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Caesarean Section and Maternal Obesity

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1. Introduction

In developed countries in women of reproductive age an increase in obesity levels has been widely reported with an associated increase in maternal obesity (Yu et al, 2006, Heslehurst et al, 2008, Huda et al, 2010). Obesity in pregnancy is associated with an increased incidence of medical complications including gestational diabetes mellitus, pre-eclampsia and venous thromboembolism (Huda et al, 2010). As a result, in part, obesity is associated with a higher incidence of obstetric interventions such as caesarean section, as well as an increase in pregnancy complications including haemorrhage, infection and congenital malformations (Yu et al, 2006, Heslehurst, 2008). The World Health Organization criteria define a Body Mass Index (BMI) <18.5kg/m^2 as underweight, 18.5-24.9 as normal weight, 25.0-29.9 as overweight and > 29.9 as obese. Obesity can be further subcategorised into class one obese which is 30.0-34.9, class two 35.0-39.9 and class three >40.0.

2. Rising caesarean section rates

In 1985, the World Health Organization (WHO) concluded that the caesarean section (CS) rate in every region should account for 5-15% of all births (Lancet, 1985). Yet by 2006, the CS rate in high-income countries ranged from 14% in the Netherlands to 40% in Italy and Mexico (OECD, 2009). In Ireland, the CS rate now exceeds 26% (O'Dwyer and Turner, 2011).

The caesarean section rate in the United States (US) has increased further in the last 13 years. The CS rate increased from 21% in 1994 to 32% in 2007. When the CS rate was analysed by the US Department for Health and Human Sciences, the CS rate was found to increase in all ages, racial groups and gestations. This may be due to more conservative clinical practice and legal pressures (MacDorman et al, 2008).

In a 2007 meta-analysis examining strategies to reduce the CS rate, audit and feedback and a multifaceted approach were found to reduce the CS rate without compromising maternal and fetal outcomes. Multifaceted strategies included the use of clinical guidelines, hospital payment policies, malpractice reform and identification of barriers to change. However, WHO has since finessed its position on CS rates by stating that the most important issue is that every woman who needs a CS should have one. It acknowledges that there is little scientific evidence to support a 15% CS rate (Chaillet and Dumont, 2007).

3. Rising obesity levels and rising caesarean section rates

With rising adult obesity levels there has been an associated increase in maternal obesity. A Scottish study found that the prevalence of obesity had increased from 9.4% to 18.9% over a 12 year period (Kanagalingam et al, 2005). In other studies in Britain and Ireland, nearly a fifth of women booking for antenatal care were obese (Fattah et al, 2010; CMACE 2010). The severity of obesity is also increasing. Based on the WHO sub-categorisation of obesity, a recent UK national audit of pregnant women found that 5.0% had Class 2 or moderate obesity and 2.0% had Class 3 or severe obesity (CMACE, 2010).

Rising levels of obesity in women of child-bearing age and gestational weight gain have been reported which has implications for the woman's lifelong health as well as for the pregnancy itself (Sherrard et al, 2007). In the US concerns are so great that the Institute of Medicine (IOM) has published new guidelines for weight gain during pregnancy (IOM, 2009). The new 2009 guidelines are based on the WHO BMI categories with a specific, relatively narrow range of recommended gain for obese mothers of 5.0 – 9.0 kgs.

Numerous studies have reported an association between maternal obesity and an increased CS rate (Weiss et al, 2004; Cedergren et al, 2004; Rode et al, 2005). It has been estimated that each 1% decrease in the number of obese mothers in the United States would translate into 16,000 fewer CS per annum.

There have been three recent meta-analyses which studied the issue of obesity and caesarean section. In the 2007 analysis, the risk of CS overall was increased by 2.05 (95% CI 1.86-2.27) in obese women, and 2.89 (95% CI 2.28-3.79) in morbidly obese women (Chu et al, 2007).The 2008 meta-analysis found that the overall CS was twice as high in the obese BMI category compared with the ideal BMI (MacDorman et al, 2008). The increase was significant for emergency sections (n=6 studies), but not for elective sections (n=3 studies). In the 2009 systematic review and meta-analysis of 11 cohort studies, the risk of CS was increased by 2.26 (95% CI 2.04-2.51) in obese women and by 3.38 (95% CI 2.49-4.57) in morbidly obese women compared with women with a normal BMI (Poobalan et al, 2009). This study was confined to primigravidas. There was an increase in both elective (OR 1.87) and emergency CS (OR 2.23) in the obese women.

