A five-year retrospective cohort study of maternal, neonatal outcomes and anesthetic management in women with extreme obesity at an Australian hospital

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Abstract : *Background* : Maternal obesity during pregnancy is associated with adverse perinatal outcomes. Data from Australia and New Zealand shows that women with extreme obesity have a high rate of general anesthesia for cesarean delivery (CD).
Objective : To assess the anesthesia, maternal and neonatal outcomes of women with extreme obesity delivering at the Royal Brisbane and Women's Hospital (RBWH). These results were compared with published data for Australia and New Zealand.
Design and Setting: Five year retrospective single centre cohort study at the Royal Brisbane and Women's Hospital (Australia), approved by institutional ethics committee.
Materials and Methods : Women were included if they had a booking weight > 140kg or BMI greater than 50 kg m^{-2} and delivered between January 2013 and December 2017. Data were obtained from the obstetric database and electronic medical records.
Results : We identified 127 women with a median (IQR) booking weight of 144 (140-156) kg and BMI of 51.9 (49.1-55.6) kg m^{-2}. Of these, 88% had an antenatal anesthetic assessment. Seventy-nine (62.2%) delivered by CD and of these 40 (31.5%) were elective deliveries. Neuraxial anesthesia was the preferred technique for CD, used in 76 women (96.2%) with 7 (9.2%) of these neuraxial blocks converted to general anesthesia. Of the 78 women commending active labor, 47 (60.3%) used epidural analgesia. Sixty-five (50%) neonates were admitted to Special care Nursery/Neonatal Intensive Care Unit (SCN/NICU).
Conclusions : Our data shows a high rate of CD and use of labor epidural analgesia compared with the general population, but similar to population-based data for obese women from Australia and New Zealand. A high proportion of neonates required admission to SCN/NICU.

Key words : Pregnancy, Obesity, Morbid, Pregnancy Outcome, Prenatal Care, Anesthesia.

INTRODUCTION

Obesity is a global epidemic. Half of pregnant Australian women are overweight or obese at their first obstetric appointment, while one in five are obese (1). Increased body mass index (BMI) is associated with a greater risk of maternal co-morbidities, maternal complications during pregnancy and adverse neonatal outcomes (2). Maternal obesity has been shown to contribute to anesthesia-related maternal deaths in the United Kingdom (3).

Published population-based data from Australia and New Zealand demonstrate that women with a BMI greater than 50 kg m^{-2} or weight > 140 kg have poor maternal and fetal outcomes, including a greater risk of gestational diabetes, pre-eclampsia, cesarean delivery (CD), greater use of pre- and post-natal thromboprophylaxis, neonatal macrosomia and Neonatal Intensive Care Unit (NICU) admission(4). Evidence from studies in United Kingdom (U.K.), United States of America (U.S.A.) and Canada corroborates this(5-7).

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With the rate of obesity increasing, anesthetists are more likely to be faced with obese parturients with multisystem co-morbidities. Obesity enhances the physiological changes of pregnancy, makes neuraxial anesthesia more difficult and increases the risk of airway complications and aspiration with general anesthesia (GA) (8,9). Recently published Australian data showed that the duration of surgical and anesthesia time for CD increases with increasing BMI, suggesting increasing technical difficulty (10).

The World Health Organization (WHO) classi-fication does not distinguish between different levels of Class III obesity (BMI ≥40 kg m^{-2}) (11). In this paper, the term "extreme obesity" will be used to refer to women with a BMI > 50kg m^{-2} or weight >140 kg at the time of booking. In Australia, the incidence of mothers with a BMI >50 kg m^{-2} varies from 0.2-0.6% depending on the location (1). The majority of publications relating to maternal obesity refer to the WHO categories only (10,12-14). International guidelines for the management of obesity in pregnancy do not distinguish between the management for example, of a woman with a BMI of 45 kg m^{-2} and a woman with a BMI of 70 kg m^{-2} (15-17). Women with a very high BMI comprise a small fraction of all pregnant women and are therefore underrepresented in large cohort studies. A recent cohort study of 1457 pregnant women included only 76 women with a BMI >45kg m^{-2} 14. However, these women are likely to present more extreme technical challenges to clinicians.

