

Unplanned Cesarean Delivery in the Second Stage of Labor Holds Higher Odds of Complications than in the First Stage, while Similar in Primiparas and Multiparas

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Keywords

Cesarean delivery · Second stage of labor · Maternal morbidity · Neonatal morbidity · Primiparas · Multiparas

Abstract

Background: While endeavors to reduce cesarean delivery (CD) rates are given priority worldwide, it is important to evaluate if these efforts place parturients and neonates at risk. CD performed in the second stage of labor carries higher risks of maternal and fetal complications and is a more challenging surgical procedure than that performed in the first stage or before labor. In a population with a low CD rate, we sought to evaluate the rate of maternal and fetal complications associated with unplanned CD (UCD) performed in the second vs. the first stage of labor, in primiparas and multiparas, as well as the risk factors leading to and the complications associated with UCD in the second stage of labor in this low-CD rate setting. **Methods:** This was a retrospective, electronic medical record-based study of 7,635 term and preterm singletons born via UCD in the period 2003–2015. Maternal and neonatal background and outcome parameters were compared between groups. Logistic regression modeling was applied to adjust for clinically and statistically

significant risk factors. **Results:** UCD was more likely to be performed in the second stage of labor in mothers delivering larger fetuses (head circumference and body weight ≥ 90 centile) and those with persistent occiput posterior (POP) presentation. UCD in the second stage was strongly associated with serious maternal complications (excessive hemorrhage and fever) compared to UCD performed in the first stage, in both primiparas and multiparas. **Conclusions:** UCD performed in the second stage of labor, while less frequent than first-stage UCD, is more likely with larger neonates and POP presentation, and is associated with a higher rate of maternal complications in primiparas and multiparas. Complication rates in our low-CD-rate population did not exceed those reported in the literature from high-CD-rate areas.

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Introduction

Cesarean delivery (CD) can be a life-saving surgical procedure when certain complications arise during pregnancy and labor. However, it constitutes major surgery, is associated with immediate maternal and perinatal risks, and may have implications for future pregnancies as well

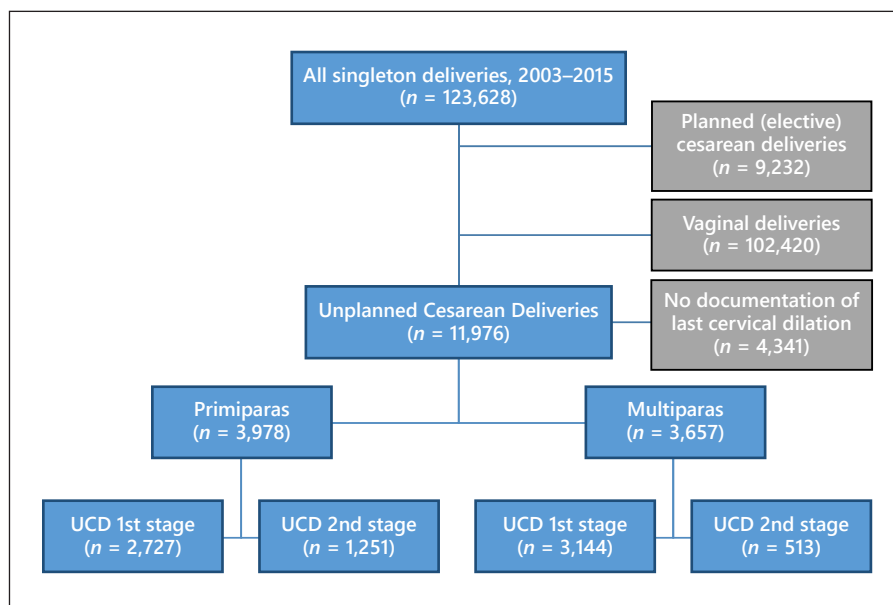


Fig. 1. Cohort flowchart of the study population.

as long-term effects that are still being investigated [1, 2]. CD rates continue to rise, and reached 27% of all deliveries in Europe and 32% in North America in 2015 [1, 3] while the rate supplied by the World Health Organization (WHO) is 10–15% [4]. By comparison, the rate in Israel stands at 16.2%, one of the lowest rates supplied by the Organisation for Economic Cooperation and Development (OECD) [5]. As the overall rate of CD rises, so does the rate in the second stage of labor [6, 7].

