Maternal and Newborn Outcomes after a Prior Cesarean Birth by Planned Mode of Delivery and History of Prior Vaginal Birth

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ABSTRACT

Background

As cesarean birth rates continue to rise, increasingly more women are faced with the choice to plan a vaginal or a repeat cesarean birth after a previous cesarean. In Canada fewer than 20% of women choose vaginal birth.

Methods

We undertook a population-based retrospective cohort study to compare the safety of planned vaginal vs. cesarean birth after 1-2 previous cesarean sections. We compared outcomes among women with none vs. at least one previous vaginal birth. We included singleton term births in British Columbia from 2000-2008. We estimated relative risks (RR) and their 95% Confidence Intervals (CI) for composite outcomes using Poisson regression.

Results

The composite risk for life threatening outcomes was elevated among women planning vaginal vs. cesarean birth both with and without a prior vaginal birth; RR 2.06, 95% CI (1.20-3.52) and 2.52, 95% CI (2.04-3.11). Absolute differences (attributable risk, AR) were 1.01% and 1.31% respectively. Non life-threatening outcomes were decreased among women planning a vaginal birth if they had had at least one prior vaginal delivery, RR 0.51, 95% CI (0.33-0.77), AR 1.17%. The composite risk of intrapartum stillbirth, neonatal death or life threatening neonatal outcomes did not differ among women planning vaginal vs. cesarean birth with a prior vaginal delivery and non-life threatening neonatal outcomes were decreased , RR 0.67, 95% CI (0.52-0.86), AR 1.92%.

Interpretation

The association between planned mode of delivery and adverse outcomes after 1 or 2 previous cesarean section is modified by history of prior vaginal birth. Absolute differences remain small.

Keywords

Hysterectomy, maternal mortality, perinatal mortality, previous cesarean section, uterine rupture, vaginal birth after cesarean section.

INTRODUCTION

As cesarean birth rates continue to rise, increasingly more women are faced with the choice to plan a vaginal or cesarean birth after a previous cesarean delivery. Current clinical practice guidelines in Canada recommend that planned vaginal birth be offered to women with one previous transverse low-segment cesarean and no contraindications, provided that discussions of maternal and perinatal risks and benefits have taken place.[1] Similar guidelines were issued by the US National Institute of Health following a consensus conference in 2010.[2] Lack of adherence to these guidelines continues, partly due to increasing fear of litigation on the part of physicians.[3,4] In 2011 the Canadian cesarean section rate reached 27.1%.[5] Among women with a previous cesarean delivery the rate of repeat cesarean deliveries in Canada was 81.7%.[6]

Recent comparisons of elective repeat cesarean section with planned vaginal birth have reported inconsistent findings.[7-10] A Canadian study of over 300,000 women comparing elective repeat cesarean section versus planned vaginal birth reported a two-fold elevated risk for uterine rupture, 0.65 vs. 0.25 per 100,000, adjusted odds ratio (OR) 2.38, (95% CI 2.12-2.67) among women planning vaginal birth.[8] A study of 6,500 women with both a prior vaginal and cesarean birth in the United States reported lower composite major morbidity (uterine rupture, uterine artery laceration, bladder injury, or bowel injury) among women planning vaginal birth compared to elective repeat cesarean delivery, OR 0.32, (95% CI 0.14-0.72).[11] A systematic review of 12 cohort studies and 402,883 patients reported a three-fold reduction in maternal mortality among women undergoing planned vaginal birth RR 0.33, (95% CI 0.13-0.88) and higher perinatal mortality RR 1.82, (95% CI 1.24-2.67).[12] A prospective multicentre study by Landon et al. in the US [13] reported that rates of maternal death, hysterectomy, and thromboembolic disease did not differ, but uterine dehiscence OR 1.38, (95% CI 1.04 – 1.85), blood transfusion OR 1.71, (95% CI 1.41 – 2.08), and endometritis OR 1.62, (95% CI 1.40-1.87) occurred more frequently in the planned vaginal birth group. Uterine rupture occurred in 0.7% of planned vaginal

births and not at all among elective repeat cesarean births. There were no differences in rates of intrapartum stillbirth or neonatal death. A meta-analysis from Scotland with 313,238 subjects reported excess risk of perinatal death associated with planned vaginal birth, 12.9 vs. 1.1/10,000, OR 11.7, (95% CI 1.4-101.6).[14]

