

# Neonatal outcomes associated with mode of subsequent birth after a previous caesarean section in a first pregnancy: a Swedish population-based register study between 1999 and 2015

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## ABSTRACT

**Objective** To investigate neonatal outcomes within 28 days in the subsequent birth in women who gave birth to their first baby by caesarean section (CS).

**Design and setting** National retrospective population-based register study. A cohort of 94 451 neonates who were born in Sweden between 1999 and 2015 as a second child to a mother who had her first birth by emergency or planned caesarean.

**Methods** Data were retrieved from the national registers held by Statistics Sweden and the National Board of Health and Welfare. Logistic regression was used to calculate unadjusted and adjusted ORs (aOR) with 95% CIs for each outcome.

**Main outcome measures** Neonatal infection, neonatal asphyxia/respiratory distress, neonatal hospital care and neonatal death within 28 days.

**Results** Emergency CS and instrumental vaginal birth were associated with a doubled risk of neonatal infection (aOR 2.0) and planned CS with a decreased risk (aOR 0.7) compared with spontaneous vaginal birth. Compared with spontaneous vaginal birth, an increased risk of birth asphyxia and/or respiratory distress was identified with all other modes of birth (aOR 2.2–3.2). Emergency CS and instrumental vaginal birth, but not planned CS, were associated with neonatal hospital care (aOR 1.8 and 1.7) and an increased mortality rate during the neonatal period (aOR 2.9 and 3.2), compared with spontaneous vaginal birth.

**Conclusions** In childbirth following a previous birth by CS, spontaneous vaginal birth appears to confer better neonatal outcomes within 28 days after birth overall than other modes of birth.

## INTRODUCTION

The rate of caesarean section (CS), which is rising in many countries, is of general concern due to the increased risk of associated maternal mortality and morbidity.<sup>1</sup> Repeat CS has been noted as a common factor attributing to the increased CS rate.<sup>2</sup> Although Sweden has a low CS rate, it has increased

### WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Caesarean section (CS) rates are rising in many countries.
- ⇒ Repeat planned CS is common after previous CS.
- ⇒ A planned vaginal birth after previous CS may result in an emergency CS and risk of worse neonatal outcomes.

### WHAT THIS STUDY ADDS

- ⇒ Spontaneous vaginal birth after previous CS was related to lower risk of neonatal asphyxia and/or respiratory distress when compared with any other mode of birth.
- ⇒ Spontaneous vaginal birth after previous CS was related to a lower risk of neonatal hospital care when compared with instrumental vaginal or emergency CS birth.
- ⇒ Spontaneous vaginal birth after previous CS was related to a lower risk of neonatal death when compared with instrumental vaginal or emergency CS birth.

### HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Vaginal birth may be recommended as a safe option after previous CS.

from 5% in the early 1970s to 17.9% in 2020.<sup>3</sup> During 2020, 27% of all CS in Sweden was a repeat CS.<sup>4</sup>

In pregnancies subsequent to a CS birth, the possibility for repeat planned CS or a planned vaginal birth after caesarean (VBAC) must be considered by women and clinicians (midwives and obstetricians).<sup>5</sup> A systematic review and a meta-analysis from 2010<sup>6</sup> demonstrated that risk of maternal mortality (relative risk (RR) 0.33, 95% CI 0.13 to 0.88) was decreased if a woman had a planned VBAC compared with a planned repeat CS. On the other hand, perinatal mortality increased in

cases of planned VBAC compared with planned repeat CS, although absolute rates were low (0.13% compared with 0.05%).<sup>6</sup> The increased risk of perinatal morbidity and mortality is greater among women who attempt a VBAC but ultimately have an emergency CS.<sup>5</sup> These findings complicate the decision-making process as women and clinicians attempt to balance the risks and benefits involved for both the mother and the baby.<sup>6</sup>

A Swedish population-based registry study<sup>7</sup> investigated vitality (Apgar score <7 at 5 min after birth) and mortality of the neonate in women who had a VBAC following a previous CS birth compared with women who had undergone vaginal birth only. The study found increased risks for low Apgar score and/or neonatal death in the neonates of women who had a previous CS. An increased frequency of unexplained stillbirth has also been found in women who have previously undergone CS.<sup>8</sup> It is thus important to consider neonatal risks in future studies exploring outcomes associated with VBAC, and while some studies have investigated this few studies have been carried out in countries with low CS and high VBAC rates such as Sweden and the Scandinavian countries.<sup>7 9 10</sup> The aim of this study was to investigate neonatal outcomes within 28 days in women's subsequent birth to a first birth that was a CS in Sweden between the years of 1999 and 2015.

