

## TIMING OF ELECTIVE CESAREAN DELIVERY AT TERM AND NEONATAL RESPIRATORY MORBIDITY.

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### Abstract

**Aim** To investigate the association between elective cesarean sections and neonatal respiratory morbidity and the importance of timing of elective cesarean sections

**Methods** Cohort study with prospectively collected data of all elective Caesarean sections on mothers with a gestational age of 37+0 weeks and more, that were performed in our Hospital from 1 January 2011 to 1 January 2017. Multiple pregnancies, fetuses with congenital anomalies, intrauterine deaths, and emergency Caesarean sections were excluded. Primary outcome measures of neonatal respiratory morbidity included transient tachypnea of newborn, respiratory distress syndrome, persistent pulmonary hypertension of the newborn.

**Results** 4290 infants were delivered by elective cesarean section at 37+0 and then after compared with newborns from vaginal delivery, and emergency cesarean section an increased risk of respiratory morbidity was found for infants delivered by elective cesarean section at 37+0 weeks' gestation to 37+6 weeks (odds ratio 4.5 95% confidence interval 3.3 to 6.3), 38+0 weeks' gestation to 38+6 weeks (2.7, 1.9 to 3.6), and 39+0 weeks' gestation (2.1, 1.6 to 3.0). Also increasing the incidence of admission to the NICU with decreasing gestational age at term birth below the 39 weeks of gestation

**Conclusions:** Compared with newborns delivered vaginally or by emergency cesarean sections, those delivered by elective cesarean section around term have an increased risk of respiratory morbidity. The relative risk increased with decreasing gestational age.

**Keywords** Elective cesarean section, neonatal respiratory morbidity, neonatal transient tachypnea, Respiratory distress syndrome, pulmonary hypertension

### Introduction

Infants born before 39 weeks of gestation are at increased risk for neonatal adverse respiratory outcomes, and the risk

increases progressively as gestational age at birth declines.<sup>1,2</sup> As compared with infants born vaginally, those born by cesarean section are at increased risk for adverse

respiratory outcomes, especially when delivery occurs before the onset of labor.<sup>1,2,5-</sup> This increased risk persists even in infants who are delivered by cesarean section at full term (i.e., at or beyond 37 completed weeks of gestation).

The rate of cesarean delivery in the United States rose from 20.7% in 1996 to 31.1% in 2006.<sup>6-</sup> Deliveries by cesarean section continue to increase in both developed and developing countries. Rates as high as 50% have been reported in some regions of Latin America.<sup>4</sup>

Lately, many other factors, such as reduced risk to the mother as a result of improved anesthetic procedures and surgical techniques, elective cesarean section because of breech presentation, or previous cesarean section may have contributed to changes in obstetric practice and patient choice.<sup>234</sup> Thus increased rates of the elective cesarean section without any obvious or generally accepted medical or obstetric indication have been reported to contribute further to the increasing rate of elective cesarean sections.<sup>78</sup> If no medical indication is present evidence-based information about risks and benefits for mothers as well as newborns becomes all the more important for adequate counselling.<sup>9</sup>

Gestational age at the time of elective cesarean section may also be important for respiratory morbidity in neonates.<sup>10111213</sup>

We evaluated the association between the elective cesarean section and neonatal respiratory morbidity in a large cohort of women with low-risk pregnancies. We also separately analyze the effect of gestational age at the time of elective cesarean section.

### Methods

Cohort study with prospectively collecting data from 1 January 2011 and 31 December 2016 at University Obstetric-Gynecologic Hospital “Queen Geraldine”

for 41 095 live singletons delivery. We included in our analyses all live-born singletons without congenital malformations of gestational ages 37 to 40 completed weeks (24836 pregnancies). A subgroup (23414 pregnancies) was constructed to analyze the outcome of low-risk pregnancies only. We, therefore, excluded all pregnancies associated with intrauterine growth retardation (n 320), diabetes (gestational or overt; n=120) and pre-eclampsia or hypertension (n=982). We defined intrauterine growth retardation as birth weight less than 2500 g in infants born after 36 completed weeks of gestation.

Deliveries were categorized as vaginal, elective cesarean section, emergency cesarean section.