A few studies have evaluated a history of prior vaginal birth in moderating adverse maternal outcomes of birth after a cesarean section. A 1999-2002 study of 13,532 births in 19 medical centres in the US among women with at least one prior cesarean birth reported a significant decrease in the rate of uterine rupture for planned vaginal births after at least one prior vaginal birth.[15] Prior vaginal birth was associated with one fifth the risk of uterine rupture in a US hospital-based study reporting on 3783 births.[16] A third small hospital-based study (n=2,204) reported no difference in rates of uterine rupture.[17] We compared both maternal and perinatal outcomes according to history of prior vaginal birth in a population of women planning a vaginal vs. cesarean birth after a previous cesarean section.

METHODS

We conducted a retrospective cohort study with data from the British Columbia Perinatal Registry for 2000-2008. We analyzed birth outcomes among women with one or two prior cesarean births in order to reflect the experience of our population under study. In British Columbia (BC), 17.9% of women have more than two children.[18] We included women carrying a singleton fetus in cephalic presentation at term (37-41 completed weeks gestation). We excluded women with pregnancy induced hypertension, pre-existing diabetes, and cardiac disease.

Data for the 40,000 births that take place annually in BC in home or hospital are extracted from standardized birth records by trained health records staff. Additional diagnostic and procedural codes from the Canadian Institute of Health Information (CIHI) hospital discharge data are merged with the perinatal registry using unique personal identifiers. The data is compared to British Columbia Vital Statistics Agency data in order to ensure its completeness and accuracy.[19]

Outcomes were designated as life threatening or non-life threatening by a multidisciplinary group of obstetricians, pediatricians, anesthetists, nurses and midwives funded to apply methods in quality assurance to evaluate cesarean section rates in B.C.[20] Maternal outcomes categorized as life threatening included deep vein thrombosis, pulmonary embolism, amniotic embolism, uterine rupture, hysterectomy, surgery to control intrapartum or postpartum bleeding, receipt of blood transfusion, septic embolism, and pulmonary, cardiac, or central nervous system complications from anesthesia. Non-life threatening adverse outcomes included uterine dehiscence, surgical wound infection, puerperal infection or sepsis, and non-life threatening anesthesia complications, including failed or difficult intubation.

Fetal/neonatal outcomes were similarly categorized. Death or life threatening outcomes included intrapartum stillbirth, neonatal death, 5 minute Apgar score ≤ 3, admission to a neonatal intensive care unit, need for ventilation, diagnosis of hypoxic ischemic encephalopathy, or intraventricular hemorrhage. Non-life threatening outcomes included 5 minute Apgar score of 4-6, requirement for oxygen more than 24 hours, admission to an observation nursery, or birth trauma, including Erb's Palsy or other facial nerve injury, ocular damage, liver hematoma, or fracture of the clavicle, long bones, or skull. Infants with congenital anomalies were excluded from the analyses of neonatal outcomes.

Given the number of subjects in our study sample within strata of prior vaginal birth history, we had more than 80% power to detect an absolute difference of 1.0% in our composite outcomes (1.5% among non-life threatening maternal outcomes) from our baseline rates among the planned cesarean birth group, with a type one error of 0.05, two sided. Relative risks were calculated using Poisson regression with robust error variance.[21] We assessed sociodemographic and pregnancy-related characteristics for their role as confounders. We planned to retain variables in the final multivariate models if their sequential removal from the full multivariable model changed the estimates of relative

risks between planned mode of delivery and outcomes of interest by at least 10%. We report absolute differences (attributable risk, AR) in outcomes according to planned mode of delivery. We calculated number needed to treat (NNT) or harm (NNH) as the inverse of the AR. No adjustments were made for multiple comparisons. All analyses were carried out using SAS software version 9.3 (SAS Institute Inc., Cary, NC). Approval to conduct the study was obtained from the University of British Columbia Clinical Ethics Board.

