

Risk of Maternal Morbidity with Increasing Number of Cesareans

Kristina E. Sondgeroth, MD¹ Leping Wan, MPH¹ Roxane M. Rampersad, MD¹
Molly J. Stout, MD, MSCI¹ George A. Macones, MD, MSCE¹ Alison G. Cahill, MD, MSCI¹
Methodius G. Tuuli, MD, MPH²

¹Department of Obstetrics and Gynecology, Washington University School of Medicine in St. Louis, St. Louis, Missouri

²Department of Obstetrics and Gynecology, Indiana University School of Medicine, Indianapolis, Indiana

Address for correspondence Kristina E. Sondgeroth, MD, Department of Obstetrics and Gynecology, Washington University School of Medicine in St. Louis, 4901 Forest Park Avenue, 10th Floor, COH, Suite 10102, St. Louis, MO 63108 (e-mail: epplink@wustl.edu).

Am J Perinatol 2019;36:346–351.

Abstract

Objective To estimate the risk of perioperative morbidity with increasing number of cesareans.

Study Design We conducted a retrospective cohort study from 2004 to 2010. Patients delivered by cesarean were included. Outcome measures were a composite organ injury (bowel or bladder), hysterectomy, hemorrhage requiring transfusion, severe morbidity, or surgical site complications. The Cochran–Armitage’s test of trend was used to assess increasing incidence of each morbidity with number of prior cesareans. Multivariable logistic regression was used to estimate adjusted risks for each morbidity with increasing number of cesareans compared with primary cesarean.

Results Of the 15,872 women in the cohort, 5,144 had cesarean delivery: 3,113 primary, 1,310 one prior, 510 two prior, and 211 three or more prior cesareans. There was a significant increase in organ injury, hysterectomy, and surgical site complications with increasing number of cesareans. In multivariable analysis, the risk of organ injury and hysterectomy was increased compared with primary cesarean after two prior cesareans, and after three or more cesareans for hemorrhage requiring transfusion and surgical site complications.

Conclusion The risks of organ injury and hysterectomy are increased after two or more prior cesareans, and risks of hemorrhage and surgical site complications are increased after three or more cesareans.

Keywords

- ▶ maternal morbidity
- ▶ cesarean
- ▶ complications
- ▶ repeat cesarean

Almost 1.3 million women in the United States have a cesarean delivery annually, with a cesarean delivery rate at 32% of all deliveries.¹ National recommendations supporting trial of labor after cesarean aided in increasing the vaginal birth after cesarean (VBAC) rate to around 28%, resulting in a lower cesarean delivery rate in the 1990s.² However, given rising concern over uterine rupture, the VBAC rate in 2016 was 12.4%.³ The cesarean rate has remained fairly steady in the past several years despite numerous efforts by the American College of Obstetricians and Gynecologist and Society for Maternal-Fetal Medicine to reduce it.^{1,4}

Prior studies have shown that there are short-term and long-term complications of cesarean delivery; however, the majority of work has focused on elective cesareans. One large, multicenter study of women undergoing repeat cesarean without labor showed significant morbidity for women with high order repeat, most of which was attributable to abnormal placentation and hysterectomy.⁵ This study also showed that repeat cesarean deliveries were associated with cystotomy, bowel injury, and transfusion. Another prospective study of 500 women undergoing cesarean showed that a higher

received

April 10, 2018

accepted after revision

August 28, 2018

published online

October 29, 2018

Copyright © 2019 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <https://doi.org/10.1055/s-0038-1673653>.
ISSN 0735-1631.

number of cesareans was associated with increased operative time, abdominal adhesive disease, and enterotomy, but no difference in cystotomy or blood transfusion.⁶ However, in recent work in an obese cohort, the number of prior cesareans was not a significant risk factor for intraoperative injury.⁷

Given the high prevalence of cesarean deliveries, maternal morbidity with both primary and repeat cesarean deliveries is of utmost importance for practicing obstetricians. Knowledge of the risk of morbidity would inform preoperative planning and may be needed to reduce and manage complications. Identifying women with the highest risk of morbidity could allow for referral to a higher level of maternal care.⁸ The objective of this study was to estimate maternal morbidity for women undergoing cesarean delivery with or without labor, with the hypothesis that women undergoing higher order repeat cesareans would have increased specific operative morbidities.