We categorized cesarean sections after the start of labor or rupture of the membranes as emergency cesarean sections. Labor was defined as regular uterine contractions with the progression of cervical dilation.

We measured gestational age in completed weeks on the basis of the last menstrual period. (LMP) or ultrasound of the first –trimester.

We considered information only related to newborn admissions to the hospital immediately after delivery. The following neonatal outcomes adverse respiratory outcomes (respiratory distress syndrome or transient tachypnea of the newborn), resuscitation, Apgar score at 1 and 5 minute, admission to the neonatal intensive care unit (ICU), and day hospital care. The prespecified primary outcome was a composite that included any of the above outcomes. The infants were followed up until discharge from the hospital.

The diagnosis of respiratory distress syndrome required signs of respiratory distress syndrome (RDS), consistent radiologic features, and oxygen therapy with a fraction of inspired oxygen (FIO<sub>2</sub>) of 0.40

or greater for at least 24 hours or until death. Transient tachypnea of the newborn (TTN) was defined by the presence of tachypnea within hours after birth and typical radiologic findings, and persistent pulmonary hypertension of the newborn as a serious respiratory morbidity requiring treatment for three or more days with continuous oxygen supplementation, nasal continuous positive airway pressure, or any period of mechanical ventilation.

We repeated analyses after exclusion of newborns with meconium aspiration syndrome (n=82), sepsis; (n=253), or pneumonia (n=45) because these conditions may cause respiratory symptoms unrelated to delayed transition from fetus to a newborn but are associated with vaginal delivery.

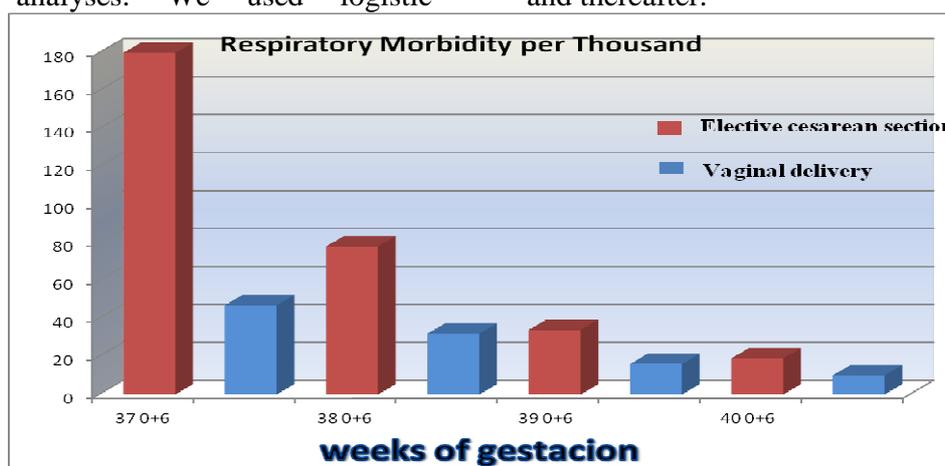
We carried out bivariate analyses to compare the risk of respiratory morbidity in babies delivered by elective cesarean section with the risk after vaginal delivery and emergency section cesarean within each gestational week. We present the association between mode of delivery and respiratory morbidity as odds ratios with 95% confidence intervals. To evaluate effect modification by gestational age we used stratified analyses. We used logistic

regression analyses to evaluate potential confounding variables (parity, maternal age.). Adjusted odds ratios are also presented for respiratory morbidity but not for serious respiratory morbidity owing to the small number of observations.

### Results

Between January 2011 - December 2016 there were 23414 live singleton births at our hospital. Among them 17497 term newborn or 74.7% delivered vaginally, 4290 (18.3 %) term newborns delivered by elective cesarean section, and 1627 (6.9% ) delivered by emergency cesarean section.

The number of infants with respiratory morbidity (RDS, TTN PH) associated with elective cesarean delivery or vaginal delivery between the weeks at term is shown in Fig. 1. The incidence of respiratory morbidity (RDS, TTN, and HP) after elective cesarean delivery term and after vaginal delivery was, respectively, 180 and 19 /1000 deliveries, and 47 and 10/ 1000 deliveries. In comparison with vaginal births, infants delivered by elective cesarean section showed a significant progressive reduction in the incidence of neonatal Respiratory morbidity from week 37 + 0 to week 37 +6 and thereafter.