RESULTS

We studied 33,812 women with either one or two prior cesarean births. Only 2% of all women in British Columbia who gave birth during the study period had more than two prior cesarean births. Among 28,406 women with no prior vaginal deliveries 7,614 (26.8%) planned a vaginal birth. Among these, 62.6% subsequently delivered vaginally. There were 5,406 women (16.0 %) who had a prior vaginal birth and of these, 3,726 (68.9%) planned a vaginal birth. Among these, 88.5% subsequently delivered vaginally. We excluded women for whom planned mode of delivery was not documented (n=41).

Women planning a vaginal birth were slightly younger and more likely to have normal or low body mass index than those planning a cesarean birth both with and without a prior vaginal delivery (Table 1). Single parent status, newborn birthweight, and size of the hospital where the birth took place did not differ between comparison groups. In our multivariate models, exclusion of each of these covariates did not alter the relative risk by 10% or more, and therefore we present unadjusted relative risks.

Maternal Outcomes

There were no maternal deaths. The composite risk of life threatening outcomes was significantly elevated among women planning vaginal vs. cesarean birth after no prior vaginal deliveries, RR 2.52, 95% CI (2.04-3.11) and after one or more previous vaginal deliveries, RR 2.06, (95% CI 1.20-

3.52) (Table 2). The ARs were 1.31% and 1.01% respectively. The NNH were 76 and 99, respectively, i.e. the number of women who would have to have a vaginal birth prior to the expectation of a life threatening outcome. The risk of uterine rupture was significantly elevated among women planning a vaginal vs. cesarean birth without a previous vaginal delivery RR 6.93, (95% CI 3.65-13.16), but not among those with a previous vaginal delivery. The risk of blood transfusion, RR 1.44, (95% CI 1.01-1.72) was similarly elevated only among women planning vaginal birth without a previous vaginal delivery. The risk of surgical intervention to control bleeding was significantly elevated among women planning vaginal birth with or without a prior vaginal delivery.

Non-life threatening maternal outcomes, compared in composite, did not differ among women planning vaginal vs. cesarean birth without a prior vaginal delivery and were decreased among women planning vaginal birth with a prior vaginal delivery, RR 0.51, (95% CI 0.33-0.77). The AR was -1.17%, with a NNT (with planned vaginal birth) of 85 to prevent a non-life-threatening outcome. Rates of uterine dehiscence were significantly increased among women planning vaginal birth without a previous vaginal delivery, RR 2.94, (95% CI 2.04-4.17) but not among women with a prior vaginal delivery. Rates of obstetrical wound infection and puerperal infection were significantly decreased among women planning vaginal birth regardless of whether or not they had a prior vaginal delivery.

Fetal/Neonatal Outcomes

The composite risk of intrapartum stillbirth, neonatal death or life threatening neonatal outcomes among neonates were significantly elevated among women planning vaginal versus cesarean birth after no prior vaginal delivery, RR 1.65, (95% CI 1.20-2.26), but not after a prior vaginal delivery (Table 3). The AR was 0.32%. The NNH was 312. The risk of 5 minute Apgar score ≤ 3, RR 8.85 (95% CI 2.89-27.14) and admission to a neonatal intensive care unit, RR 1.54, (95% CI 1.04-2.26) was elevated among newborns of women planning a vaginal birth without a prior vaginal delivery but not among those whose mothers had a prior vaginal delivery.