Materials and Methods

This is a retrospective cohort study of all consecutive women with singleton, nonanomalous gestations admitted for delivery who underwent a cesarean delivery from 2004 to 2010. This cohort included women with or without labor to represent the entire population of women undergoing cesarean. Labor was determined if the patients' initial admission diagnosis included labor or induction. Trained research personnel extracted detailed maternal sociodemographic information, obstetric and medical history, and intrapartum and postpartum courses from the medical record. The study was conducted at a single, academic teaching hospital, and was approved by the Washington University School of Medicine, Human Research Protection Office.

Outcome measures were composite organ injury (cystotomy and/or enterotomy), hysterectomy, hemorrhage requiring blood transfusion, composite severe maternal morbidity, and composite surgical site complications. Composite severe maternal morbidity included any of the following: acute renal failure, respiratory complication, postoperative ventilation, pulmonary edema, pulmonary embolism, thromboembolism, or intensive care unit (ICU) admission. Composite surgical site complications included any of the following: wound drain placement, hematoma, seroma, skin separation, fascial dehiscence, endometritis, or utilization of home health for wound care.

Differences in baseline characteristics were estimated using analysis of variance, chi-square test, or Fisher's exact test as appropriate. Rates of morbidity were determined for women undergoing a primary, first repeat, second repeat, and third or more repeat cesareans. A one-sided Cochran–Armitage's test of trend was used to evaluate for trend with increasing cesarean deliveries. Multivariable logistic regression was used to estimate the adjusted risk estimates for each morbidity with increasing number of cesareans. Primary cesarean was used as the reference group. A sensitivity analysis was performed for women who did not labor prior to cesarean.

We included all patients meeting inclusion criteria, and no a priori sample size estimation was performed. All tests

were two-sided except for the Cochran–Armitage's trend test. Test with $p < 0.05$ were considered significant. Statistical analyses were performed with SAS 9.4 (SAS Institute, Cary, NC) statistical software.

Results

There were 15,872 women in the total cohort, and 5,144 (32%) delivered by cesarean and were included in this analysis. Of the women delivered by cesarean, 3,113 were primary, 1,310 had one prior, 510 had two prior, and 211 had three or more prior cesareans. The mean maternal age increased with increasing number of cesareans (►Table 1). Two-thirds (64%) of the women in this cohort were African American and a similar proportion were obese (body mass index [BMI] $> 30\text{kg/m}^2$). Women undergoing a primary cesarean were more likely to have a normal BMI. Women undergoing their third or more cesarean had the highest rate of having a BMI $> 40\text{kg/m}^2$.

The majority of women undergoing a primary cesarean was for fetal intolerance to labor or labor arrest. More than half of women undergoing a primary cesarean presented in labor or had an induction compared with 24.7, 9.8, and 7.1% for one prior, two prior, and three prior cesareans, respectively. The majority of repeat cesareans was elective repeats, and this indication increased with increasing number of cesareans. Cigarette smoking was associated with increasing number of cesareans. There were no differences in rates of diabetes or macrosomia.

There was an increase in composite organ injury, hysterectomy, and composite surgical site complications with increasing number of cesareans in univariate analysis (►Fig. 1). There was no difference among the groups for hemorrhage requiring transfusion and composite severe maternal morbidity. A detailed breakdown for each morbidity is shown in ►Table 2. For composite organ injury, the risk of bladder injury increased with increasing number of cesareans. The rate of bowel injury trended toward an increase; however, there were no cases in women with three or more prior cesareans. The rate of hysterectomy increased with increasing number of cesarean: 0.8, 1.53, 2.35, and 6.64% for primary, one prior, two prior, and three or more prior cesareans, respectively.

The rate of hemorrhage requiring transfusion was similar for women undergoing a primary cesarean and for one prior (1.12 vs. 1.15%). The lowest rate was in the group with two prior cesareans (0.59%) and the highest for three or more cesareans (3.32%). The overall rate of composite severe maternal morbidity was low. The rate was the highest for a primary cesarean (1.12%). Pulmonary edema was the most common severe maternal morbidity and was not different across the groups. There were no cases of pulmonary embolism. Composite surgical site complications increased with increasing number of cesareans. Drain placement for abscess or seroma was the most common wound diagnosis, and was most common among women with three or more prior cesareans (5.21%). Endometritis was the only surgical site complication which decreased with number of prior cesarean.

