Haemodynamics in pregnant women with severe and morbid obesity

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Outline

1. Rationale for project
2. Aim
3. Method
4. Results
5. Conclusions
6. Implications and relevance to obstetric anaesthesia
Rationale for project (1) – Maternal mortality

- Class II (severe) obesity (body mass index (BMI) > 35 kg.m\(^{-2}\)) and class III (morbid) obesity (BMI > 40 kg.m\(^{-2}\)) in pregnant women represents a significant health issue.

- Maternal obesity is associated with mortality.

### Table 1.18. Body Mass Index by Direct and Indirect maternal death for women who had a BMI recorded; UK: 2006–08

<table>
<thead>
<tr>
<th></th>
<th>Under 18.5</th>
<th>18.5–24.9</th>
<th>25.0–29.9</th>
<th>30.0–39.9</th>
<th>40 and over</th>
<th>All mothers with BMI 25+</th>
<th>Total with known BMI</th>
<th>Not recorded*</th>
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<tbody>
<tr>
<td><strong>Numbers</strong></td>
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<tr>
<td>Direct</td>
<td>0</td>
<td>49</td>
<td>15</td>
<td>21</td>
<td>7</td>
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<tr>
<td>Indirect</td>
<td>10</td>
<td>57</td>
<td>35</td>
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<td>68</td>
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<td>Total</td>
<td>10</td>
<td>106</td>
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<td>227</td>
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<td><strong>Percentages</strong></td>
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<td>Direct</td>
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*This includes women who did not book for antenatal care, had a miscarriage or ectopic pregnancy or booked after 12 weeks of gestation.*
Rationale for project (1) – Maternal mortality

- Class II (severe) obesity (body mass index (BMI) > 35 kg.m\(^{-2}\)) and class III (morbid) obesity (BMI > 40 kg.m\(^{-2}\)) in pregnant women represents a significant health issue.

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*This includes women who did not book for antenatal care, had a miscarriage or ectopic pregnancy or booked after 12 weeks of gestation.
Rationale for project (2) – Maternal morbidity

- Complications occur more frequently in these women and it is recommended that women with a BMI > 40 kg.m\(^2\) are reviewed by an anaesthetist antenatally.

**Box 1.6. Risks related to obesity in pregnancy\(^{14}\)**

For the mother increased risks include:
- spontaneous first trimester and recurrent miscarriage
- maternal death or severe morbidity
- cardiac disease
- pre-eclampsia
- dysfunctional labour
- gestational diabetes
- thromboembolism
- higher chance of needing a caesarean section
- post-caesarean wound infection
- postpartum haemorrhage
- low breastfeeding rates.

For the baby increased risks include:
- stillbirth and neonatal death
- congenital abnormalities
- prematurity.

References for these are available in the CMACE report\(^{14}\) and the last Report of this Enquiry for 2003–05\(^3\).
Rationale for project (3) – Clinical monitoring of haemodynamics is important

• Coexisting disease is common – especially cardiac disease.

• Diagnostic dilemmas may occur when these women present with breathlessness - what is the cause? Cardiac, respiratory, obesity, other.

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Rationale for project (4) – Transthoracic echocardiography is recommended

Cardiac disease: specific recommendation
- Women with a known history of cardiac disease must be referred for consultant-led obstetric care in a maternity unit where there is a joint obstetric/cardiology clinic or a cardiologist with expertise in the care of women with heart disease in pregnancy.

Cardiac disease: learning points
There must be a low threshold for further investigation of pregnant or recently delivered women who complain of chest pain that is severe, or radiates to the neck, jaw or back, or is associated with other features such as agitation, vomiting or breathlessness, tachycardia, tachypnoea, orthopnoea or acidosis. This is especially important for women who smoke, are obese or who have hypertension. Appropriate investigations to rule out, or confirm, cardiac disease or aortic dissection include an electrocardiogram (ECG), a chest X-ray, cardiac enzymes (Troponin), an echocardiogram and computed tomography pulmonary angiography.
Women with chest, back or epigastric pain severe enough to require opioid analgesia must be fully investigated for all possible causes, including cardiac disease.
Wheezing can be a feature of pulmonary oedema as well as asthma. Pulmonary oedema requires investigation with a chest X-ray and an echocardiogram and oxygen saturation.
Arterial blood gases are frequently measured when investigating suspected pulmonary embolus and may also provide important information about underlying cardiac disease. Hypoaemia is a feature of pulmonary oedema, and a metabolic acidosis (increased base excess, reduced bicarbonate), with or without an elevated serum lactate, is a feature of a reduced cardiac output secondary to cardiac disease.
The curriculum and training of obstetricians following the advanced training skills module in maternal medicine and maternal and fetal medicine subspecialisation should reflect the importance of heart disease as a cause of maternal death. Such training should equip the obstetrician with knowledge of when and which women with pre-existing or new onset heart disease to refer to specialists.
Rationale for project (5) – Technical challenges