In 2015, Sullivan et al. (4) published results of 370 pregnant women with a BMI > 50kg m^{-2} or weight >140 kg, who delivered in Australia and New Zealand over a 10-month period in 2010. Our retrospective cohort study aimed to assess maternal and neonatal outcomes and anesthetic management of pregnant women with extreme obesity at the Royal Brisbane and Women's Hospital (RBWH) and compare it with published data for Australia and New Zealand(4).

MATERIALS AND METHODS

Study design and population

This five-year retrospective cohort study was undertaken at the Royal Brisbane & Women's Hospital (RBWH). The RBWH is a tertiary referral centre with 4500 annual deliveries. Ethics exemption (HREC/18/QRBW/86) was obtained from the Chairperson of the RBWH Human Research Ethics Committee on 28/02/2018 located at RBWH, Queensland, Australia. Women were included if they gave birth between January 2013 and December 2017 and had either a pre-pregnancy BMI of greater than 50 kg m^{-2} or a weight of more than 140 kg. Data was obtained from the institutional obstetric database and individual electronic medical records. This manuscript adhered to the applicable STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines (18).

Study outcomes and definitions

Data were collected regarding patient demo-graphics, co-morbidities, antenatal anesthetic con-sultation as well as relevant obstetric, neonatal and anesthesia outcomes. Maternal pre-existing conditions were documented, including hyper-tension, diabetes, obstructive sleep apnea, (OSA) and mental health disorders. Gestational diabetes was defined according to the local practice guidelines (19). Gestational hypertension and pre-eclampsia were defined according to the Society of Obstetric Medicine in Australia and New Zealand (20). Mode of delivery was categorized as vaginal delivery, elective CD or emergency CD. The RANZCOG classification of urgency of CD was applied and the indication for emergency CD included (21). The antenatal and post-natal use of maternal thromboprophylaxis was documented along with the duration and requirement for post-natal supplemental oxygen and intensive care unit (ICU) or high dependency unit (HDU) admission. Neonatal outcomes included Apgar score at one minute, birth weight, hypoglycemia (blood sugar level less than 2.6 mmol), admission and length of stay to the NICU or Special Care Nursery (SCN) and method of breast feeding on discharge. Anesthetic management data included evidence of an antenatal anesthetic consultation, labor analgesia management and anesthetic management in the case of CD. The type of neuraxial analgesia and/or anesthesia was documented, as well of the number of attempts recorded in the clinical record. In the case of GA, the indication (planned GA or conversion of neuraxial anesthesia) and grade of laryngeal view (Cormack and Lehane classification) was noted. The mode of post-operative analgesia was also documented. For the demographic continuous variables are represented by means, standard deviations, medians, ranges and interquartile ranges. For the categorical variables numbers and percentages were calculated.

RESULTS

We identified 127 women with a mean (SD) age of 30.3 (5.1) years, a median (IQR, range) booking

weight of 144 (140-156, 66-212) kg, BMI of 51.9 (49.1-55.6, 42.2-73.9) kg m⁻², gestation of 38.5 (38.1-39.3) weeks and 83 (65.3%) were nulliparous. The 127 deliveries represented 0.57% of the total 22 221 births at RBWH during this time period. Of the 127 women, 99 (77.9%) were Caucasian, 17 (13.4%) identified as Australian Aboriginal, 11 (8.6%) were of other ethnicity or not stated. These women gave birth to 130 neonates, including three sets of twins.

Anesthesia outcomes

One hundred and twelve (88.2%) of the 127 women had an antenatal anesthetic consultation. Of the 79 women who delivered by CD, neuraxial anesthesia was the preferred mode of anesthesia overall with 76 (96.2%) women receiving neuraxial anesthesia as the primary technique. Table 1 shows all anesthesia techniques used for CD.