Table 1 Baseline characteristics

Characteristic	Primary CD (N = 3,113)	1 repeat CD (N = 1,310)	2 repeat CD (N = 510)	≥3 repeat CD (N = 211)	p-Value ^a
Maternal age, mean (SD)	25.6 (6.4)	27.6 (5.9)	28.7 (5.5)	29.7 (5.0)	<0.01
Ethnicity, n (%)					
African American	1,971 (63.9)	838 (64.6)	341 (67.7)	129 (61.4)	<0.01
Caucasian	893 (28.9)	354 (27.3)	114 (22.6)	55 (26.2)	
Hispanic	135 (4.4)	69 (5.3)	36 (7.1)	21 (10.0)	
Other	86 (2.8)	37 (2.9)	13 (2.6)	5 (2.4)	
BMI categories, n (%)					
< 25 kg/m ²	362 (11.9)	99 (7.8)	38 (7.7)	10 (4.9)	<0.01
25–30 kg/m ²	775 (25.5)	287 (22.7)	101 (20.5)	47 (22.9)	
30–40 kg/m ²	1,317 (43.3)	578 (45.7)	216 (43.8)	87 (42.4)	
> 40 kg/m ²	589 (19.4)	301 (23.8)	138 (28.0)	61 (29.8)	
BMI > 30 kg/m ² , n (%)	1,906 (62.7)	879 (69.5)	354 (71.8)	148 (72.2)	<0.01
Diabetes, n (%)	99 (3.2)	55 (4.2)	21 (4.1)	9 (4.3)	0.31
Smoker, n (%)	519 (16.7)	248 (18.9)	120 (23.5)	70 (33.2)	<0.01
Indication for cesarean, n (%)					
Elective	202 (6.49)	936 (71.45)	444 (87.06)	181 (85.78)	<0.01
Failed induction	181 (5.81)	28 (2.14)	2 (0.39)	0 (0.00)	<0.01
Failure to progress	870 (27.95)	104 (7.94)	4 (0.78)	0 (0.00)	<0.01
Fetal intolerance	1,004 (32.25)	155 (11.83)	18 (3.53)	0 (0.00)	<0.01
Malpresentation	518 (16.64)	77 (5.88)	24 (4.71)	9 (4.27)	<0.01
HSV outbreak	49 (1.57)	11 (0.84)	2 (0.39)	0 (0.00)	<0.01
Abnormal placentation	33 (1.06)	9 (0.69)	5 (0.98)	5 (2.37)	0.15
Shoulder dystocia	7 (0.22)	1 (0.08)	0 (0.00)	0 (0.00)	0.61
Other	1,114 (35.79)	232 (17.71)	85 (16.67)	45 (21.33)	<0.01
Labor	1,804 (58.0)	324 (24.7)	50 (9.8)	15 (7.11)	<0.01
Gestational age (wk), mean(SD)	36.9 (4.1)	37.6 (2.8)	37.1 (2.9)	36.8 (3.0)	<0.01

Abbreviations: CD, cesarean delivery; HSV, herpes simplex virus; SD, standard deviation.

^ap-Values are based on analysis of variance, chi-square test, or Fisher's exact test.

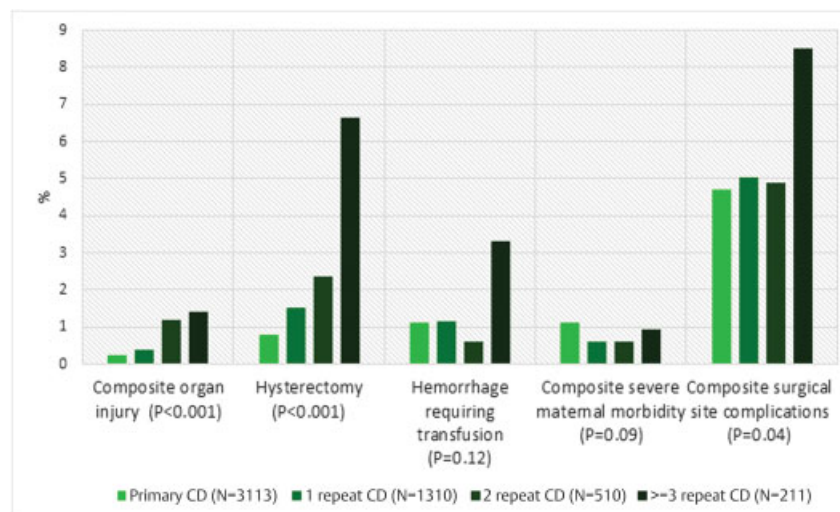


Fig. 1 Maternal morbidity with cesarean. Rates of maternal morbidity with increasing number of cesareans. CD, cesarean delivery.

