH <10th centile
- Crossing centile lines (>30%)

Normal growth
- Estimated fetal weight (EFW)
- Individual fetal measurements
- Umbilical artery Doppler if suspected abnormal growth

If major risk factors identified potential for:
- Reduction in SGA with low dose aspirin & smoking cessation
- Increased detection with serial scanning
- If SGA confirmed manage according to SGA guideline
- Timely delivery of SGA infant can reduce perinatal mortality

Risk of SGA stillbirths by gestation


- Stillbirth risk for SGA fetus 4x > than AGA fetus
- Risk for SGA fetus > 38 wks 6.4/1000 vs 1.7/1000 for AGA

 Worksheet for management of women with SGA pregnancies

Thank you
Hypothetical framework for late stillbirth risk

Adapted from Warland & Mitchell, BMC Pregnancy & Childbirth, 2014,14:142