Table 1

Primary anesthesia technique and post-operative analgesia for caesarean section in 79 women with extreme obesity who labored at the Royal Brisbane and Women's Hospital between 2013-2017

Primary anesthesia technique	n (%)
- Combined spinal-epidural	50 (63.3)
- Spinal	8 (10.1)
- Epidural	4 (5.1)
- Epidural top-up	14 (17.7)
- Primary general anesthesia	3 (3.8)
Neuraxial converted to general anesthesia (n=75)	7 (9.3)
Analgesia post-cesarean section	
Pethidine PCEA*	59 (74.7)
Neuraxial morphine	7 (8.9)
Oral analgesia	7 (8.9)
IV PCA**	6 (7.6)

* PCEA = patient-controlled epidural analgesia ; ** IV PCA = intravenous patient-controlled analgesia.

GA was the planned anesthetic technique in three women with 7 other women requiring a GA due to failure of neuraxial technique. Of the 40 women who had an elective CD, 39 (97.5%) had neuraxial anesthesia as the primary technique, 1(2.5%) primary GA and 2 had neuraxial anesthesia which was converted to GA. The neuraxial anesthesia techniques used for elective CD were combined spinal-epidural (CSE) in 34, epidural in 3 and single shot spinal in 2 cases. Of the 39 women who had an emergency CD, 37 (94.8%) had neuraxial anesthesia as the primary technique, 2 (5.1%) had a primary GA

and 5 had neuraxial anesthesia which was converted to GA. CSE was used in 18, epidural top-up in 12 and single shot spinal for 7 of the emergency cases. Of the 68 neuraxial techniques performed in theatre, 45 (66.2%) required more than one attempt at insertion. Of the ten women who received GA, the Cormack and Lehane laryngeal grade was > 2 in two women. Post-operative analgesia used after CD is shown in Table 1.

Neuraxial analgesia in labor

Of 78 (61.4%) women who commenced labor, 47 (60.3%) women had a labor epidural inserted, as shown in Figure 1. Of the 47 epidurals performed for labor analgesia 32 (68.1%) required more than one attempt at insertion.
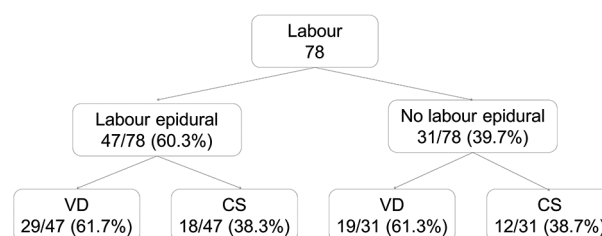

Fig. 1. — Epidural use and mode of delivery of 78 women with extreme obesity who commenced labor at the Royal Brisbane and Women's Hospital between 2013-2017.

Twelve (9.4%) women received antepartum thromboprophylaxis. Pharmacological agents used included enoxaparin in 9(75.0% of 12), fondaparinux in 1 (8.3%) and heparin in 2 (16.6%) women. Ninety-eight (77.2%) women received post-partum thromboprophylaxis. This included 55 (56.1% of 98) receiving heparin, 29 (29.6%) enoxaparin, 13 (12.2%) dalteparin and 1 (1.0%) fondaparinux.

Maternal and neonatal outcomes

Table 2 shows mode of delivery, indication for CD and neonatal outcomes. Figures 2 and 3 show results for RBWH compared with those of Sullivan et al. (4) where available, for maternal and neonatal outcomes respectively. Of 127 women, 12 (9.4%) had OSA, 7 (5.5%) had diabetes 49 (38.6%) had pre-existing mental health conditions (30 with depression, 6 with anxiety, 12 with both anxiety and depression, and one woman with borderline personality disorder).