A 2011 study found that maternal obesity, based on accurate calculation of BMI in the first trimester, was associated with an increase in emergency CS in primigravidas and an increase in elective CS in multigravidas (O'Dwyer et al, 2011). The increase in emergency CS in obese primigravidas was associated with induction of labour and a high rate of CS for fetal distress. The increase in elective CS in multigravidas was associated with a high rate of repeat elective CS.

4. Pre-conceptual counselling for obese women

Pre-pregnancy lifestyle changes including a healthy diet and exercise should be advised. If obese women lose weight prior to pregnancy this can prevent some of the pregnancy complications associated with obesity including neural tube defects and miscarriage. Obese women have a higher risk of neural tube defects (Rasmussen et al, 2008). Therefore it has been recommended that they start high dose folic acid supplementation pre-pregnancy (CMACE, 2010).

It has been reported that maternal obesity is associated with an increased risk of spontaneous miscarriage after spontaneous and assisted conception (Metwally et al, 2008). Increased rates of miscarriage also occur in obese women with polycystic ovarian syndrome (Lashen et al, 2004; Bellver et al, 2003). In a Finish study the miscarriage rate was found to be higher at the extremes of weight compared with normal weight women (Veleva et al, 2008). In a study examining the probability of pregnancy after assisted reproduction the odds ratio was 0.73 for obese Class 1 women and 0.5 for obese Class 2-3 women, compared with women in the normal BMI category (Wang et al, 2000; 2002).

Recurrent miscarriage is defined as three consecutive miscarriages. It affects 1% of couples. In a study of 491 women with a history of recurrent miscarriage the miscarriage rates in subsequent pregnancies were higher in obese women compared with normal weight women (Metwally et al, 2010). In another study the risk of recurrent miscarriage was four times higher in obese women compared with normal weight controls. Diabetes mellitus is a known cause of recurrent miscarriage but, in this study the prevalence was low in obese women and it did not explain their higher risk of miscarriage (Lashen et al, 2004).

5. Pregnancy after bariatric surgery

Pregnancy after bariatric surgery is safe once a woman's weight has stabilised, usually 1 -2 years after surgery. Antenatal care should include monitoring nutrition and appropriate gestational weight gain in these women (Karmon et al, 2008). The risk of maternal and neonatal adverse outcomes is lower in women post bariatric surgery than in obese women. In a systematic review of pregnancy after bariatric surgery there were lower rates of gestational diabetes mellitus, pre-eclampsia, low birth weight babies and macrosomia among women after bariatric surgery compared with obese women (Maggard et al, 2008).

A caesarean section is not required for delivery after bariatric surgery. The risk of caesarean section may be lower due to the lower risk of pregnancy complications in women after bariatric surgery compared with obese women. However, some studies have reported a higher risk of caesarean section in women after bariatric surgery. In a study period of 159,210 deliveries, of which 298 deliveries (0.2%) occurred in patients with previous bariatric surgery there were higher rates of CS among the bariatric operation group (25.2% vs 12.2%; odds ratios, 2.4; 95% confidence interval, 1.9-3.1; $p<0.001$) (Sheiner et al, 2004).

6. Antenatal care for the obese woman

Hypertension in pregnancy, including pre-eclampsia, occurs in almost 8% of pregnancies and is an important cause of pregnancy complications for both mother and baby. Pre-eclampsia is defined as hypertension (a systolic blood pressure of > 140 mmHg and/or a diastolic blood pressure of > 90 mmHg) measured on at least two separate occasions at least 6 hours apart with proteinuria (> 300 mg over 24 hours) after 20 weeks gestation. Epidemiological reviews have reported an association between pre-eclampsia and maternal obesity, based on a Body Mass Index (BMI) > 29.9kg/m^2 (Weiss et al, 2004; Abenheim et al, 2007).