The composite risk of one or more non-life threatening neonatal outcomes was not different according to planned mode of birth among women with no previous vaginal deliveries and significantly decreased among women planning a vaginal birth with a previous vaginal delivery, RR 0.67, (95% CI 0.52-0.86). The AR was -1.92% and the NNT was 52. Rates of admission to an observation or step-down nursery were significantly decreased among newborns of women who planned vaginal birth as was the risk of requiring oxygen therapy for more than 24 hours regardless of history of vaginal delivery. The risk of a 5 minute Apgar score of 4-6 was increased for women planning a vaginal birth regardless of history of prior vaginal delivery. Birth trauma occurred more frequently among neonates born to women who planned vaginal birth with no prior vaginal delivery RR 3.94, 95% CI (2.16-7.18) but not among women with a prior vaginal delivery.

Given that 87% of women in our sample had only one previous cesarean birth, we analyzed outcomes for this subset (Tables 4 and 5). The direction and size of differences for each outcome group according to planned mode of delivery was similar to those for the entire sample.

INTERPRETATION

The association between planned mode of delivery and adverse outcomes after one or two previous cesarean births may be modified by history of prior vaginal birth. Life threatening maternal outcomes overall were more common among women planning vaginal vs cesarean birth regardless of history of prior vaginal delivery but the risk of uterine rupture and requirement for blood transfusion were each elevated only among women without a previous vaginal delivery. Non-life threatening maternal outcomes, compared in composite, were decreased only among women with a prior vaginal delivery, as were rates of uterine dehiscence. The risk of death or life threatening neonatal outcomes overall were significantly elevated only among women who had not had a prior vaginal delivery. The same was true for individual outcomes of 5 minute Apgar score ≤ 3 and admission to a neonatal

intensive care unit. The risk of non-life threatening outcomes among neonates was significantly decreased only among women with a previous vaginal delivery. Differences in relative risks according to number of previous cesarean births (1 vs. 1-2) were negligible.

Mercer and colleagues, reporting on singleton pregnancies after one or more previous cesareans, found comparable decreases in morbidity associated with planned vaginal birth after none vs. one or more prior vaginal deliveries.[15] The rates of uterine rupture were 0.87% vs. 0.45% compared to ours of 0.43% vs. 0.19%. Corresponding rates of hypoxemic ischemic encephalopathy were 0.17% and 0.07%, higher than our rates. In this study women were included if their prior vaginal birth took place after a previous cesarean and the birth took place in one of 19 participating academic medical centres. From a single centre, Zelop et al. reported rates of uterine rupture among planned vaginal births of 1.1% without prior vaginal delivery and 0.2% with prior vaginal delivery, midway between the Mercer study and our study. [16]

A study from a Montreal academic teaching hospital of women with previous cesarean births planning a vaginal birth (n=2,204), reported rates of uterine rupture of 1.5% and 0.5% according to history of no prior vs. prior vaginal delivery.[17] Rates of uterine dehiscence were 5.35% and 2.8%, considerably higher than our rates of 0.81% and 0.48%.

Our results are comparable to those of Cahill and colleagues who conducted a retrospective study among 17 medical centres.[11] Similar to our study, rates of a composite maternal outcome incorporating uterine rupture, uterine artery laceration and bladder and bowel injuries were twice as high (2.84% vs.1.07%) among women with none vs. one or more prior vaginal births. In the Cahill study rates of uterine rupture were 1.94% and 0.40% compared to our corresponding rates of 0.43% and 0.19%.

Our findings are limited by our retrospective design in which we rely on the coding protocols used by health records staff, which in turn rely on diagnoses charted by caregivers who may not use

consistent standards for differentiating, for example, uterine rupture from dehiscence. However, we have no reason to believe that documentation would differ by exposure groups. Further, use of composite measures limits comparison among studies, but we included comparisons of individual outcomes as well. We anticipate that women want to know the risk of any serious outcome versus a series of comparisons for individual outcomes.