Post-delivery, 48 (37.8%) women required supplemental oxygen via nasal prongs for a median (IQR) time of 1(1-2) days. Two women (1.6%) were admitted to ICU/HDU for one day. The median (IQR) length of stay of women was 4 (3-6)

Table 2

Mode of delivery and neonatal outcomes of 127 women with extreme obesity delivering 130 neonates at the Royal Brisbane and Women's Hospital between 2013-2017

Delivery outcomes	n (%)
Vaginal birth	48 (37.8)
- spontaneous, non-augmented	4
- spontaneous, augmented	12
- induced	32
Caesarean section	79 (62.2)
- elective	40
- emergency	39
Indication for emergency cesarean section	
- failure to progress	25
- fetal distress	8
- severe pre-eclampsia	3
- malpresentation	3
Neonatal outcomes n=130	n (%)
Apgar score < 7 at 1 min	21 (16.2)
Blood sugar level <2.6mmol L-1	47 (36.2)
Ventilatory support at delivery*	51 (39.2)
Alive on discharge	129 (99.2)
Breast feeding on discharge (n=123, 7 missing data)	69 (56.1)

*Ventilatory support at delivery included facial oxygen (n=5), intermittent positive pressure ventilation(n=41), continuous positive airway pressure CPAP (n=2) and intubation (n=3).

days Sixty-five (50.0%) of the 130 neonates were admitted to NICU/SCN for a median (IQR) of 1(1-3) days. The indications for NICU/SCN admission included respiratory observation or treatment in 29 (44.6%), hypoglycemia in 15 (23.1%), prematurity in 11 (16.9%), observation due to infection risk in 6 (9.2%) and other indications in 4 (6.2%).
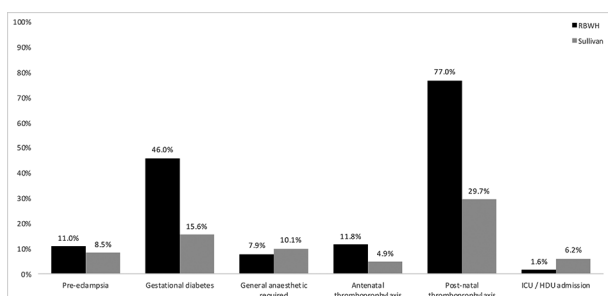
Fig. 2. — Maternal outcomes for 127 women with extreme obesity delivering at the Royal Brisbane and Women's Hospital between 2013-2017, compared with results from Sullivan et al. (4) (Post-natal oxygen requirement was delivered via nasal prongs ; ICU : Intensive care unit ; HDU : High dependency unit ; RBWH : Royal Brisbane & Women's Hospital).

There were no maternal deaths and one (0.8%) neonatal death. That neonate was delivered by spontaneous breech at a pre-viable gestation of 23 weeks, with an Apgar of one at one minute and intubated at delivery. The neonate died within 24 hours in NICU. The mother was a nulliparous nineteen-year-old with extreme obesity and no other maternal co-morbidities. She had received antenatal obstetric care and did not have an anesthetic management plan prior to her admission.
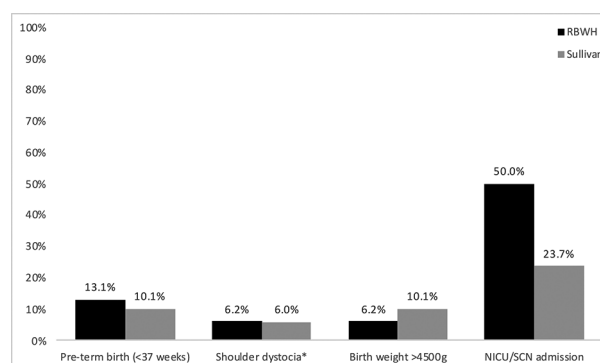
Fig. 3. — Neonatal outcomes for 130 neonates born to 127 women with extreme obesity delivering at the Royal Brisbane and Women's Hospital between 2013-2017, compared with results from Sullivan et al. (4) (*Based on number of vaginal deliveries (n=48), NICU/SCN : Neonatal intensive care unit/Special care nursery).