## METHODS

### Study design

A large nationwide population-based retrospective study based on data from national registers held by Statistics Sweden and the National Board of Health and Welfare; the Swedish Medical Birth Register, the Swedish National Patient Register and the Cause of Death Register. A unique 10-digit Personal Identification Number (PIN) assigned for all residents at birth or at immigration was used to link information from these registers.

### Study population

The study population included all second birth neonates during the study period 1999–2015 of women who underwent a planned or emergency CS birth with their first baby. For inclusion, both births must have occurred in Sweden.

### Outcomes

Outcome variables included neonatal infection (International Classification of Diseases 10th Revision (ICD-10) codes P35-P39); asphyxia and/or respiratory distress (ICD-10 codes P20-P29); admission to neonatal hospital care and neonatal death (all causes). Diagnoses included in the code ranges for neonatal infection and asphyxia and/or respiratory distress are shown in table 1. All outcomes were measured within 28 days after birth.

### Statistical analysis/data management

Each individual is identified with a unique PIN in the registers. This PIN was replaced by a running number

**Table 1** Range of used diagnose codes

<b>Neonatal infection (infections specific to the perinatal period) (ICD-10 codes P35-P39)</b>	
P35	Congenital viral diseases
P36	Bacterial sepsis of newborn
P37	Other congenital infectious and parasitic diseases
P38	Omphalitis of newborn
P39	Other infections specific to the perinatal period
<b>Asphyxia and/or respiratory distress (ICD-10 codes P20-P29)</b>	
P20	Intrauterine hypoxia
P21	Asphyxia at birth
P22	Respiratory distress of newborn
P23	Congenital pneumonia
P24	Neonatal aspiration
P25	Interstitial emphysema and related conditions originating in the perinatal period
P26	Pulmonary haemorrhage originating in the perinatal period
P27	Chronic respiratory disease originating in the perinatal period
P28	Other respiratory conditions originating in the perinatal period
P29	Cardiovascular disorders originating in the perinatal period
ICD-10, International Classification of Diseases 10th Revision.	

(LopNr) by the registers before sending data to the study team. The key file denoting the correspondence between PIN and LopNr is held at Statistics Sweden, and therefore the data file we received was anonymous. We linked data from different registers by using the LopNr provided. We identified the mode of birth from the information in the Swedish Medical Birth Register. We calculated the number of cases and the percentage in each mode of birth category and for each outcome. Logistic models were adopted to calculate the ORs with 95% CIs using spontaneous vaginal birth as the reference group. Unadjusted and adjusted ORs (aORs) were calculated for each outcome. Adjustments included the maternal factors of age, smoking, diabetes (type I and type II), body mass index (BMI), psychological/mental disorder and neonatal prematurity (up to week 36+6). There were no missing data on maternal age, maternal BMI, maternal psychiatric care, mode of birth, neonatal infection, neonatal asphyxia and/or respiratory distress, neonatal hospital care and neonatal death within 28 days due to use of national registers. Missing data for variables used in the adjusted analyses: maternal smoking (5.3% missing), maternal diabetes (1.5% missing) and for prematurity up to week 36+6 (0.04% missing). Data management and statistical analyses were performed using STATA V.16 (StataCorp, Texas, USA).

**Table 2** Adjustment variables per outcome variable versus mode of birth in the study population, n=94 451

	Vaginal spontaneous	Vacuum/Forceps	Planned CS	Emergency CS	Total
Count, n (%)	34 007 (36.0)	8076 (8.55)	30 326 (32.1)	22 042 (23.3)	94 451 (100)
<b>Outcomes</b>					
Neonatal infection, n (%)	277 (0.81)	111 (1.37)	129 (0.43)	504 (2.29)	1021 (1.08)
Asphyxia and/or respiratory distress, n (%)	776 (2.28)	406 (5.03)	1262 (4.16)	2159 (9.79)	4603 (4.87)
Neonatal care/hospital care, n (%)	3070 (9.03)	1057 (13.09)	3280 (10.82)	4615 (20.94)	12 022 (12.73)
Neonatal death, n (%)	33 (0.1)	14 (0.17)	29 (0.1)	114 (0.52)	190 (0.2)
<b>Maternal conditions</b>					
Age, mean (SD)	31.11 (4.44)	32.07 (4.29)	32.78 (4.72)	32.23 (4.58)	31.99 (4.61)
Smoking, n (%)	1892 (5.85)	380 (4.94)	1773 (6.18)	1261 (6.07)	5306 (5.93)
Diabetes, n (%)	192 (0.56)	92 (1.14)	647 (2.13)	507 (2.3)	1438 (1.52)
BMI $\geq$ 30, n (%)	7199 (21.17)	1575 (19.5)	7649 (25.22)	6443 (29.23)	22 866 (24.21)
Mental illness, n (%)	269 (0.79)	75 (0.93)	515 (1.7)	282 (1.28)	1141 (1.21)
<b>Neonatal condition</b>					
Prematurity, n (%)	1378 (4.05)	238 (2.95)	800 (2.64)	3055 (13.87)	5471 (5.79)

BMI, body mass index; CS, caesarean section.