CD can be performed before or during the first or second stage of labor. CD performed in the second stage is a more challenging surgical procedure than in the first stage or before labor [8–10]. When performed in the second stage of labor, it is known that CD carries higher risks of maternal and fetal complications, including maternal intraoperative trauma and hemorrhage, prolonged operation time, a neonatal 5-min Apgar score <3 or <7, neonatal intensive care unit (NICU) admission, and other intraoperative complications [6–9, 11–14]. CD performed during the second stage can affect future deliveries; higher rates of spontaneous preterm delivery were found to be associated with pregnancies after a previous second-stage CD [15].

In this study, we aimed to systematically compare the rates of maternal and fetal risk factors that increase the likelihood of second-stage unplanned CD (UCD) as well as the complications associated with CD performed in the second and first stages of labor, in primiparas and multiparas in a health system with a low CD rate, to provide

evidence to aid intrapartum patient management and resource allocation. Our secondary aim was to compare the rates of these parameters between primiparas and multiparas.

Materials and Methods

This was a retrospective study based on the electronic medical records of 7,635 UCDs of singleton fetuses at 24⁺⁰–42⁺⁶ weeks' gestation performed in our medical centers in 2003–2015. Vaginal deliveries and planned CDs (intended or performed) were excluded.

UCD in the second stage of labor was defined as that performed after commencement of the second stage, i.e., at full cervical dilation or 10 cm. Women were assigned to this study group when the last cervical dilation measurement documented in the labor file was 10 cm. Women who underwent UCD and in whom the last cervical dilation measurement was documented as 0–9 cm were assigned to the UCD in the first stage of labor group. Women in whom the cervical dilation at the time of the decision to section was missing in the documentation were excluded.

Obstetric background and outcome data collected included maternal demographic parameters: parity, gestational age (GA) at delivery, last cervical dilation measurement documented, estimated hemorrhage $\geq 1,000$ mL, fever during labor $\geq 38^\circ\text{C}$; and fetal/neonatal outcome parameters: presentation, 5-min Apgar score, umbilical artery pH, NICU admission, and neonatal head circumference (HC) and birth weight (BW) as representative of fetal size. The investigators who extracted and analyzed data (M.L., S.M.C., and J.G.) were not involved in patient care and the ward staff who recorded data in real time at point of care were not aware of the study.

Table 1. Demographic and obstetric characteristics of the study cohort

Parameters	Primipara (<i>n</i> = 3,978)			Multipara (<i>n</i> = 3,657)		
	UCD in 2nd stage of labor	UCD in 1st stage of labor	<i>p</i> value*	UCD in 2nd stage of labor	UCD in 1st stage of labor	<i>p</i> value*
Deliveries	1,251 (31.4)	2,727 (68.6)		513 (14)	3,144 (86)	
Maternal age, years	28.0±4.7	28.3±5.4	0.06	31.9±5.0	32.2±5.4	0.269
Gestational diabetes mellitus	25 (2.3)	92 (4)	0.009	9 (2.1)	126 (5.1)	0.006
Gestational age at birth, weeks	39.7±1.4	39.3±2.1	<0.001	39.6±1.6	38.9 ±2.4	<0.001
Median length of 1st stage, h (95% CI)*	14.4 (9.6–21.5)	15.3 (6.50–22.5)	0.706	10.7 (6.0–16.0)	7.15 (3.4–13.0)	0.088
Male sex	746 (59.6)	1,582 (58)	0.349	321 (62.6)	1,790 (56.9)	0.018
Neonatal head circumference, cm	34.8±1.2	34.3±1.3	<0.001	35.2±1.2	34.5±1.4	<0.001
Neonatal birth weight, g	3,382±453	3,105±577	<0.001	3,508±482	3,175±641	<0.001

Values are expressed as *n* (%) or mean ± SD, unless otherwise indicated. * Comparing unplanned cesarean delivery (UCD) performed in the 2nd versus the 1st stage, using χ^2 or Fisher's exact test or Mann-Whitney U-test, as appropriate.

Figure 1 presents a flowchart showing the breakdown of the birth cohort into study groups. Analyses were performed comparing maternal and fetal risk factors for second-stage UCD, and obstetric and neonatal outcomes for UCD performed in the second versus the first stage of labor, in primiparas and multiparas separately. Secondary analysis compared these parameters in primiparas and multiparas who underwent second-stage UCD.