**Fig 1.** Incidence of respiratory morbidity per thousand live births are shown by each week of gestation and mode of delivery. The number of infants with RM following elective cesarean delivery diminishes significantly with each week of gestation up to a week

**The link between gestational ages and Transient tachypnea of the newborn:**

Table 1. The odds ratio of TTN of babies delivered from 2011-2016, after ECS, vaginal delivery and emergency section cesarean according to Completed Week of Gestation at Delivery.

The trends toward the increasing the incidence TTN with decreasing gestational

age at term birth below the 39 weeks of gestation remained significant in analyses adjusted for potential confounders; the adjusted odds ratios 4.3 for ECS and 2.3 for vaginal delivery for 37 weeks of gestation, and for 38 weeks of gestation is respectively 2.4 for ESC and 1.9 for emergency section cesarean.

**Table 1: Odds Ratio of TTN According to Completed Week of Gestation at Delivery and way of birth -Odds Ratio from the Binary Logistic Regression**

	Variable	Model 1 ‡			Model 2 ¶		
		OR §	95% CI *	Value of P †	OR	95% CI *	Value of P †
<b>Vaginal delivery</b>	<b>Gestational age †</b>			<0.001 (3)			<0.001 (3)
	37.0-37.06 weeks	2.6	1.7-4.0	<0.001	<b>2.8</b>	1.8-4.2	<0.001
	38.0-38.06 weeks	1.4	0.9-2.3	0.127	1.5	0.9-2.4	0.097
	39.0-39.06 weeks	1.0	0.7-1.5	0.822	1.1	0.7-1.5	0.797
	40.0-40.06 weeks	1.0	-	-	1.0	-	-
<b>Emergency SC</b>	<b>Gestational age †</b>			0.090 (3)			0.093 (3)
	37.0-37.06 weeks	1.2	0.3-5.4	0.828	1.3	0.3-6.1	0.735
	38.0-38.06 weeks	1.8	0.7-4.8	0.254	1.9	0.7-5.2	0.214
	39.0-39.06 weeks	0.4	0.2-1.1	0.081	0.4	0.2-1.2	0.113
	40.0-40.06 weeks	1.0	-	-	1.0	-	-
<b>Elective SC</b>	<b>Gestational age †</b>			<0.001 (3)			<0.001 (3)
	37.0-37.06 weeks	4.3	2.0-9.2	<0.001	<b>4.3</b>	2.0-9.3	<0.001
	38.0-38.06 weeks	2.4	1.1-5.0	<b>0.022</b>	2.4	1.1-5.0	<b>0.022</b>
	39.0-39.06 weeks	1.4	0.7-2.9	0.394	1.4	0.7-2.9	0.384
	40.0-40.06 weeks	1.0	-	-	1.0	-	-

§ Odds Ratio of transient tachypnea of the newborn ( TTN) According to Completed Week of Gestation at Delivery – Binary logistic regression.

\* confidence interval 95% (95% CI) per OR

† P value statistically significant from binary logistic regression and degrees of freedom (in parentheses).

‡ Model 1 unadjusted for any of factors

¶ Model 2: adjusted for maternal age.

**Table 2 Odds Ratio of Respiratory Distress Syndrome (RDS) after vaginal delivery, emergency s.c. and E.C.S.**

**according to Completed Week of Gestation at Delivery for 2011-2016.**

The trends toward the increasing the incidence of respiratory distress with

decreasing gestational age at term birth for 37 weeks of gestation at E.C.S remained significant in analyses adjusted for potential confounders; the adjusted odds ratios 39.8 at

37 weeks of gestation and 1.3 to 12.1 at 38 weeks of gestation, as compared with 1.0 at 40 weeks of gestation . (Model 2)

**Table 2.** Odds Ratio of RDS According to Completed Week of Gestation at Delivery and way of birth Odds Ratio from the Binary Logistic Regression