To avoid misdiagnosing pregnancy-induced hypertension or pre-eclampsia women with a mid-arm circumference (MAC) >33cm should have their blood pressure measured with a

large cuff. Previous studies have reported a MAC >33cm in 44% of class 1 (BMI < 35kg/m2) obese women and 100% of class 2-3 (BMI ≥ 35 kg/m2) obese women (Hogan et al, 2010). There is a higher rate of caesarean section in women with pre-eclampsia probably due to a higher rate of induction of labour (Kim et al, 2010). It is highly desirable that a CS for an unsuccessful labour induction is avoided in obese women especially if the induction may have been medically unnecessary. Therefore it is important that blood pressure is measured accurately in obese women.

Gestational Diabetes Mellitus (GDM) affects 1.1-14.3% of the pregnant population depending on the population studied and on the diagnostic criteria used (SOGC, 2002; Reece et al, 2009; Torloni et al, 2009). There is a higher rate of induction of labour and caesarean section in women with GDM. Previous studies have reported an association between increased rates of Gestational Diabetes Mellitus (GDM) and maternal obesity, based on a Body Mass Index (BMI) categorisation > 29.9kg/m^2. In a meta-analysis of 20 studies, the risk of developing GDM was about two, four and eight times higher among overweight, obese and severely obese women (Chu et al, 2007). Obese women should be offered a glucose tolerance test (GTT) at 24-28 weeks in countries where selective screening for GDM is performed (NICE, 2002). By identifying women with gestational diabetes the risk of neonatal mortality and morbidity such as congenital abnormalities, macrosomia, hypoglycaemia and jaundice may be reduced. There are, however, no studies that show that the diagnosis and treatment of GDM in obese women avoids the need for CS. Ideally, women should avoid prepregnancy obesity which may prevent the development of PET and GDM.

The HAPO study (2008) found an association between maternal hyperglycaemia and the rate of caesarean delivery and separately, gestational diabetes has been shown to be an independent risk factor for caesarean delivery (Rosenberg, 2005). However, others argue that obesity is an independent risk factor for caesarean section even when GDM is considered a confounder (Sebire et al, 2001; Ehrenberg et al, 2004; Rosenberg, 2005). Numerous studies have demonstrated pregestational diabetes to be independent risk factor for caesarean delivery (Sebire et al, 2001; Ray et al, 2001; Rosenberg, 2005). The complex interaction of obesity, diabetes, insulin resistance and the inflammatory milieu during pregnancy is the subject of ongoing research and these factors may have an effect on the progression of labour (Hauguel-de Mouzon, 2006; Chu, 2007; Schmatz, 2010). Ethnicity is also associated with the rate of caesarean delivery and studies have shown higher caesarean section rates in women of African descent (Rosenberg et al, 2005; Bragg et al, 2010).

There is an increased risk of congenital abnormalities, including neural tube defects, cardiac abnormalities and gastrointestinal anomalies in obese women compared to those with a normal BMI (Rasmussen et al, 2008; Waller et al, 2007). Detection of these anomalies is, however, more challenging in obese women (Paldini, 2009). This is due to poor visualisation of fetal anatomy because of the impaired acoustic window. The impaired acoustic window is due to the depth of insonation required and the absorption of energy by adipose tissue. Structures with low impedance such as the heart, kidneys, lips and cerebellum are difficult to visulaise. Despite technical advances such as lower emission frequencies, harmonic imaging and speckle reduction ultrasound imaging in obese women remains challenging.

7. Intrapartum care for the obese woman

In labour external abdominal fetal heart monitoring is hindered by the amount of subcutaneous tissue between the cardiotocograph and the uterus. Fetal scalp electrodes are often used instead of external monitoring when continuous fetal surveillance is required. In a recent review of intrapartum care for morbidly obese women there was a higher rate of invasive fetal monitoring and difficulty monitoring uterine contractions in the morbidly obese group compared with normal weight controls. Furthermore, fetal blood sampling can be challenging in obese women. Previous studies have described the technical difficulty and longer duration required to perform a fetal blood sampling (FBS) in obese women. There was also a higher rate of difficulty with vaginal examinations due to poor access to the perineum in the morbidly obese women (Ray et al, 2008).

Ideally morbidly obese women should be reviewed in an anaesthetic clinic as part of their antenatal care to access the possibility of peripheral venous access, regional and general anaesthesia. The anaesthetist on duty should also be informed when a morbidly obese woman presents in established labour. Peripheral venous access should be established early in labour. An epidural catheter should be placed early in labour in morbidly obese women so that there is no delay if an emergency caesarean section is required.