Decision-making regarding planned mode of delivery after a prior cesarean birth is complex. In consideration of safety, advantage may be attributed to planned vaginal or repeat cesarean birth depending on whether one is assessing maternal or neonatal outcomes, the level of morbidity involved and the nature of the outcomes. Our data may encourage the development of decision aids that weight women's values for safety for different categories of outcomes. Our data offer women and their caregivers the opportunity to consider risk profiles separately for women who have and have not had a prior vaginal delivery. A consistent finding across comparisons is that absolute risk differences remain small, at most 2%, whereas ratio measures demonstrate increases as high as nine-fold. We encourage the inclusion of absolute measures of risk in patient counselling to provide more interpretable comparisons.[22]

Table 1. Characteristics of women according to number of prior vaginal deliveries and planned mode of birth. .

	0 Previous Vaginal Births		≥ 1 Previous Vaginal Births	
	Planned vaginal n=7,614	Planned CS n=20,792	Planned vaginal n=3,726	Planned CS n=1,680
	n (%)	n (%)	n (%)	n (%)
Maternal Age				
< 20	62 (0.8)	102 (0.5)	10 (0.3)	0 (0.0)
20-24	692 (9.1)	1514 (7.3)	207 (5.5)	76 (4.5)
25-29	1935 (25.4)	4513 (21.7)	887 (23.8)	365 (21.7)
30-34	3001 (39.4)	7725 (37.1)	1329 (35.7)	604 (36.0)
35-39	1688 (22.2)	5669 (27.3)	1013 (27.2)	474 (28.2)
40-55	236 (3.1)	1269 (6.1)	280 (7.5)	161 (9.6)
Body Mass Index				
Normal/Under	3703 (65.9)	7419 (57.5)	1504 (60.8)	514 (53.5)
Overweight	1290 (22.9)	3162 (24.5)	568 (23.0)	244 (25.4)
Obese	630 (11.2)	2327 (18.0)	401 (16.2)	202 (21.0)
Unknown	1991	7884	1253	720
Previous Cesareans				
1	7504 (98.5)	16913 (81.3)	3623 (97.2)	1406 (83.7)
2	110 (1.4)	3879 (18.7)	103 (2.8)	274 (16.3)
Augmentation of Labour				
Oxytocin	1171 (15.4)	0	368 (9.9)	0
Induction of Labour				
Oxytocin	609 (8.0)	0	350 (9.4)	0
Prostaglandin	283 (3.7)	0	175 (4.7)	0
Both	54 (0.7)	0	19 (0.5)	0
Hospital Size				
1-49 Births/Year	23 (0.3)	108 (0.5)	18 (0.5)	11 (0.7)
50-249 Births/Year	480 (6.4)	1289 (6.2)	303 (8.2)	125 (7.5)
250-999 Births/Year	1293 (17.1)	3069 (14.8)	784 (21.3)	322 (19.2)
1000-2499 Births/Year	2199 (29.1)	6827 (32.9)	1097 (29.8)	514 (30.6)
> 2500 Births/Year	3530 (46.7)	9449 (45.6)	1453 (39.4)	705 (42.0)
Home Birth	33 (0.4)	0	28 (0.8)	0
Single Parent	178 (2.6)	560 (3.0)	123 (3.7)	54 (3.6)
Birth Weight, grams, mean (sd)	3552 (463)	3500 (450)	3584 (493)	3501 (487)

Table 2. Maternal outcomes after 1-2 previous cesarean by planned mode of delivery and number of previous vaginal births.