	Variable	Model 1 ‡			Model 2 ¶		
		OR §	95% CI *	P value †	OR	95% CI *	P value †
Vaginal delivery	Gestacional age †			<b>0.019 (3)</b>			<b>0.017 (3)</b>
	37.0-37.06 week						
	38.0-38.06 week	1.5	0.8-2.7	0.197	1.5	0.8-2.8	0.176
	39.0-39.06 week	2.1	1.3-3.5	<b>0.003</b>	2.2	1.3-3.6	<b>0.003</b>
	40.0-40.06 week	1.1	0.7-1.7	0.599	1.1	0.7-1.7	0.588
		1.0	-	-	1.0	-	-
Emergency section cesarea	Gestacional age †			-			-
	37.0-37.06 week						
	38.0-38.06 week	NA	-	-	NA	-	-
	39.0-39.06 week	NA	-	-	NA	-	-
	40.0-40.06 week	NA	-	-	NA	-	-
		1.0	-	-	1.0	-	-
Elective Secio cesarea	Gestacional age †			<b>&lt;0.001 (3)</b>			<b>&lt;0.001 (3)</b>
	37.0-37.06 week	39.4	5.4-286.7	<b>&lt;0.001</b>	<b>39.8</b>	5.4-289.9	<b>&lt;0.001</b>
	38.0-38.06 week	12.1	1.7-88.1	<b>0.014</b>	<b>12.1</b>	1.6-88.2	<b>0.014</b>
	39.0-39.06 week	2.4	0.3-18.5	0.414	2.4	0.3-18.6	0.411
	40.0-40.06 week	1.0	-	-	1.0	-	-

§ Odds Ratio of respiratory distress (RDS) for each week of gestational age at delivery – Binary logistic regression.

\* confidence interval 95% (95% CI) per OR

† P value statistically significant from binary logistic regression and degrees of freedom (in parentheses).

‡ Model 1 unadjusted for any of factors

¶ Model 2: adjusted for maternal age.

NA – Model Not Applied due to very few cases of interest

**Table 3. Odds ratios (95% confidence intervals) of neonatal respiratory morbidity after vaginal delivery ,emergency s.c. and E.C.S. according to Completed Week of Gestation at Delivery for 2011-2016.**

Compared with infants delivered by women intended to have a vaginal delivery, those delivered by elective cesarean section had an

increased risk of respiratory morbidity at any gestational age before 40 weeks. A nearly fourfold increased risk was found at 37 weeks’ gestation (odds ratio 4.5, 95% confidence interval 3.3 to 6.3) and a threefold increase in risk at 38 weeks’ gestation (2.7, 1.9 to 3.6), whereas the risk was doubled in infants delivered at 39 weeks’ gestation (2.1, 1.6 to 3.0;)

**Table 3.** Odds Ratio of Neonatal Respiratory Morbidity According to Completed Week of Gestation at Delivery and way of birth –Odds Ratio from the Binary Logistic Regression

RESPIRATORY MORBIDITY					
GESTATIONAL AGE	Nr. Delivery	Nr % of infant	Odds ratio <sup>§</sup>	95% CI *	Value of P †( 3)
<b>Type of delivery</b>					
<b>37 0+6 week</b>					
<b>E. S.C.</b>	525	97 (18)	<b>4.5</b>	3.3 to 6.3	<b>p&lt;0.0001</b>
<b>Vaginal delivery</b>	1559	74(4.7)	Reference		
<b>38 0+6 week</b>					
<b>E. S.C.</b>	1603	126(7.8)	<b>2.7</b>	1.9 to 3.6	<b>p&lt;0.0001</b>
<b>Vaginal delivery</b>	1869	58 (3.2)	Reference		
<b>39 0+6 week</b>					
<b>E. S.C.</b>	1750	60(3.4)	2.1	1.6 to 3.0	<b>p&lt;0.001</b>
<b>Vaginal delivery</b>	7115	114(1.6)	Reference		
<b>40 0+6 week</b>					
<b>E. S.C.</b>	411	8(1.9)	1.2	0.6 to 2.6	P =0.50
<b>Vaginal delivery</b>	6954	106 (1.5)	Reference		

§ Odds Ratio of Neonatal Respiratory Morbidity for each week of gestational age at delivery – Binary logistic regression.