BUT

• Severe or morbid obesity may make TTE scanning technically difficult.
Rationale for project (6) – Previous work

1. Established a method of TTE scanning in pregnant women – Rapid Obstetric Screening Echocardiography (ROSE) scan.


Dennis AT: Transthoracic echocardiography in obstetric anaesthesia and obstetric critical illness. IJOA 2011; 20:160-168

2. Determined haemodynamics using this method in
   – Healthy pregnant women – BMI < 33 kg.m\(^{-2}\), mean ± SD 28 ± 3.5 kg.m\(^{-2}\)
   – Obese pregnant women – BMI > 30 kg.m\(^{-2}\), mean ± SD 35 ± 4 kg.m\(^{-2}\)
   – Women with preeclampsia
   – Healthy non-pregnant women

Dennis AT, Arhanghelschi I, Simmons SW, Royse CF. IJOA 2010;19:142-8
Dennis AT, Castro JM, Ong M, Carr C. IJOA 2012;21:129-134
Aim

To measure haemodynamics using transthoracic echocardiography in pregnant women with a BMI > 35 kg.m$^{-2}$
Method

- Institutional ethics approval and written informed consent

- 15 obese pregnant women, otherwise healthy, with a BMI > 35 kg.m$^{-2}$

- Standardised abbreviated TTE examination according to American Society of Echocardiography recommendations

- 40 healthy pregnant historical controls were used as the comparison group

- Statistical analysis used the General Linear Model

Dennis AT, Castro JM, Ong M, Carr C. Haemodynamics in obese pregnant women. IJOA 2012;21:129-134

Experimental method

- Ethics
- Selection
- Recruitment
- Consent
- Height / Weight

Preparation (hours): 0, 1, 2
Experimental method

- Ethics Selection
- Recruitment
- Consent
- Height / Weight

<table>
<thead>
<tr>
<th></th>
<th>Rest period</th>
<th>BP ECG</th>
<th>TTE Image Acquisition in study position</th>
</tr>
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</table>

- Preparation (hours)
- Time into Experiment (hours)

The Royal Women’s Hospital, Melbourne
Experimental method

- PLAX
- PSAX
- A4C
- A5C

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| Rest period | BP | ECG | TTE Image Acquisition in study position |

| Preparation (hours) | Time into Experiment (hours) |

The Royal Women's Hospital, Melbourne
Experimental method
Experimental method

Measurements
HR, LVOTd, VTI, LVEDD, LVESD, LVEDA, LVESA, VTI time, ss', ss' time, IVCT, LAD, se', sa', MVE, MVA, MVDT, MVA duration, IVRT, IVST, PWT

Ethics Selection Recruitment Consent Height / Weight

Rest period BP ECG TTE Image Acquisition in study position

Data conversion (DICOM) TTE Image analysis

Time for post-processing (hours)
0 1 2 3

Preparation (hours) Time into Experiment (hours)
0 0.5 1

The Royal Women’s Hospital, Melbourne University of Melbourne
Experimental method

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**Measurements**
- HR, LVOTd, VTI, LVEDD, LVESD, LVEDA, LVESA, VTI time, ss’, ss’ time, IVCT, LAD, se’, sa’, MVE, MVA, MVDT, MVA duration, IVRT, IVST, PWT

**Derived values**
- BMI, BSA, CO, CI, SV, FS, FAC, Vcfc, MVE/se, MVE/A, se/sa, MAP, SVR, LV mass, (MVE/se)/LVEDD, Tei index, SWI, CWI

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**Ethics Selection Recruitment Consent Height / Weight**

<table>
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| Data conversion (DICOM) | TTE Image analysis |

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**Time for post-processing (hours)**

0 1 2 3

**Preparation (hours)**

0 1

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The Royal Women’s Hospital, Melbourne

University of Melbourne
Results

• TTE scanning with good quality images was achieved in all women.