	0 Previous Vaginal Deliveries						≥ 1 Previous Vaginal Deliveries					
	Planned Vaginal (n=7,614)		Planned CS (n=20,792)				Planned Vaginal (n=3,726)		Planned CS (n=1,680)			
	n	%	n	%	RR	95% CI	n	%	n	%	RR	95% CI
Life Threatening Maternal Outcomes or Death												
Maternal Death	0	0.00	0	0.00	--	--	0	0.00	0	0.00	--	--
Uterine Rupture	33	0.43	13	0.06	6.93	3.65 - 13.16	7	0.19	1	0.06	3.16	0.39 - 25.63
Hemorrhage requiring Blood Transfusion	46	0.60	87	0.42	1.44	1.01 - 2.06	19	0.51	12	0.71	0.71	0.35 - 1.47
Surgical Control of Bleeding[1]	89	1.17	45	0.22	5.40	3.78 - 7.72	51	1.37	3	0.18	7.67	2.40 - 24.52
Hysterectomy	2	0.03	23	0.11	0.24	0.06 - 1.01	1	0.03	1	0.06	0.45	0.03 - 7.20
Complications of Anaesthesia[2]	3	0.04	11	0.05	0.74	0.21 - 2.67	1	0.03	0	0.00	--	--
Deep Vein Thrombosis	0	0.00	5	0.02	--	--	0	0.00	0	0.00	--	--
Pulmonary Embolism	0	0.00	3	0.01	--	--	0	0.00	0	0.00	--	--
Obstetric Septic Embolism	0	0.00	1	0.00	--	--	0	0.00	0	0.00	--	--
Amniotic Embolism	0	0.00	1	0.00	--	--	0	0.00	0	0.00	--	--
≥ 1 Life Threatening Outcome	165	2.17	179	0.86	2.52	2.04 - 3.11	73	1.96	16	0.95	2.06	1.20 - 3.52
Non-life Threatening Maternal Outcomes												
Uterine Dehiscence	62	0.81	58	0.28	2.94	2.04 - 4.17	18	0.48	7	0.42	1.16	0.49 - 2.77
Complications of Anaesthesia[3]	43	0.56	115	0.55	1.02	0.72 - 1.45	9	0.24	1	0.06	4.06	0.51 - 32.00
Obstetric Surgical Wound Infection	50	0.66	252	1.21	0.54	0.40 - 0.73	17	0.46	29	1.73	0.26	0.15 - 0.48
Puerperal Infection	19	0.25	133	0.64	0.39	0.24 - 0.63	8	0.21	15	0.89	0.24	0.10 - 0.57
Puerperal Sepsis	9	0.12	23	0.11	1.07	0.49 - 2.31	1	0.03	3	0.18	0.15	0.02 - 1.44
≥ 1 Non-life Threatening Outcome	159	2.09	439	2.11	0.99	0.82 - 1.18	45	1.21	40	2.38	0.51	0.33 - 0.77

[1] Surgical control of bleeding uterus and surrounding structures, or dilation and curettage following delivery.
[2] Pulmonary, cardiac or central nervous system complications of anesthesia including aspiration pneumonitis, toxic reaction to anesthesia and failed or difficult intubation.
[3] Spinal and epidural induced headache, other, and unspecified complications of anesthesia.

Table 3. Neonatal outcomes after 1-2 previous cesarean section by planned mode of delivery and number of previous vaginal births.[1]

	0 Previous Vaginal Deliveries						≥ 1 Previous Vaginal Deliveries					
	Planned Vaginal (n=7,417)		Planned CS (n=20,212)				Planned Vaginal (n=1,639)		Planned CS (n=3,634)			
	n	%	n	%	RR	95% CI	n	%	n	95% CI	RR	CI
Life Threatening Fetal/Neonatal Outcomes or Death												
Intrapartum Stillbirth	2	0.03	0	0.00	--	--	0	0.00	0	0.00	--	--
Death at ≤ 7 Days	3	0.04	2	0.01	4.09	0.68 - 24.46	0	0.00	0	0.00	--	--
Death at 8-28 Days	0	0.00	6	0.03	--	--	0	0.00	0	0.00	--	--
Admission to Level III NICU[2]	40	0.54	71	0.35	1.54	1.04 - 2.26	8	0.22	8	0.49	0.45	0.17 - 1.20
Ventilation Required	18	0.24	34	0.17	1.40	0.79 - 2.47	6	0.17	6	0.37	0.45	0.15 - 1.40
5 Minute Apgar ≤ 3	13	0.15	3	0.02	8.85	2.89 – 27.14	1	0.03	0	0.00	--	--
Hypoxic Ischemic Encephalopathy	1	0.01	0	0.00	--	--	0	0.00	0	0.00	--	--
Intraventricular Hemorrhage	0	0.00	0	0.00	--	--	0	0.00	0	0.00	--	--
≥ 1 Life Threatening Outcome	61	0.82	100	0.50	1.65	1.20 - 2.26	14	0.39	11	0.67	0.57	0.26 - 1.26
Non-life Threatening Neonatal Outcomes												
Admission to Level II NICU[3]	238	3.21	772	3.82	0.84	0.73 – 0.97	96	2.64	84	5.13	0.52	0.39 - 0.69
> 24 Hours of Oxygen Required	30	0.40	129	0.64	0.63	0.43 - 0.94	10	0.28	13	0.79	0.35	0.15 - 0.79
5 Minute Apgar of 4-6	81	1.09	45	0.22	4.90	3.41 – 7.05	30	0.83	5	0.31	2.70	1.05 – 6.95
Birth Trauma	26	0.35	18	0.09	3.94	2.16 - 7.18	18	0.50	3	0.18	2.71	0.80 - 9.17
≥ 1 Non-life Threatening Outcome	333	4.49	887	4.39	1.02	0.90 - 1.16	143	3.94	96	5.86	0.67	0.52 - 0.86