\* confidence interval 95% (95% CI) per OR

† P value statistically significant from binary logistic regression and degrees of freedom (in parentheses).

¶ Model 2: adjusted for maternal age.

**Table 4. Odds Ratio of Admission to the NICU after vaginal delivery, emergency S.C. and E.S.C. According to Completed Week of Gestation at Delivery for 2011-2016.**

The trends toward the increasing the incidence of admission to the NICU with decreasing gestational age at term birth

below the 39 weeks of gestation remained significant in analyses adjusted for potential confounders; the adjusted odds ratios 16.2 for ECS and 9 for Emergency cesarean section for 37 weeks of gestation, and for 38 weeks of gestation is respectively 5.3 for ESC, 1.6 for vaginal delivery. (Model 2 ).

**Table 4.** Odds Ratio of Admission to the NICU According to Completed Week of Gestation at Delivery and way of birth -Odds Ratio from the Binary Logistic Regression

		Model 1 ‡			Model 2 ¶		
		OR §	95% CI *	P value †	OR	95% CI *	P value †
<b>Vaginal delivery</b>	<b>Gestational age †</b>			<0.001 (3)			<0.001 (3)
	37.0-37.06 week						
	38.0-38.06 week	2.0	1.4-3.0	<0.001	2.0	1.4-3.0	<0.001
	39.0-39.06 week	1.6	1.1-2.4	<b>0.018</b>	1.6	1.1-2.4	<b>0.022</b>
	40.0-40.06 week	1.1	0.8-1.4	0.760	1.1	0.8-1.4	0.768
		1.0	-	-	1.0	-	-
<b>Emergency secio cesarea</b>	<b>Gestational age †</b>			<b>0.002 (3)</b>			<b>0.002 (3)</b>
	37.0-37.06 week						
	38.0-38.06 week	7.5	2.4-23.8	<b>0.001</b>	9.0	2.7-30.3	<0.001
	39.0-39.06 week	0.6	0.1-4.9	0.619	0.7	0.1-5.6	0.700
	40.0-40.06 week	1.7	0.6-4.5	0.296	1.9	0.7-5.3	0.212
		1.0	-	-	1.0	-	-
<b>Elective secio cesarea</b>	<b>Gestational age †</b>			<0.001 (3)			<0.001 (3)
	37.0-37.06 week						
	38.0-38.06 week	16.2	5.8-44.6	<0.001	<b>16.2</b>	5.9-44.8	<0.001
	39.0-39.06 week	5.3	1.9-14.6	<b>0.001</b>	<b>5.3</b>	1.9-14.7	<b>0.001</b>
	40.0-40.06 week	1.7	0.6-4.9	0.315	1.7	0.6-4.9	0.313
		1.0	-	-	1.0	-	-

§ Odds Ratio of Admission to NICU for each week of gestational age at delivery – Binary logistic regression.

\* confidence interval 95% (95% CI) per OR

† P value statistically significant from binary logistic regression and degrees of freedom (in parentheses).

‡ Model 1 unadjusted for any of factors

¶ Model 2: adjusted for maternal age.

NA – Model Not Applied due to very few cases of interest

No mortality was recorded among either vaginally or cesarean-delivered neonates.

## Discussion

The risk of neonatal respiratory morbidity after the elective cesarean section in singletons born at University Obstetric Gynecologic Hospital “Queen Geraldine”, between 1 January 2011 and 31 December 2016 was twice to four times that after intended vaginal delivery within each gestational week from 37 to 39 weeks. When the risk of respiratory morbidity after elective cesarean section in each gestational week was compared with the risk after intended vaginal delivery at 40 weeks’

gestation, the relative risk decreased from seven times higher at 37 weeks to three times higher at 38 weeks, whereas the relative risk at 40 weeks was no longer statistically significant.

The careful planning of elective cesarean deliveries after week 39+ 0 could mean substantial cost savings and avoid the need to separate babies from their parents, which causes considerable anxiety to the family. Although mortality from respiratory disease in our infants was zero, the affected babies suffered painful procedures with the

related risks of complications and additional morbidity, negative effects on their physiological and biochemical responses to birth, the development of pulmonary air leaks and persistent fetal circulation, and continuing respiratory symptom after discharge<sup>1415</sup>

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