Statistical Analysis

Statistical analysis was performed with SPSS v24 for Windows (IBM Corp., Armonk, NY, USA); and Office Excel 2010 (Microsoft, Seattle, WA, USA). Dichotomous variables were compared with the χ^2 test or Fisher's exact test in cases of small numbers, as appropriate; the Mann-Whitney U test was applied to analyze differences in continuous variables. Logistic regression was applied to identify risk factors associated with higher adjusted odds ratios (ORs) for UCD in second- and first-stage labor while controlling for possible confounders.

Results

The total cohort collected during the study period comprised 123,628 singleton births, including 102,420 vaginal deliveries (8,076 [6.5%] instrumental deliveries), 9,232 (7.5%) planned (elective) CDs, and 11,976 (9.7%) UCDs. Documentation of cervical dilation was available in 103,616 (84%) cases. Of these, 7,635 had documentation of cervical dilation prior to an UCD. The cohort thus involved 7,635 UCDs of infants of between 23 and 43 weeks' gestation (mean GA 38.2 ± 2.95 SD), comprising 3,978 primiparas (52.1%) and 3,657 multiparas (47.9%). The CD rate (after excluding elective CDs) was 3,978/30,381 (13.1%) in primiparas and 3,657/73,235 (5%) in multiparas. Of these, 2,727 primiparas (9%) and 3,144 (4.29%) multiparas underwent UCD in the first

stage, and 1,251 (4.1%) primiparas and 513 (0.7%) multiparas underwent second-stage UCD.

The babies of women who underwent second-stage UCD had a larger neonatal HC (mean 34.8 vs. 34.3 cm in primiparas and 35.2 vs. 34.5 in multiparas, *p* < 0.001) and greater BW (mean 3,382 vs. 3,105 g in primiparas and 3,508 vs. 3,175 g in multiparas, *p* < 0.001) than those who underwent UCD in the first stage of labor (Table 1). In addition, UCD in the second stage was more likely with persistent occiput posterior (POP) presentation (14.5 vs. 6% in primiparas, *p* < 0.001, OR 2.67 [95% CI 2.06–3.47]; 10.1 vs. 3% in multiparas, *p* < 0.001, OR 3.6 [2.39–5.52]). Second-stage UCD was more likely to result in maternal hemorrhage (≥1,000 mL) in multiparas and maternal fever during delivery (≥38°C) (Table 2).

In contrast, UCDs performed in the first stage of labor were more often preterm deliveries (GA 23⁺⁰–36⁺⁶ weeks; 2.7 vs. 10%, *p* < 0.001, OR 0.25 [95% CI 0.17–0.36] in primiparas and 4.5% vs. 15.5%, *p* < 0.001, OR 0.26 [0.17–0.39] in multiparas); and more often induced (26.2 vs. 33.3%, *p* < 0.001, OR 0.71 [0.61–0.83] in primiparas and 14.2 vs. 20.8%, *p* < 0.001, OR 0.63 [0.49–0.82] in multiparas). These neonates had higher rates of NICU admission (2.6 vs. 7%, *p* < 0.001, OR 0.36 [0.25–0.52] in primiparas and 1.8 vs. 8.7%, *p* < 0.001, OR 0.19 [0.09–0.37] in multiparas) (Table 2). No intrapartum or neonatal deaths occurred in this cohort.

The primary indication for UCD performed in the first stage of labor was fetal distress, while that for UCD performed in the second stage of labor was dysfunctional labor (Table 3). In addition, 4.4% (176) of primiparas and 1.2% (44) of multiparas underwent UCD in the second stage following failed vacuum extraction.

Table 2. Univariate ORs (95 CIs) for obstetric, neonatal, and maternal complications comparing UCD performed in the second and first stage of labor in primiparas and multiparas