[1] Excludes infants with congenital anomalies.
[2] Baby has high acuity, or is at risk of high acuity, and requires multispecialty care
[3] Baby requires increased observation and acute management

Table 4. Maternal outcomes after 1 previous cesareans by planned mode of delivery and number of previous vaginal births.

	0 Previous Vaginal Deliveries						≥ 1 Previous Vaginal Deliveries					
	Planned Vaginal (n=7,504)		Planned CS (n=16,913)				Planned Vaginal (n=3,623)		Planned CS (n=1,406)			
	n	%	n	%	RR	CI	n	%	n	%	RR	CI
Life Threatening Maternal Outcomes or Death												
Maternal Death	0	0.00	0	0.00	--	--	0	0.00	0	0.00	--	--
Uterine Rupture	32	0.43	11	0.07	6.56	3.31 - 13.00	6	0.17	1	0.07	2.33	0.28 - 19.32
Blood Transfusion	46	0.61	73	0.43	1.42	0.98 - 2.05	17	0.47	10	0.71	0.66	0.30 - 1.44
Surgical Control of Bleeding[1]	88	1.17	34	0.20	5.83	3.93 - 8.66	51	1.41	2	0.14	9.90	2.42 – 40.59
Hysterectomy	2	0.03	19	0.11	0.24	0.06 - 1.02	1	0.03	1	0.07	0.39	0.02 - 6.20
Complications of Anaesthesia[2]	2	0.03	10	0.06	0.45	0.10 - 2.06	1	0.03	0	0.00	--	--
Deep Vein Thrombosis	0	0.00	2	0.01	--	--	0	0.00	0	0.00	--	--
Pulmonary Embolism	0	0.00	2	0.01	--	--	0	0.00	0	0.00	--	--
Obstetric Pyaemic or Septic Embolism	0	0.00	1	0.01	--	--	0	0.00	0	0.00	--	--
Amniotic Embolism	0	0.00	0	0.00	--	--	0	0.00	0	0.00	--	--
≥ 1 Life Threatening Outcome	162	2.16	142	0.84	2.57	2.06 - 3.22	70	1.93	13	0.92	2.09	1.16 - 3.76
Non-life Threatening Maternal Outcomes												
Uterine Dehiscence	61	0.81	38	0.22	3.62	2.42 - 5.42	16	0.44	2	0.21	2.07	0.60 - 7.09
Complications of Anaesthesia[3]	43	0.57	86	0.51	1.13	0.78 - 1.63	9	0.25	1	0.07	3.49	0.44 - 27.54
Obstetric Surgical Wound Infection	46	0.61	196	1.16	0.53	0.38 - 0.73	17	0.47	24	1.71	0.27	0.15 - 0.51
Puerperal Infection	17	0.23	113	0.67	0.34	0.20 - 0.56	8	0.22	13	0.92	0.24	0.10 - 0.57
Puerperal Sepsis	9	0.12	20	0.12	1.01	0.46 - 2.23	1	0.03	3	0.21	0.13	0.01 – 1.24
≥ 1 Non-life Threatening Outcome	154	2.05	332	1.96	1.05	0.87 - 1.26	43	1.19	31	2.20	0.54	0.34 - 0.85

[1] Surgical control of bleeding uterus and surrounding structures, or dilation and curettage following delivery.