• All women found the technique acceptable and would participate in a similar study in the future.

• There were no complications from being involved in the study.
## Results – Demographic data

<table>
<thead>
<tr>
<th></th>
<th>Non-obese pregnant women n = 40</th>
<th>Obese pregnant women n = 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>32 ± 3.9</td>
<td>31 ± 5.0</td>
</tr>
<tr>
<td>Gestation (weeks)</td>
<td>36 ± 4.5</td>
<td>34 ± 5.1</td>
</tr>
<tr>
<td>Body Mass Index (kg.m(^{-2}))</td>
<td>28 ± 4.1</td>
<td>43 ± 5.3*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Weight range 92-143 kg)</td>
</tr>
</tbody>
</table>

Data are mean ± SD, *statistically significant
## Results – Haemodynamic data

<table>
<thead>
<tr>
<th></th>
<th>Non-obese pregnant women n= 40</th>
<th>Obese pregnant women n = 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP (mmHg)</td>
<td>81 ± 8.3</td>
<td>83 ± 10.8</td>
</tr>
<tr>
<td>CO (ml.min(^{-1}))</td>
<td>4109 ± 594.5</td>
<td>4664 ± 523.2*</td>
</tr>
<tr>
<td>HR (beats.min(^{-1}))</td>
<td>78 ± 9.6</td>
<td>85 ± 9.7*</td>
</tr>
<tr>
<td>SV (ml)</td>
<td>53 ± 7.9</td>
<td>55 ± 7.2</td>
</tr>
<tr>
<td>SVR (dyne.s.cm(^{-5}))</td>
<td>1613 ± 315.4</td>
<td>1437 ± 246.2*</td>
</tr>
<tr>
<td>FAC (%)</td>
<td>57 ± 9.2</td>
<td>58 ± 10.7</td>
</tr>
<tr>
<td>LVEDA (cm(^2))</td>
<td>17 ± 2.7</td>
<td>17 ± 4.0</td>
</tr>
<tr>
<td>Septal e (cm.s(^{-1}))</td>
<td>11.4 ± 2.3</td>
<td>10.5 ± 2.0</td>
</tr>
<tr>
<td>MV E/A</td>
<td>1.5 ± 0.2</td>
<td>1.3 ± 0.2</td>
</tr>
<tr>
<td>MV E/septal e´</td>
<td>6.7 ± 1.3</td>
<td>7.2 ± 1.6</td>
</tr>
<tr>
<td>LV mass (g)</td>
<td>130.8 ± 21.0</td>
<td>179 ± 36.8*</td>
</tr>
</tbody>
</table>

Data are mean ± SD  
* Statistically significant

MAP = mean arterial pressure  
CO = cardiac output  
HR = heart rate  
SV = stroke volume  
SVR = systemic vascular resistance  
FAC = fractional area change  
LVEDA = left ventricular end-diastolic area  
MV = mitral valve  
LV = left ventricle
Mitral valve inflow velocities – Pulse-wave Doppler - Apical 4-chamber view - obese pregnant woman

E wave velocity

A wave velocity
Interventricular septum velocities – Tissue Doppler – Apical 4-chamber view – obese pregnant woman

Septal s’ wave velocity

Septal a’ wave velocity

Septal e’ wave velocity
Conclusions

1. Increased cardiac output in severe and morbidly obese women is due to increased heart rate without changes in stroke volume or left ventricular end diastolic area.
   - Supports the theory that contractile heart function reaches a maximum towards the end of pregnancy and in situations where increases in CO are necessary i.e. obesity, increased CO is achieved through an increase in HR

2. Diastolic function is preserved.
   - Different from women with pre-eclampsia

3. TTE determined haemodynamic variables in all obese women.
Implications and relevance to obstetric anaesthesia

1. Mechanisms of increasing cardiac output in morbidly obese pregnant women
   Increasing HR may be preferable to increasing contractility
   The absence of diastolic dysfunction indicates that increases in preload may be well tolerated

2. Assessment of cardiac function in obese women with TTE
Limitations

1. Small study of 15 obese pregnant women
2. All scans were performed by a single experienced operator
Acknowledgements

• Pregnant women who have participated in our research

• Staff at the Royal Women's Hospital, Parkville, Australia