Discussion

The incidence of extreme obesity at our institution was consistent with that reported for pregnant women in Australia (1). Our cohort study has demonstrated high rates of CD delivery and use of labor epidural analgesia in women with extreme obesity, consistent with the results of Sullivan et al. (4). The World Health Organization Statement on Cesarean Rates 2015, states that at population level, CD rates higher than 10% do not improve perinatal outcomes (22). The rate of CD delivery in Australia peaked in 2016 at 34% (1). Consistent with data from the UK, Australia and Canada, in our institution women with extreme obesity had a higher rate of CD than our institutional CD rate of 35.5% and higher than the Australian general population (4,5,7). To our knowledge this is the first publication of the anaesthesia management and obstetric outcomes of pregnant women with extreme obesity at an institutional level.

Use of labor epidural analgesia by women with extreme obesity (60.3%) was higher than our overall departmental rate of 40.3%. Early epidural analgesia for obese parturients is recommended by some guidelines but this recommendation is not universally accepted by obstetric anesthetists (23,24). Neuraxial analgesia is considered ideal, with the possibility of extending the block, should operative delivery be required (25). However, this may not be straightforward in an obese parturient, complicated by difficulty positioning for neuraxial insertion, uncertain identification of the midline and epidural space and catheter dislodgement(26). Multiple attempts at catheter placement are common (26,27). Although evidence is variable, patients with a BMI≥40 kg m^{-2} might be more likely to fail

epidural extension for CD (24, 28). In our cohort, the rate of vaginal delivery in laboring women was the same, with or without epidural analgesia.

Neuraxial anesthesia was the preferred anesthesia technique in our cohort. The rate of GA was similar to that reported by Sullivan et al. and Knight et al. (4,5). A strength of our study is our reporting of the rate of GA as a primary anesthetic technique or as a conversion from a failed neuraxial approach. Neuraxial anesthesia has become the preferred anesthetic technique in obstetric anesthesia in many countries, although significant variation still occurs (29). The Royal College of Anesthetists (RCA) suggests that >95% of elective and >85% of emergency CD should be performed under neuraxial anesthesia (30). In our population of women with extreme obesity, both these RCA targets were met when considering the primary anesthetic technique.

The combination of obesity and pregnancy presents an increased risk of difficult intubation and acid aspiration (9). Airway changes during labor have been shown to increase airway class from pre-labor (31). Quinn et al. identified that the risk of failed intubation in obstetrics increases by 7% for every 1 unit increase in BMI (9). While laryngeal grade was reported as >2 in two of the women requiring GA, there were no failed intubations. It is likely that anesthetists have increased vigilance for patient positioning and use of airway adjuncts when intubating pregnant women with extreme obesity.

Existing guidelines suggest antenatal anesthetic consultation of obese parturients (15-17,32) and in some institutions obese women comprise a significant portion of high-risk clinic attendees (33). Some women remain unaware of the risks of obesity in pregnancy despite antenatal anesthetic consultation and the antenatal anesthesia consultation can influence their decision-making regarding intra-partum care (34). Antenatal anesthetic consultation occurred in most but not all women with extreme obesity at our institution. The importance of antenatal anesthetic consultation is highlighted by results from our cohort, in which only 19 women delivered their baby without neuraxial analgesia or some form of anesthesia. Anesthesia assessment may be hampered by admission close to delivery or where inter-hospital transfer occurs. "Telehealth" assessments, where patients are reviewed by video-link have been successfully used in other areas and could be used to facilitate anesthetic assessment in this circumstance (35).