Parameters:	Primipara (n = 3,978)				Multipara (n = 3,657)			
	UCD in 2nd stage of labor	UCD in 1st stage of labor	p value	OR (95% CI)	UCD in 2nd stage of labor	UCD in 1st stage of labor	p value	OR (95% CI)
<i>Obstetric</i>								
Deliveries	1,251 (31.4)	2,727 (68.6)	–	–	513 (14)	3,144 (86)	–	–
Preterm deliveries	34 (2.7)	273 (10)	<0.001	0.25 (0.17–0.36)	23 (4.5)	487 (15.5)	<0.001	0.26 (0.17–0.39)
Induction	328 (26.2)	907 (33.3)	<0.001	0.71 (0.61–0.83)	73 (14.2)	654 (20.8)	<0.001	0.63 (0.49–0.82)
POP vs. vertex presentation	164 (14.1)	135 (5.9)	<0.001	2.64 (2.08–3.56)	45 (9.8)	72 (2.9)	<0.001	3.63 (2.47–5.35)
<i>Neonatal</i>								
HC ≥90th centile (36 cm) ^a	143 (22.9)	143 (12)	<0.001	2.18 (1.69–2.81)	77 (32)	184 (15.8)	<0.001	2.50 (1.83–3.42)
BW ≥90th centile (3,855 g)	202 (16.2)	229 (8.4)	<0.001	2.10 (1.72–2.58)	108 (21.1)	363 (11.6)	<0.001	2.05 (1.61–2.59)
Male fetus	746 (59.6)	1,582 (58)	0.349	1.07 (0.93–1.23)	321 (62.6)	1,790 (56.9)	0.018	1.27 (1.04–1.53)
NICU admission	33 (2.6)	192 (7)	<0.001	0.36 (0.25–0.52)	9 (1.8)	272 (8.7)	<0.001	0.19 (0.09–0.37)
Apgar score at 5 min ≤7	35 (2.8)	52 (1.9)	0.081	1.47 (0.95–2.27)	13 (2.6)	76 (2.4)	0.877	1.05 (0.58–1.90)
pH ≤7.1 ^b	23 (4.1)	37 (3.4)	0.486	1.24 (0.73–2.11)	11 (5.6)	40 (3.7)	0.232	1.54 (0.78–3.07)
<i>Maternal</i>								
Hemorrhage ≥1 L	48 (3.8)	73 (2.7)	0.058	1.45 (1.01–2.1)	38 (7.4)	102 (3.2)	<0.001	2.39 (1.62–3.51)
Fever during delivery ≥38°C	193 (15.4)	254 (9.3)	<0.001	1.78 (1.07–2.74)	23 (4.5)	84 (2.7)	0.033	1.71 (1.07–2.74)

Values express n (%). OR, odds ratio; CI, confidence interval; UCD, unplanned cesarean delivery; POP, persistent occiput posterior; HC, head circumference; BW, birth weight.

^a Available for 1,811 primiparas and 1,532 multiparas (HC recorded electronically since 2010); ^b available for 1,662 primiparas and 1,290 multiparas.

Table 3. The main indication recorded for unplanned cesarean delivery (UCD) performed in the first and second stages of labor in primiparas and multiparas

	Primipara (n = 3,115)			Multipara (n = 2,456)		
	UCD in 2nd stage of labor	UCD in 1st stage of labor	p value*	UCD in 2nd stage of labor	UCD in 1st stage of labor	p value*
Fetal distress	293 (23.4)	1,636 (60)	<0.001	148 (28.9)	1,579 (50.2)	<0.001
Dysfunctional labor	738 (59)	608 (22.3)	<0.001	267 (52.1)	326 (10.4)	<0.001

Values express n (%). * 2nd- versus 1st-stage UCD, using the χ^2 test.

Logistic regression modeling was applied to identify factors associated with UCD performed in the second stage of delivery as opposed to the first, while controlling for possible confounders. Analysis showed that POP presentation, HC ≥90th centile (36 cm) and BW ≥90th centile (3,855 g) were significant indicators for UCD in the second stage rather than the first in primiparas (adjusted OR 2.28 [95% CI 1.55–3.37], 1.99 [1.49–2.64], and 1.41 [1.00–1.98], respectively) and multiparas (adjusted OR 2.70 [1.50–4.87], 2.08 [1.44–3.03], and 1.41 [0.93–2.13], respectively). Induction of labor was more strongly indicative of UCD in the first stage of labor (Table 4).

In our secondary analysis, we examined the above parameters, comparing primiparas and multiparas who un-

derwent UCD in the second stage of labor. Fetal outcomes did not differ between the groups (NICU admission, 5-min Apgar <7, and umbilical pH). The rate of maternal fever >38°C was significantly higher among primiparas (15.4 vs. 4.5%; OR 3.89 [95% CI 2.49–6.07]), while the rate of maternal hemorrhage was 2-fold higher among multiparas (7.4 vs. 3.8%; OR 0.50 [0.32–0.77]).