Table 2 Detailed rates of morbidity with increasing cesareans, univariate analysis

Morbidity	Primary CD (N = 3,113)	1 repeat CD (N = 1,310)	2 repeat CD (N = 510)	≥3 repeat CD (N = 211)	p-Value ^a
Composite organ injury, n (%)	7 (0.23)	5 (0.38)	6 (1.18)	3 (1.42)	<0.001
Bladder injury, n (%)	5 (0.16)	3 (0.23)	3 (0.59)	3 (1.42)	
Bowel injury, n (%)	4 (0.13)	2 (0.15)	3 (0.59)	0 (0.00)	
Hysterectomy, n (%)	25 (0.80)	20 (1.53)	12 (2.35)	14 (6.64)	<0.001
Hemorrhage requiring transfusion, n (%)	35 (1.12)	15 (1.15)	3 (0.59)	7 (3.32)	0.12
Composite severe maternal morbidity, n (%)	35 (1.12)	8 (0.61)	3 (0.59)	2 (0.95)	0.09
Acute renal failure, n (%)	5 (0.16)	0 (0.00)	0 (0.00)	0 (0.00)	
Respiratory complication, n (%)	5 (0.16)	1 (0.08)	0 (0.00)	1 (0.47)	
Ventilation, n (%)	6 (0.19)	3 (0.23)	1 (0.20)	0 (0.00)	
Pulmonary edema, n (%)	20 (0.64)	6 (0.46)	2 (0.39)	1 (0.47)	
Pulmonary embolism or thrombotic embolism, n (%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
ICU admission, n (%)	4 (0.13)	0 (0.00)	0 (0.00)	0 (0.00)	
Composite surgical site complications, n (%)	147 (4.72)	66 (5.04)	25 (4.90)	18 (8.53)	0.04
Wound diagnoses (drain), n (%)	49 (1.57)	36 (2.75)	13 (2.55)	11 (5.21)	
Wound diagnoses (hematoma), n (%)	25 (0.80)	13 (0.99)	2 (0.39)	2 (0.95)	
Wound diagnoses (seroma), n (%)	5 (0.16)	5 (0.38)	4 (0.78)	2 (0.95)	
Wound diagnoses (skin separation), n (%)	15 (0.48)	5 (0.38)	4 (0.78)	1 (0.47)	
Wound diagnoses (fascial dehiscence), n (%)	6 (0.19)	5 (0.38)	1 (0.20)	1 (0.47)	
Wound diagnoses (home health nurse), n (%)	12 (0.39)	5 (0.38)	3 (0.59)	3 (1.42)	
Endometritis, n (%)	58 (1.86)	12 (0.92)	3 (0.59)	1 (0.47)	

Abbreviations: CD, cesarean delivery; ICU, intensive care unit.
^ap-Values are based on one-sided Cochran–Armitage’s trend test.

After adjusting for confounders, there was no difference in rates of composite organ injury for women with one prior cesarean (adjusted odds ratio [aOR]: 2.04, confidence interval [CI]: 0.61, 6.78) (► **Table 3**). However, women with two

prior cesareans were almost seven times more likely to have organ injury (aOR: 6.97, CI: 2.04, 23.81), and those with three or more prior cesareans were more than eight times more likely to have injury (aOR: 8.58, CI: 1.94, 37.94). The risk of