There was a higher rate of gestational diabetes in women with extreme obesity compared with Sullivan et al. (4). Revised and more stringent diagnostic criteria for gestational diabetes were published in 2010 by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) (36). Application of these criteria locally is likely to have increased the rate of diagnosis in this already at-risk group (19). Despite the greater proportion of women with gestational diabetes, there were fewer macrosomic neonates. Early identification and management of gestational diabetes can reduce macrosomia and our results may reflect a treatment effect (37). There were more neonatal admissions to SCN/NICU in our study, compared with those reported by Sullivan et al. (4). This is consistent with literature demonstrating an association between obesity, gestational diabetes and the requirement of ventilatory support of neonates at delivery (37). The rate of maternal admission to HDU/ICU admission was lower than that reported by Sullivan et al. (4). It is important to note there is likely to be significant variation between different institutions, regarding critical care admission criteria for neonates and mothers. There was a high rate of pre-existing mental health conditions, consistent with previously published rates of depressive symptoms in obese pregnant women (38, 39).

Venous thromboembolism (VTE) is a leading cause of maternal mortality in the developed world and obesity has been recognized as a principal contributing factor (40,41). In our cohort, low molecular weight heparin, unfractionated heparin and fondaparinux were utilised for antepartum and post-partum thromboprophylaxis. Institutional thromboprophylaxis is guided by a Statewide Clinical Guideline (42) which supports the use of enoxaparin or dalteparin when low-molecular weight heparin (LMWH) is required (dalteparin became available for use part-way through the audit period). Clinician discretion leads to unfractionated heparin (UFH) being prescribed antenatally when delivery is imminent and post-natally when the risk of post-surgical bleeding is assessed to be high. This is because of the short duration of action and easy reversibility of UFH. Fondaparinux was prescribed for a woman with severe allergy to LMWH and UFH. With a significant proportion of women receiving antenatal thromboprophylaxis, it essential that a plan for withholding these anticoagulant medications is documented, to facilitate the anesthetists' preference for neuraxial techniques (25,43). The timing of anticoagulation administration must also be considered for safe removal of epidural catheters in the post-natal period.

LIMITATIONS

This is a retrospective study of a complex subset of women with Class III obesity, about whom little is published. However, it is limited by its retrospective methodology and restriction to a single centre. Our results cannot be generalized to other institutions, but do provide results against which similar institutions may compare their practice. As a teaching hospital, neuraxial placement may have been performed by less experienced anesthesia staff. Future prospective studies should include other risk factors including previous bariatric surgery, weight change over pregnancy and the influence of socio-economic and smoking status.

CONCLUSION

Women with extreme obesity are more likely to have complicated pregnancies and require anesthetic interventions to facilitate delivery. Despite this, there are no institutional-level publications against which to compare our practice. By publishing our data, we hope to encourage other institutions to examine and share their outcomes for this subset of women with extreme obesity. Multidisciplinary management is critical for this small subset of women and formal clinical pathways should be used to facilitate antenatal anesthetic consultation and manage anticoagulant medications. Recognition of the increased requirement for labor epidurals and cesarean delivery in women with very high BMI should guide levels of supervision and staffing in institutions caring for women with extreme obesity.