Primiparas had higher rates of induction and POP presentation than multiparas (14.1 vs. 9.8%, $p = 0.021$, OR 1.52 [95% CI 1.07–2.15]). However, multiparas had larger neonates with HC ≥90th centile (32 vs. 22.9%, $p = 0.007$, OR 0.63 [0.46–0.88]) and BW ≥90th centile (21.1 vs. 16.2%, $p = 0.016$, OR 0.72 [0.56–0.93]) than primiparas (Table 5).

Table 4. Logistic regression-modeled adjusted odds ratios for risk factors for unplanned cesarean delivery performed in the second and first stages of labor in primiparas and multiparas, controlling for neonatal sex and preterm delivery

	Primipara		Multipara	
	adjusted odds ratio	<i>p</i> value	adjusted odds ratio	<i>p</i> value
Induction	0.67 (0.54–0.84)	<0.001	0.47 (0.31–0.69)	<0.001
Persistent occiput posterior presentation	2.28 (1.55–3.37)	<0.001	2.70 (1.50–4.87)	0.001
Neonatal head circumference ≥90th centile	1.99 (1.49–2.65)	<0.001	2.08 (1.44–3.03)	0.001
Birth weight ≥90th centile	1.41 (1.00–1.98)	0.049	1.41 (0.93–2.13)	0.104

Table 5. Univariate ORs (95% CIs) for obstetric, neonatal, and maternal complications comparing outcomes of primiparas and multiparas in UCDs performed in the second stage of labor

Parameters	Primiparas undergoing 2nd-stage USD (<i>n</i> = 1,251)	Multiparas undergoing 2nd-stage USD (<i>n</i> = 513)	<i>p</i> value	OR (95% CI)
<i>Obstetrics</i>				
Preterm delivery	34 (2.7)	23 (4.5)	0.074	0.60 (0.35–1.02)
Induction	328 (26.2)	73 (14.2)	<0.001	2.14 (1.62–2.83)
POP vs. vertex presentation	164 (14.1)	45 (9.8)	0.021	1.52 (1.07–2.15)
<i>Neonatal</i>				
HC ≥90th centile (36 cm) ^a	143 (22.9)	77 (32)	0.007	0.63 (0.46–0.88)
BW ≥90th centile (3,855 g)	202 (16.2)	108 (21.1)	0.016	0.72 (0.56–0.93)
Male fetus	746 (59.6)	321 (62.6)	0.260	0.88 (0.72–1.09)
NICU admission	33 (2.6)	9 (1.8)	0.306	1.52 (0.72–3.19)
Apgar score at 5 min ≤7	35 (2.8)	13 (2.6)	0.872	1.10 (0.58–2.10)
pH ≤7.1 ^b	23 (4.1)	11 (5.6)	0.426	0.73 (0.35–1.53)
<i>Maternal</i>				
Hemorrhage ≥1 L	48 (3.8)	38 (7.4)	0.002	0.50 (0.32–0.77)
Fever during delivery ≥38°C	193 (15.4)	23 (4.5)	<0.001	3.89 (2.49–6.07)

Values express *n* (%). OR, odds ratio; CI, confidence interval; UCD, unplanned cesarean delivery; POP, persistent occiput posterior; HC, head circumference; BW, birth weight.

^a Available for 625 primiparas and 241 multiparas in the subgroup (HC electronically recorded since 2010); ^b available for 558 primiparas and 198 multiparas in the subgroup.

Discussion

In this large retrospective cohort study, conducted in a health system with one of the lowest rates of CD among the countries of the OECD [5] we observed that large fetal size and POP presentation increased the odds of UCD being performed in the second stage of labor, while prematurity and induction of labor led more often to UCD being performed in the first stage of labor. The rates of complications with second-stage UCD observed in our cohort did not differ from those reported in other health systems with high CD rates [7, 8, 11, 13]. Furthermore, in this cohort comprising 7,635 singleton UCDs at all weeks of gestation,

we found that only a minority of these UCDs were performed in the second stage, comprising 4% of primiparous laboring women and 0.7% of multiparas. Thus, in a setting of low CD rates, approaching the target rates set by the WHO [4], higher complication rates were not observed.

UCD in the second stage of labor was strongly associated with serious maternal complications (excessive hemorrhage and fever) compared to the first stage, in both primi- and multiparas, while higher rates of NICU admission were observed with UCD performed in the first stage of labor.

While the rates and ORs of serious neonatal outcomes did not differ between the primi- and multipara sub-

groups undergoing second-stage UCD, the rate of maternal hemorrhage was higher among multiparas and maternal fever during delivery was higher among primiparas.