### Patient and public involvement

Neither patients nor the public were involved in the study design.

### RESULTS

During the study period, 1999–2015, the total number of babies born was 1 774 984. Of these births, 94 451 neonates were born in Sweden as a second child to a woman who had a CS birth with her first child. Proportionately, the mode of birth of these 94 451 neonates was: 36% spontaneous vaginal birth, 8.6% instrumental vaginal birth and 55.4% second CS (planned or emergency) (table 2).

The results of logistic models are presented in table 3. Compared with spontaneous vaginal birth, the associated risk for neonatal infection within 28 days of birth was lower after planned CS but higher after instrumental vaginal birth and after emergency CS. An increased risk for asphyxia and/or respiratory distress was associated with instrumental vaginal birth and all CS (planned CS and emergency CS) compared with spontaneous vaginal birth. Neonatal care/hospital care within 28 days was significantly increased in neonates of women who had an instrumental vaginal birth and any category of CS (planned CS and emergency CS). Increased neonatal death within 28 days after emergency CS and instrumental vaginal birth compared with spontaneous vaginal birth was found, but planned CS was not associated with an altered risk for neonatal death.

In the adjusted model, emergency CS and instrumental vaginal birth were associated with significantly increased risk of neonatal infection, neonatal hospital

care and neonatal death within 28 days, compared with spontaneous vaginal birth. Planned CS was associated with a significantly decreased risk of neonatal infection, compared with spontaneous vaginal birth. Compared with spontaneous vaginal birth, significantly increased risk of birth asphyxia and/or respiratory distress was identified with all other modes of birth. In the adjusted model, only those with complete information on all of the adjustment variables were included in the analysis (n=89 477).

### DISCUSSION

The present study showed that spontaneous vaginal birth after previous CS was associated with an increased risk of the combined outcome of asphyxia and/or respiratory distress when compared with any other mode of birth. Furthermore, the study showed that spontaneous vaginal birth was associated with a lower risk of neonatal hospital care and neonatal death within 28 days when compared with instrumental vaginal birth and emergency CS.

There was an increased risk for neonatal infection (P35-P39, ICD-10 codes) after instrumental vaginal birth and emergency CS, and a decreased risk after planned CS, compared with spontaneous vaginal birth. It might be reasonable to assume that an increased infection risk after emergency CS<sup>11</sup> and instrumental vaginal birth could be related to the indication for the procedure, for example, the occurrence of an infection in the fetus or labour that has been prolonged, as well as the procedure itself.

**Table 3** Adverse neonatal outcomes associated with second mode of birth in women who had a CS first birth

Outcome		Unadjusted OR (95% CI)	Adjusted OR (95% CI)	P value adjusted OR
Neonatal infection within 28 days N=93 430	Vaginal spontaneous	Reference	Reference	
	Vacuum/Forceps	1.70 (1.36 to 2.12)	2.00 (1.58 to 2.53)	<0.001
	Planned CS	0.52 (0.42 to 0.64)	0.68 (0.53 to 0.86)	0.002
	Emergency CS	2.85 (2.46 to 3.30)	2.03 (1.71 to 2.40)	<0.001
Asphyxia and/or respiratory distress N=89 848	Vaginal spontaneous	Reference	Reference	
	Vacuum/Forceps	2.27 (2.01 to 2.56)	2.74 (2.39 to 3.13)	<0.001
	Planned CS	1.86 (1.70 to 2.04)	2.16 (1.93 to 2.41)	<0.001
	Emergency CS	4.65 (4.28 to 5.06)	3.24 (2.94 to 3.57)	<0.001
Neonatal care/hospital care within 28 days N=82 429	Vaginal spontaneous	Reference	Reference	
	Vacuum/Forceps	1.52 (1.41 to 1.63)	1.70 (1.57 to 1.84)	<0.001
	Planned CS	1.22 (1.16 to 1.29)	1.02 (0.95 to 1.08)	0.603
	Emergency CS	2.67 (2.54 to 2.80)	1.79 (1.69 to 1.90)	<0.001
Neonatal death within 28 days N=94 261	Vaginal spontaneous	Reference	Reference	
	Vacuum/Forceps	1.79 (0.96 to 3.34)	3.15 (1.55 to 6.39)	0.001
	Planned CS	0.99 (0.60 to 1.62)	1.73 (0.94 to 3.19)	0.077
	Emergency CS	5.35 (3.63 to 7.89)	2.88 (1.82 to 4.57)	<0.001

OR was obtained by logistic models. Both unadjusted and adjusted results are presented. P value of adjusted model is presented. Adjusted OR: adjustments were made for mother's age, smoking, diabetes, BMI, mental illness and prematurity (up to week 36+6) in all adjusted models.  
BMI, body mass index; CS, caesarean section.