References

1. Australian Institute of Health and Welfare. 2018. Australia's mothers and babies 2016 - in brief. Perinatal statistics series no. 34. Cat. no. PER 97. Canberra: AIHW
2. Marshall NE., Guild C., Cheng YW., Caughey AB and Halloran DR. 2012. Maternal superobesity and perinatal outcomes. Am. J. Obstet. Gynecol. 206: 417 e1-6.
3. Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer - 2003-2005. 2007 In: Lewis G, ed. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH, p. 236
4. Sullivan EA., Dickinson JE., Vaughan GA., Peek MJ., Ellwood D. and Homer CS. et al. 2015. Maternal super-obesity and perinatal outcomes in Australia: a national population-based cohort study. BMC Pregnancy Childbirth. 15: 322.
5. Knight M., Kurinczuk JJ., Spark P., Brocklehurst P. and UK Obstetric Surveillance System. 2010. Extreme obesity in pregnancy in the United Kingdom. Obstet. Gynecol. 115: 989-997.
6. Mbah AK., Kornosky JL., Kristensen S., August EM., Alio AP. and Marty PJ. et al. 2010. Super-obesity and risk for early and late pre-eclampsia. BJOG. 117: 997-1004.
7. Crane JM., Murphy P., Burrage L. and Hutchens D. 2013. Maternal and perinatal outcomes of extreme obesity in pregnancy. J. Obstet. Gynaecol. Can. 35: 606-611.
8. Martin A., Krishna I., Ellis J., Paccione R. and Badell M. 2014. Super obesity in pregnancy: difficulties in clinical management. J. Perinatol. 34: 495-502.
9. Quinn AC., Milne D., Columb M., Gorton H. and Knight M. 2013. Failed tracheal intubation in obstetric anaesthesia : 2 yr national case-control study in the UK. Br. J. Anaesth.110: 74-80.
10. Dennis AT., Lamb KE., Story D., Tew M., Dalziel K. and Clarke P. et al. 2017. Associations between maternal size and health outcomes for women undergoing caesarean section: a multicentre prospective observational study (The MUM SIZE Study). BMJ. Open 7: e015630.
11. World Health Organization. 2000. Obesity : Preventing and Managing the Global Epidemic: Report of a WHO Consultation. Geneva, Switzerland: World Health Organi-zation, p. 268.
12. Tonidandel A., Booth J., D'Angelo R., Harris L. and Tonidandel S. 2014. Anesthetic and obstetric outcomes in morbidly obese parturients : a 20-year follow-up retrospective cohort study. In.t J. Obstet. Anesth. 23: 357-364.
13. Dresner M., Brocklesby J. and Bamber J. 2006. Audit of the influence of body mass index on the performance of epidural analgesia in labour and the subsequent mode of delivery. BJOG. 113: 1178-1181.
14. Pettersen-Dahl A., Murzakanova G., Sandvik L. and Laine K. 2018. Maternal body mass index as a predictor for delivery method. Acta Obstet Gynecol Scand; 97**:** 212-8.
15. ACOG Practice Bulletin No 156 : Obesity in Pregnancy. 2015. Obstet. Gynecol. 126: e112-126.
16. Davies GA., Maxwell C., McLeod L., Gagnon R., Basso M. and Bos H. et al. 2010. SOGC Clinical Practice Guidelines: Obesity in pregnancy. No. 239, February 2010. Int. J. Gynaecol. Obstet. 110: 167-173.
17. Denison FC., Aedla NR., Keag O., Hor K., Reynolds RM. and Milne A. et al. 2019. Care of Women with Obesity in Pregnancy: Green-top Guideline No. 72. BJOG. 126: e62-e106.
18. STROBE. 2008. STROBE statement-checklist of items that should be included in reports of observational studies. http://wwwStrobe-StatementOrg/IndexPhp?Id=AvailableChecklists. 1: 1-2.
19. Queensland Clinical Guidelines : Gestational diabetes mellitus, Queensland Health, 2015.
20. Lowe S., Bowyer L., Lust K., McMahon L., Morton M. and North R. et al. 2014. The SOMANZ Guideline for the Management of Hypertensive Disorders of Pregnancy: Society of Obstetric Medicine of Australia & New Zealand, p. 1-52
21. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists. 2015. Categorisation of urgency for caesarean section, p. 1-8.
22. WHO. 2015. WHO Statement on Caesarean Section Rates. Geneva, Switzerland: Department of Reproductive Health and Research, World Health Organisation, p. 8.
23. Eley VA., Callaway LK., van Zundert AA., Lipman J. and Gallois C. 2016. Anaesthetists' experiences with the early labour epidural recommendation for obese parturients : a qualitative study. Anaesth. Intensive Care. 44**:** 620-627.
24. Eley VA., van Zundert AA., Lipman J. and Callaway LK. 2016. Anaesthetic management of obese parturients: what is the evidence supporting practice guidelines? Anaesth. Intensive Care. 44: 552-559.
25. Lamon AM. and Habib AS. 2016. Managing anesthesia for cesarean section in obese patients: current perspectives. Local Reg. Anesth. 9: 45-57.