Induction of labour is known to be associated with a higher risk of caesarean section than spontaneous labour, especially in primigravidas (Seyb et al, 1990). Other studies have described a higher rate of failed induction and dystocia in labour for overweight and obese women compared with normal weight women (Yu et al, 2006; Vahration et al, 2003). In a Liverpool study of labour following induction for prolonged pregnancy the caesarean section rate was 38.7% in obese primigravidas compared with 23.8% in normal weight primigravidas (Arrowsmith et al, 2011).

8. Postpartum care

Obese women are less likely to intend, initiate and continue breastfeeding (Amir and Donath, 2007). Thus, obese women may need extra support after caesarean delivery with breastfeeding in the hospital and following discharge home (Mok et al, 2008).

Before discharging an obese woman home it is also a good opportunity for lifestyle advice and prepregnancy counselling for the future. A good diet and an exercise programme to lose weight postnatally are important.

Ideally obese women should optimise their weight before conceiving again. They should be advised that high dose folic acid is required to minimise the increased risk of neural tube defects associated with the low serum folate levels in obese women. Smoking cessation should also be advised.

It is important that obese women with gestational diabetes attend for their 6 week postnatal glucose tolerance test to identify those with type 2 diabetes mellitus. However, it is well described that attendance for postnatal glucose tolerance testing is poor (Russell et al, 2006; Persson et al, 2009). Obese women should be informed that even in the presence of a negative postnatal GTT they are at increased risk of type 2 diabetes later in life and that weight loss can reduce this risk.

9. Technical challenges of caesarean section in obese women

Ideally obese women should have an anaesthetic consultation before delivery as they are at high risk of complications due to obesity and medical co-morbidities. Obese women have higher rates of failure of epidural insertion, difficulty with inserting peripheral venous access, failed intubation and higher risk of aspiration (Yu et al, 2006). Regional anaesthesia in the obese can be technically challenging because of difficulties in identifying the usual bony landmarks. Ultrasound has been successfully used in the obese to help identify the epidural space and reduce the need for general anaesthesia (Adam & Murphy, 2000).

Special operating tables are required for morbidly obese women. It may be difficult to transfer an obese woman in a manner that is safe for both her and staff, and thus a hoist may be necessary. Surgery in the obese parturient can be challenging and requires a number of assistants with the increased use of retractors. The placement of the incision should be made at a site that will minimise the risk of wound infection. Vertical skin incisions should be avoided when possible. In a study of morbidly obese women undergoing primary caesarean section those who had a vertical skin incision had a higher rate of wound infection (OR 12.1, $p<0.001$) compared with a transverse skin incision (Wall et al, 2003).

10. Risks of caesarean section in obese women

One of the top ten recommendations from the Confidential Enquiries into Maternal and Child Health (CEMACH) report launched in 2007 refers to caesarean section. It states that whilst recognising that for some mothers and/or their babies' caesarean section (CS) may be the safest mode of delivery, however, mothers must be advised that caesarean section is not a risk-free procedure and can cause problems in current and future pregnancies. There are a number of complications associated with caesarean section and the risk of these complications is increased in obese women. Caesarean section is associated with haemorrhage, infection, damage to viscera, anaesthetic complications and long-term complications such as placenta accreta. In the 2008 meta-analysis of obstetric outcomes and obesity there was an increased risk of wound infection, endometritis and urinary tract infection for obese and morbidly obese women compared with those in the normal BMI category (Heslehurst et al, 2008). Another risk factor for postcaesarean section infectious morbidity is emergency caesarean sections, especially following a trial of labour or prolonged rupture of membranes. In a review of 81 clinical trials examining antibiotic prophylaxis for women undergoing caesarean section the reduction in endometritis and wound infection was significant enough to recommend routine antibiotic prophylaxis for these women (Smaill and Hofmeyr, 2002). In a review of 58 controlled trials, the use of routine antibiotic prophylaxis was not only found to decrease the risk of wound infection by 50-70% but also to decrease the cost of postnatal care by between £1300 and £3900/100 caesarean sections (Mugford et al, 1989). There is considerable variation in the timing of prophylactic antibiotic administration among surgical patients. In an American study there was a lower rate of infection among patients who received prophylactic antibiotics in the two hours prior to suregery (Classen et al, 1992). It is now recommended that antibiotic prophylaxis is given prior to skin incision. In an American study there was a decrease in infectious morbidity women who received cefazolin prior to skin incision compared to those who received cefazolin at cord clamping (relative risk [RR] = 0.4, 95% confidence interval

[CI] 0.18 to 0.87). In addition to this, studies recommend a higher dose of antibiotic prophylaxis for obese women undergoing caesarean section (ACOG, 2011).