Table 3 Risk of morbidity with increasing cesareans, multivariable analysis

Morbidity	Primary CD (N = 3,113)	1 repeat CD ^a (N = 1,310)		2 repeat CD ^a (N = 510)		≥3 repeat CD ^a (N = 211)	
	n (%)	n (%)	aOR	n (%)	aOR	n (%)	aOR
Composite organ injury ^b	7 (0.23)	5 (0.38)	2.04 (0.61, 6.78)	6 (1.18)	6.97 (2.04, 23.81)	3 (1.42)	8.58 (1.94, 37.94)
Hysterectomy ^c	25 (0.80)	20 (1.53)	1.80 (0.96, 3.35)	12 (2.35)	2.47 (1.14, 5.33)	14 (6.64)	7.94 (3.81, 16.53)
Hemorrhage requiring transfusion ^d	35 (1.12)	15 (1.15)	1.09 (0.56, 2.11)	3 (0.59)	0.60 (0.18, 2.05)	7 (3.32)	3.49 (1.44, 8.47)
Composite severe maternal morbidity ^c	35 (1.12)	8 (0.61)	0.55 (0.25, 1.24)	3 (0.59)	0.50 (0.15, 1.70)	2 (0.95)	0.80 (0.18, 3.49)
Composite surgical site complications ^c	147 (4.72)	66 (5.04)	0.99 (0.72, 1.36)	25 (4.90)	0.96 (0.60, 1.53)	18 (8.53)	1.78 (1.05, 3.03)

Abbreviations: aOR, adjusted odds ratio; CD, cesarean delivery.
^aReference group is primary cesarean.
^bAdjusted for labor.
^cAdjusted for obesity, maternal age older than 35 years, and labor.
^dAdjusted for obesity and labor.

hysterectomy was significantly higher for women with two prior cesareans (aOR: 2.47, CI: 1.14, 5.33), and increased to almost eightfold with three or more prior cesareans (aOR: 7.94, CI: 3.81, 16.53). Hemorrhage requiring transfusion was more than threefold more likely with three or more prior cesareans (aOR: 3.49, CI: 1.44, 8.47). There were no differences in the risk of composite severe maternal morbidity. Composite surgical site complications were only significantly increased in women with three or more prior cesareans (aOR: 1.78, CI: 1.05, 3.03).

In sensitivity analysis limited to women who did not labor prior to cesarean, the trend toward increasing organ injury and hysterectomy persisted with similar morbidity rates as in the total cohort. However, the difference in surgical site complications was not statistically significant.

Comment

We found that maternal morbidity increased with increasing number of cesarean deliveries. Women with two or more prior cesareans were at an increased risk of composite organ injury and hysterectomy at the time of cesarean. Women at the highest risk of hemorrhage requiring transfusion had three or more prior cesareans. The risk of composite surgical site complications was increased after three or more prior cesareans. Severe maternal morbidity was uncommon and not significantly different with increasing number of cesareans.

Our study highlights the significant risk of maternal morbidity with increasing number of cesareans. A study from 2006 showed that women undergoing elective repeat cesarean delivery were at an increased risk for placenta accreta, hysterectomy, organ injury, abnormal placentation, and maternal ICU admission, and their risk was directly related to the number of prior cesareans.⁵ This study shed light on the significant association among placenta previa, prior cesarean, and placenta accreta. However, it was limited to only women undergoing scheduled elective repeat deliveries without labor. Another study of 250 women with two or more prior cesareans undergoing an elective repeat showed a low overall complication rate in the absence of placenta previa. This study was descriptive in nature and lacked a comparison group.⁹ Another study performed in 500 women undergoing cesarean delivery evaluated maternal and neonatal morbidity and included unscheduled cesareans.⁶ This study found that there was an increase in bowel injuries, but no difference in several other outcomes including: bladder injury, need for blood transfusion, and wound infection. However, it was limited by the small sample size with only 95 and 53 cases with two prior and three prior cesareans, respectively, and the rate of bowel injury in the highest number cesarean group was significantly higher than previously reported literature (18.9%).⁶

Our study has several strengths. We included women undergoing a primary cesarean and those with cesarean following labor. These two groups have been excluded in prior work. We included these women to represent the entire population of women who have cesarean deliveries. Morbidity rates for all women could appropriately aid practitioners

in delivery counseling. Given that a failed trial of labor has been shown to impact maternal morbidity rates, we performed a sensitivity analysis in those without labor.¹⁰ Rates of maternal morbidity remained similar when excluding those with labor. In addition, our cohort includes a high rate of obese (64%) and morbidly obese (21%) women. Given that more than one-third of adults are obese, studies regarding perioperative complications of obese women undergoing repeat cesarean delivery are warranted.¹¹