Our total CD rate, comprising both planned and unplanned procedures, was 17%. Among primiparas, 13% were delivered via UCD versus 5% of multiparous women. These rates are markedly lower than those reported in the USA and Europe. The published rates of complications and morbidity associated with CD performed in the second and first stages of labor are derived from settings working according to these higher CD. We queried whether the differences in this lower rate of CD would impact on the rates of second-stage UCD as well as maternal and neonatal complications [8, 12].

In agreement with earlier studies, neonates born via second-stage UCD were around 300 g heavier and had a higher rate of neonatal HC ≥ 90 th centile. Alexander et al. [12] compared first- and second-stage CD in 12,000 singleton term labors and showed that the second-stage group had a mean increase of 126 g, while Asıcıoglu et al. [11] showed a mean increase of 200 g. As we have shown previously, sonographic fetal HC and estimated fetal weight [10] and neonatal high HC and BW [16] are risk factors for UCD and failed instrumental deliveries [10]. This might explain the higher rates of dysfunctional labor or labor dystocia as the primary indication cited for UCD at this stage, while fetal distress was more often cited in first-stage UCD, in our study and others [11, 12].

Opposed to Asıcıoglu et al. [11] and Pergialiotis et al. [13] in their systematic review, i.e., higher rates of 5-min Apgar scores ≤ 3 or ≤ 7 , respectively, in neonates born via CD at full dilation, we did not find significant differences in umbilical artery pH ≤ 7.1 or 5-min Apgar score ≤ 7 . We did observe higher rates of NICU admission in neonates born via first-stage UCD, a possible upshot of the higher rate of preterm deliveries in the first-stage UCD group (excluded from the other studies).

The rate of maternal hemorrhage ($\geq 1,000$ mL) during second-stage UCD was similar to other reports. Vousden et al. [7] reported a rate of 4.7 versus 2.9% during UCD performed in the second- versus the first-stage (adjusted OR 1.7 [95% CI 1.0–3.0]) and lower than others. Vitner et al. [8] reported a rate of 9.7% in second-stage UCD versus 3.8% in first-stage UCD ($p < 0.001$). Others found no statistically significant difference between groups in the need for blood transfusion [12]. Most studies examined only CD performed at term [8, 12, 13]; we included preterm delivery in our analyses as a possible factor for the likelihood of CD.

To the best of our knowledge and after a review of the literature, no other studies have compared the maternal and neonatal outcomes for primiparas versus multiparas and their offspring. Some studies analyzed mixed populations of parity [8, 11–13] and others included only primiparas [9]. We found that neonatal complications did not differ between groups, but that the rate of maternal fever during labor was higher among primiparas (perhaps due to longer deliveries). The rate of excessive hemorrhage was higher among multiparas, possibly due to the fetuses being larger.

The large study cohort collected here made it possible to study primiparas and multiparas separately and to compare groups. This study is based on data that were recorded prospectively at point of care for a very large study group, by midwives and physicians in the labor and delivery wards who were not aware of the study. However, as a retrospective study, it is nevertheless limited by its design and the biases that entails. Further studies are needed to investigate the long-term outcomes and complications associated with UCD performed at different stages of labor in various subgroups of gravidity.

Conclusion

UCD performed in the second stage of labor is technically more complex and carries a higher risk of maternal complications [7–9, 11–14, 17]. Factors strongly associated with UCD in the second stage were fetal presentation (POP) and biometric measures (HC and BW ≥ 90 th centile). Higher rates of maternal complications and neonatal NICU admission in these deliveries suggest that second-stage UCD should be avoided as much as possible.

Health services worldwide have undertaken to reduce the rate of CD. In our low-rate-CD setting, the rates of UCD in the second stage was not found to be increased, and nor were rates of maternal or neonatal complications, above those reported in high-rate-CD settings. Cognition of parameters that are likely to increase the odds of second-stage UCD may guide caregivers to avoid this procedure and its consequences where possible. For example, prelabor measurement of fetal biometry might provide labor ward staff with another tool to individualize patient management and staff allocation to optimize labor and delivery outcomes.

Statement of Ethics

Our institutional review board (IRB) reviewed and approved the study on 31 December 2015 (0632-15-HMO). Requirement for written informed consent was waived by the IRB due to the retrospective, HIPAA-compliant, deidentified nature of the patient data.

Disclosure Statement

The authors have no conflicts of interest to declare.

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