The risk of complications increases with the number of repeat caesarean sections performed. (Silver et al, 2006). Bladder and bowel injury can occur at the time of caesarean section. Injury to the gastrointestinal tract occurs in 1 in 1300 caesarean deliveries. Increased pain medication requirement and longer hospital stay occur following caesarean section compared with vaginal delivery. Maternal obesity is also associated with a longer duration of hospital stay (Galtier-Dereure et al, 2000). Therefore, it is not surprising that maternal obesity has been associated with an increase in the use of healthcare resources (Heslehurst, 2008; Rowlands, 2010).

11. Thromboprophylaxis for obese women undergoing caesarean section

Pulmonary embolism (PE) is the leading cause of direct maternal death in the UK and the developed world (CMACE, 2001; Bourjeily et al, 2010). Maternal obesity has been associated with an increased risk of venous thromboembolism (VTE) (Bourjeily et al, 2010). A BMI > 29.9 kg/m^2 in early pregnancy is considered a moderate risk factor for VTE postpartum. An elective caesarean section is associated with twice the risk of the VTE risk postpartum when compared with a vaginal delivery, and an emergency caesarean section is associated with a four-fold increase in risk of VTE (RCOG, 2009).

There is scant evidence about the optimum administration of low molecular weight heparins (LMWH) to women during pregnancy and in the postpartum period (Tooher at al, 2010). Significant physiological changes occur during pregnancy and may last up to six weeks postnatally, thus the efficacy of LMWH doses which are based on studies of the non-pregnant population are unpredictable. Some evidence, for example, suggests that pregnancy affects the pharmacokinetics of tinzaparin (Norris et al, 2004). While the relative safety of LMWH use has been established, there is little evidence to guide the appropriate prophylactic dose in pregnancy and postpartum. Current guidelines by the Royal College of Obstetricians and Gynaecologists (RCOG) indicate suitable doses during pregnancy and the postpartum period. Suboptimal thromboprophylaxis in obese women has been described in a recent large scale study conducted by CMACE (CMACE, 2010).

12. Medication dosage in obese patients

Few studies have examined increased medication costs in obese populations. An Italian study detailing medication costs in 2622 patients showed that the obese group required more prescriptions annually with a 153% increase in annual medication cost over the normal weight group (Esposti et al, 2006). Another study found obesity resulted in a 47% increase in pharmacy claims by state employees in Arkansas (Hill et al, 2009).

There is an even greater dearth of information on obesity in pregnancy and the associated medication usage. A study investigating the influence of maternal obesity on healthcare costs for minor complications found an increase in the use of sodium alginate, insulin and anti-hypertensives (Denison et al (2009). However, the usage of these medications is most likely increased in obese patients whether they are pregnant or not. An increase in outpatient medication dispensed from community pharmacies has also been reported in obese women (Chu et al, 2008).

Antenatal medication usage is associated with increasing BMI. This appears to be related to the increase in complications during pregnancy with maternal obesity. A large population study involving 19,538 pregnancies in the USA describes an association between increased outpatient medication usage and increasing BMI (Chu et al, 2008). It also identified an increase in the total and postpartum length of hospital stay in women with an increased BMI. The effect of increased BMI on length of hospital stay was independent of the mode of delivery or the presence of a high-risk obstetric condition (diabetes mellitus, hypertension), but was not a significant factor when the authors adjusted for both.