Our study has limitations that should be considered. Given that the rates of severe maternal morbidity were low in our study, there is chance that we were not powered to detect differences in some maternal morbidities. The tertiary care referral center setting of the study may make our findings not necessarily generalizable to nonreferral hospitals. Also, given that our institution is an academic center where physicians in training are involved in the vast majority of cases, this study may not necessarily be generalizable to nonteaching institutions. We were also unable to account for the potential impact of individual physician skills on outcomes. Finally, information regarding intra-abdominal adhesions were not included in our study and have been found to be increased in repeat cesareans.^{6,12-14}

In conclusion, we provide comprehensive data on maternal morbidity associated with increasing number of cesarean deliveries. This is important to inform patients regarding the risks of surgery and aid providers in preoperative planning. Depending on the resources of a facility, consideration of referral to a tertiary care center may be appropriate for patients at the highest risk for morbidity at the time of cesarean.

Note

This study was presented as a poster presentation at the 37th Annual Meeting of the Society for Maternal-Fetal Medicine, January 23–28, 2017, Las Vegas, NV.

Ethical Approval

This study was conducted with the approval of the Institutional Review Board: IRB Approval no. 201404055.

Funding

This work was supported by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (R01HD061619, Principal Investigator Cahill) and Robert Wood Johnson Foundation (66329, Principal Investigator Cahill). The contents of this publication are solely the responsibility of the authors.

Conflict of Interest

None.

References

- Martin JA, Hamilton BE, Osterman MJ, Driscoll AK, Mathews TJ. Births: final data for 2015. *Natl Vital Stat Rep* 2017;66(01):1
- Menacker F, Declercq E, Macdorman MF. Cesarean delivery: background, trends, and epidemiology. *Semin Perinatol* 2006;30(05):235–241

- 3 Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Drake P. Births: final data for 2016. *Natl Vital Stat Rep* 2018;67(01):1–55
- 4 Caughey AB, Cahill AG, Guise JM, Rouse DJ; American College of Obstetricians and Gynecologists (College); Society for Maternal-Fetal Medicine. Safe prevention of the primary cesarean delivery. *Am J Obstet Gynecol* 2014;210(03):179–193
- 5 Silver RM, Landon MB, Rouse DJ, et al; National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. Maternal morbidity associated with multiple repeat cesarean deliveries. *Obstet Gynecol* 2006;107(06):1226–1232
- 6 Özcan S, Karayalçın R, Kanat Pektas M, et al. Multiple repeat cesarean delivery is associated with increased maternal morbidity irrespective of placenta accreta. *Eur Rev Med Pharmacol Sci* 2015;19(11):1959–1963
- 7 Smid MC, Vladutiu CJ, Dotters-Katz SK, Boggess KA, Manuck TA, Stamilio DM. Maternal obesity and major intraoperative complications during cesarean delivery. *Am J Obstet Gynecol* 2017;216(06):614.e1–614.e7
- 8 Obstetric Care Consensus No. 2: levels of maternal care. *Obstet Gynecol* 2015;125(02):502–515
- 9 Lynch CM, Kearney R, Turner MJ. Maternal morbidity after elective repeat caesarean section after two or more previous procedures. *Eur J Obstet Gynecol Reprod Biol* 2003;106(01):10–13
- 10 McMahon MJ, Luther ER, Bowes WA Jr, Olshan AF. Comparison of a trial of labor with an elective second cesarean section. *N Engl J Med* 1996;335(10):689–695
- 11 Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* 2014;311(08):806–814
- 12 Arlier S, Seyfettinoğlu S, Yılmaz E, et al. Incidence of adhesions and maternal and neonatal morbidity after repeat cesarean section. *Arch Gynecol Obstet* 2017;295(02):303–311
- 13 Clark EA, Silver RM. Long-term maternal morbidity associated with repeat cesarean delivery. *Am J Obstet Gynecol* 2011;205(06, Suppl):S2–S10
- 14 Morales KJ, Gordon MC, Bates GW Jr. Postcesarean delivery adhesions associated with delayed delivery of infant. *Am J Obstet Gynecol* 2007;196(05):461–466