26. Hood DD. and Dewan DM. 1993. Anesthetic and obstetric outcome in morbidly obese parturients. Anesthesiology. 79: 1210-1218.
27. Perlow JH. and Morgan MA. 1994. Massive maternal obesity and perioperative cesarean morbidity. Am. J. Obstet. Gyneco. 170: 560-565.
28. Eley VA., van Zundert A. and Callaway L. 2015. What is the failure rate in extending labour analgesia in patients with a body mass index ≥ 40 kg/m²compared with patients with a body mass index < 30 kg/m²? a retrospective pilot study. BMC Anesthesiol. 15: 115.
29. Reynolds F. Regional Analgesia in Obstetrics: A Millennium Update, 1 edn., Springer-Verlag London, 2000.
30. Royal College of Anaesthetists. Raising the Standard: a Compendium of Audit Recipes. London: RCoA, 2012.
31. Kodali BS., Chandrasekhar S., Bulich LN., Topulos GP. and Datta S. 2008. Airway changes during labor and delivery. Anesthesiology. 108: 357-362.
32. RANZCOG. 2013 (Reviewed 2017). Obesity in Pregnancy C-Obs 49 Royal Australian and New Zealand College of Obstetricians and Gynaecologists, p. 19.
33. Salaunkey KMPR D. and Mannakkara C. 2007. An overview of a high risk obstetric anaesthetic clinic : 153. Reg. Anesth. Pain Med. 32: 80.
34. Eley VA., Donovan K., Walters E., Brijball R. and Eley DS. 2014. The effect of antenatal anaesthetic consultation on maternal decision-making, anxiety level and risk perception in obese pregnant women. Int. J. Obstet. Anesth. 23: 118-124.
35. Zairina E., Abramson MJ., McDonald CF., Li J., Dharmasiri T. and Stewart K. et al. 2016. Telehealth to improve asthma control in pregnancy : A randomized controlled trial. Respirology. 21: 867-74.
36. International Association of D., Pregnancy Study Groups Consensus P., Metzger BE., Gabbe SG., Persson B. and Buchanan TA. et al. 2010. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diab. Care. 33: 676-682.
37. Crowther CA., Hiller JE., Moss JR., McPhee AJ., Jeffries WS. and Robinson JS. et al. 2005. Effect of treatment of gestational diabetes mellitus on pregnancy outcomes. N. Engl. J. Med. 352: 2477-86.
38. Kumpulainen SM., Girchenko P., Lahti-Pulkkinen M., Reynolds RM. And Tuovinen S., Pesonen AK. et al. 2018. Maternal early pregnancy obesity and depressive symptoms during and after pregnancy. Psychol. Med. 48: 2353-2363.
39. Molyneaux E., Poston L., Ashurst-Williams S. and Howard LM. 2014. Obesity and mental disorders during pregnancy and postpartum: a systematic review and meta-analysis. Obstet. Gynecol. 123: 857-867.
40. Larsen TB., Sorensen HT., Gislum M. and Johnsen SP. 2007. Maternal smoking, obesity, and risk of venous thromboembolism during pregnancy and the puerperium: a population-based nested case-control study. Thromb. Res. 120: 505-509.
41. Malinowski AK., Bomba-Opon D., Parrish J., Sarzynska U. and Farine D. 2017. Venous thromboembolism in obese pregnant women: approach to diagnosis and management. Ginekol. Pol. 88: 453-459.
42. Queensland Clinical Guidelines: Venous thromboembolism (VTE) prophylaxis in pregnancy and the puerperium, Queensland Health, 2015.
43. Eley V., Callaway L., van Zundert A., Lipman J. and Gallois C. 2017. Interpretation of Care Guidelines for Obese Women in Labor: Intergroup Language and Social Identity. J. Lang. Soc. Psychol. 36: 388-414.