13. Long-term consequences of caesarean section in obese women

Trial of labour after caesarean delivery (TOLAC) is a reasonable option for many women (Scott, 2011). In the US the increase in the caesarean section rate can be partly attributed to the fall in the vaginal birth after caesarean section (VBAC) rate (Mac Dorman et al, 2007). The success rate for a planned trial of labour for women with one prior caesarean is approximately 75%. It is positively influenced by a history of a vaginal delivery prior to caesarean section or a previous VBAC, spontaneous onset of labour, a baby weighing between 2.5 and 4kg and not requiring oxytocin augmentation in labour. A BMI ≥ 30 kg/m^2 has a negative influence on the success rate. In a retrospective cohort study of 8,246 singleton pregnancies in Dublin, the overall caesarean section (CS) rate was 45.3% in women with morbid obesity (BMI > 39.9 kg/m2) compared with 14.4% in women with a normal BMI ($p<0.001$). Morbid obesity was associated with an increase in both elective and emergency caesarean sections, and a decrease in vaginal birth after caesarean section (VBAC) compared with a normal BMI (25.0% vs. 63.5% $p<0.001$) (Farah et al, 2009).

There is higher maternal and neonatal morbidity associated with a failed trial of labour compared with an elective repeat caesarean section (Landon et al, 2004). The risk of uterine rupture is 0.5% for women with one prior lower transverse uterine incision. Certain practices can be used to minimise the risk of adverse outcomes in these women including uterine rupture. These include the use of colour coded partograms to highlight when a woman has a prior caesarean section, avoiding prostaglandin to induce labour and careful use of oxytocin to induce or augment labour (Turner, 2002).

With rising caesarean section rates the incidence of abnormal placentation is increasing. Abnormal placentation is a known risk factor for major obstetric haemorrhage and maternal morbidity and mortality (Turner et al, 2010). Thus, the CEMACH report also recommends that women who have had a previous caesarean section must have placental localisation in their current pregnancy to exclude placenta praevia and if present, further investigation to try to identify praevia accreta and enable the development of safe management strategies.

In a study of 97,799 women, in those who had a prior caesarean section the risk of placenta praevia was 0.26% with an unscarred uterus and increased almost linearly with the number of prior caesarean sections to 10% in patients with four or more. Patients presenting with a placenta praevia and an unscarred uterus had a 5% risk of clinical placenta accreta. With a placenta praevia and one previous caesarean section, the risk of placenta accreta was 24% (Clark et al, 1985). Another study of 41,206 women found that, in patients with placenta praevia the risk of accreta is 8 times greater with scarred uterus compared to unscarred uterus with placenta praevia. Furthermore, there was a higher risk of hysterectomy in 10% and 66% in women with placenta praevia and accreta and a prior CS (Chattopadhyay et al, 1993).

14. Conclusions

During the twentieth century there were remarkable advances in obstetric practices which led to great improvements in clinical outcomes for women and their offspring, particularly in well-resourced countries. However, overabundance of food and changes in physical activity levels in these countries have also led to rising levels of maternal obesity which risk reversing the improvements achieved in maternal and fetal outcomes. Caesarean delivery in the morbidly obese woman is both clinically and technically challenging. Ideally, morbid obesity is a modifiable risk factor that should be modified prepregnancy. If morbid obesity is present in early pregnancy, a comprehensive multidisciplinary plan is mandated to prevent complications and minimise interventions.

15. References

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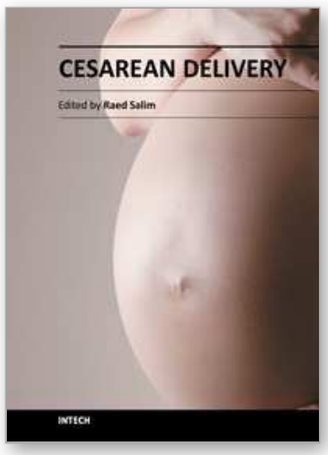

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This book provides broad, science-based information regarding the most common major surgical procedure performed, i.e. Cesarean Delivery. The book provides relevant scientific literature regarding epidemiology and rates of cesarean delivery in low and high income countries and the impact of the disparities in the rate of cesarean delivery between countries. In addition, the book systematically reviews the relevant scientific literature regarding all perioperative considerations with a broad cover of anesthetic techniques, drugs and difficulties that anesthesiologists may encounter during cesarean delivery. Care of the neonate after cesarean and crucial guidelines for obese women undergoing cesarean are also provided. The book was written by distinguished experts from different disciplines to ensure complete and accurate coverage of the recent scientific and clinical advances and to bring care providers and purchasers up to date including essential information to help improve health care quality.

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