During the time period, prophylactic antibiotics were administered to all women undergoing emergency CS and was also introduced for women undergoing planned CS in some hospitals. Prophylactic antibiotics are shown to reduce the risk of maternal infections but have not demonstrated a reduction in neonatal sepsis (RR 0.76, 95% CI 0.51 to 1.13).<sup>12</sup> Correspondingly, planned CS was related to a reduced risk of infection in the newborn. This may be related to the fact that a planned CS is performed on a woman without clinical infection. If a woman has an infection before the scheduled planned CS, she will get antibiotics and probably an emergency CS instead of waiting for the planned CS. Furthermore, the amniotic membranes are intact, a protection for infection in planned CS.

An interesting finding is the increased risk of diagnoses related to asphyxia/respiratory distress (code range P20-P29) after all instrumental births, as well as planned CS. It is well known that asphyxia is related to emergency CS and instrumental vaginal birth due to intrauterine asphyxia/hypoxia being an indication to perform an emergency CS or an instrumental vaginal birth. The increased risk of respiratory distress and/or asphyxia after planned CS in these results may be explained by the increased risk of respiratory distress such as transient tachypnoea of the newborn (TTN), so-called wet lungs in neonates not

being exposed to uterine contractions.<sup>13</sup> TTN is often treated successfully in neonatal care but could also occur as a feature of a more severe condition. As discussed in a review by Ramachandrapa and Jain, many studies have shown an increased risk of respiratory distress following planned CS.<sup>14</sup> We were not able to differentiate asphyxia (P21) from respiratory distress of the newborn (P22).

Need of hospital care for the neonate was increased after emergency CS and instrumental vaginal birth compared with spontaneous vaginal birth. Neonatal care is an important outcome and reflects the health status of the newborn, including transient and long-lasting health problems. The annual report from the Swedish Neonatal Quality Register showed that around 10% of all newborn infants in Sweden were admitted to a neonatal ward during 2020.<sup>15</sup>

The risk of death within 28 days for the neonate increased after emergency CS and after instrumental vaginal birth. This increased risk is probably related to the increased occurrence of asphyxia/respiratory distress and neonatal infection. The risk of death was not increased in the planned CS group.

An increasingly important issue is the development of guidelines or recommendations for VBAC or planned CS after a first caesarean birth and to counsel women on the best clinical choice for birth after CS. A recent study

on preterm infants showed that a preterm trial of labour did not increase the risk for neonatal morbidity when compared with planned repeat CS in women without previous vaginal birth.<sup>16</sup> Rates of repeat planned CS vary depending on both clinical and non-clinical factors, like different hospital practice<sup>17</sup> and guidelines for management of birth after a previous CS differ substantially.<sup>18</sup>

In Sweden, where this study was carried out, women do not have the right automatically to opt for a CS in the absence of medical or obstetric reasons for a CS. However, individual circumstances—for example, intense fear of childbirth—are sometimes resulting indications for having a CS.<sup>19</sup> The VBAC culture in Sweden, Finland and the Netherlands (countries with low CS rates and high VBAC rates) is homogenous, that is, have the same commonly acknowledged guidelines followed by all, professionals as well as women. Usually, women are involved in the care but the obstetricians are the professionals who make the final decision about mode of birth.<sup>20</sup> A planned VBAC may culminate in an emergency CS or an instrumental vaginal birth leading to worse health outcomes but the absolute risks for the neonate are low.<sup>21</sup>

### Strengths and limitations

The strength of this study is the large sample contributing data to the analysis, and a dataset that spans 16 years. A limitation is not having information as to how many women might have planned a VBAC but ultimately had a CS versus those who chose a planned CS (planned repeat CS) from the outset. Furthermore, some planned CS may have been classified as an emergency CS if contractions, rupture of membranes or complications occurred before the planned CS day. Limitations also include ranges of diagnostic codes for neonatal outcomes. The present study was only able to obtain information regarding the compound of ICD-10 codes P20-P29 and P35-P39, respectively. The study was not able to differentiate between asphyxia (diagnose code P20) and respiratory distress of the newborn (diagnose code P22).

### Conclusion

In conclusion, the present study found that spontaneous vaginal birth after previous CS was related to a lower risk of a combined outcome of asphyxia and/or respiratory distress when compared with any other mode of birth. Furthermore, the study found that spontaneous vaginal birth was associated with a lower risk of neonatal infection, neonatal hospital care and neonatal death within 28 days when compared with instrumental vaginal birth and emergency CS. Planned CS was associated with a lower risk of neonatal infection. The present study shows that VBAC seems to be a safe option and may be safely recommended as mode of birth after previous CS.

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