[2] Pulmonary, cardiac or central nervous system complications of anesthesia including aspiration pneumonitis, toxic reaction to anesthesia and failed or difficult intubation.

[3] Spinal and epidural induced headache, other, and unspecified complications of anesthesia.

Table 5. Neonatal outcomes after 1 previous cesarean section by planned mode of delivery and number of previous vaginal births.[1]

	0 Previous Vaginal Deliveries						≥ 1 Previous Vaginal Deliveries					
	Planned Vaginal (n=7,310)		Planned CS (n=16,442)				Planned Vaginal (n=3,533)		Planned CS (n=1,374)			
	n	%	n	%	RR	95% CI	n	%	n	%	RR	95% CI
Life Threatening Neonatal Outcomes or Death												
Intrapartum Stillbirth	2	0.03	0	0.00	--	--	0	0.00	0	0.00	--	--
Death at ≤ 7 Days	3	0.04	2	0.01	3.37	0.56 - 20.19	0	0.00	0	0.00	--	--
Death at 8-28 Days	0	0.00	5	0.03	--	--	0	0.00	0	0.00	--	--
Admission to Level III NICU[2]	40	0.55	59	0.36	1.52	1.02 - 2.28	7	0.20	8	0.58	0.34	0.12 - 0.94
Ventilation Required	18	0.25	26	0.16	1.56	0.85 - 2.84	6	0.17	5	0.36	0.47	0.14 - 1.53
5 Minute Apgar ≤ 3	13	0.18	4	0.02	7.31	2.38 – 22.41	1	0.03	0	0.00	--	--
Hypoxic Ischemic Encephalopathy	1	0.01	0	0.00	--	--	0	0.00	0	0.00	--	--
Intraventricular Hemorrhage	0	0.00	0	0.00	--	--	0	0.00	0	0.00	--	--
≥ 1 Life Threatening Outcome	61	0.83	83	0.50	1.65	1.19 - 2.30	13	0.37	10	0.73	0.51	0.22 - 1.15
Non-life Threatening Neonatal Outcomes												
Admission to Level II NICU[3]	234	3.20	624	3.79	0.84	0.73 – 0.98	93	2.63	71	5.17	0.51	0.38 - 0.69
> 24 Hours of Oxygen Required	29	0.40	93	0.57	0.70	0.46 - 1.06	9	0.25	13	0.95	0.27	0.12 - 0.63
5 Minute Apgar of 4-6	79	1.08	37	0.22	4.80	3.25 – 7.09	30	0.85	3	0.22	3.89	1.19 - 12.72
Birth Trauma	26	0.35	14	0.09	4.18	2.18 – 7.99	18	0.51	1	0.07	7.00	0.94 - 52.39
≥ 1 Non-life Threatening Outcome	326	4.46	713	4.34	1.03	0.90 - 1.17	139	3.93	81	5.90	0.67	0.51 - 0.87

[1] Excludes infants with congenital anomalies

[2] Baby has high acuity, or is at risk of high acuity, and requires multispecialty care

[3] Baby requires increased observation and acute management

CONTRIBUTIONS

C. Bickford conceived the design of the study. P. Janssen acquired the data from Perinatal Services BC. and contributed substantively to the design. C. Bickford was the primary data analyst. C. Bickford wrote the first draft of the article and both authors participated in the revisions and have read and approved the final version. Both have agreed to act as a guarantor of the work.

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