Accepted Manuscript

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PII: S0301-2115(18)30063-0
DOI: https://doi.org/10.1016/j.ejogrb.2018.02.007
Reference: EURO 10226

To appear in: *EURO*

Received date: 13-10-2017
Revised date: 9-2-2018
Accepted date: 9-2-2018

Please cite this article as: KARALIS ELINA, TAPPER ANNA-MAIJA, GISSLER MIKA, ULANDER VELI-MATTI.The impact of increased number of low-risk deliveries on maternal and neonatal outcomes: A retrospective cohort study in Finland in 2011-2015.*European Journal of Obstetrics and Gynecology and Reproductive Biology* https://doi.org/10.1016/j.ejogrb.2018.02.007

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The impact of increased number of low-risk deliveries on maternal and neonatal outcomes: A retrospective cohort study in Finland in 2011-2015

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Condensation

Increasing the patient load in a high volume delivery unit does not damage the capacity to deliver quality of care.

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Abstract

Objectives: Our aim was to demonstrate the influence of increased number of low-risk deliveries on obstetric and neonatal outcome.

Study Design: The study hospital was Kätilöopisto Maternity Hospital in Helsinki. Simultaneously, we studied all three delivery units in the Helsinki region in the population-based analysis. The study population was singleton hospital deliveries occurring between 2011-2012, and 2014-2015. The study hospital included 11 237 and 15 637 births and the population-based group included 28 950 and 27 979 births. We compared outcome measures in different periods by calculating adjusted odds ratios (AOR). Main outcome measures were induced delivery, mode of delivery, third or fourth degree perineal tear, Apgar score at five minutes < 7, umbilical artery pH < 7.00, transfer to higher level of neonatal care, neonatal antibiotic treatment, respiratory support of the neonate, hospitalization of the neonate > 7 days, and perinatal death.

Results: In the study hospital, induction rate increased from 22.4% to 24.8% (AOR 1.06, 95% CI; 1.00-1.12) while in the population-based analysis the rate decreased from 22.2% to 21.5% (AOR 0.96, 95% CI; 0.92-1.00). Percentage of neonatal transfers, low Apgar scores, and severe perineal tears increased both in study hospital and in population-based group. Changes in operative delivery rate and other adverse perinatal outcomes were statistically insignificant.

Conclusions: Increasing the volume of a delivery unit does not compromise maternal or neonatal outcome. Specific characteristics of a delivery unit affect the volume outcome association.

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Keywords Maternity unit size, neonatal asphyxia, neonatal death, perinatal death, hospital safety.

Introduction

Many studies demonstrate that when an experienced surgeon operates on a difficult condition the patient outcome is better (1,2). A study on abdominal hysterectomy for endometrial cancer shows that complications during and after surgery are lower in patients treated by high-volume surgeons (3). Moreover, many studies report that the higher the hospital volume the lower the mortality (4,5).

In obstetrics, many studies demonstrate that centralization of very low-birth-weight and very premature deliveries in tertiary clinics with more experience of similar cases results in better outcomes (6,7). A consensus on the management of low-risk deliveries does not exist. Some studies detect worse outcomes, for both mother and child, in very small and very large hospitals (8). Some studies suggest it is not the volume that predicts the outcome but the academic status of the delivery unit (9). Other studies comparing different levels of delivery units reveal no difference in patient outcome (10,11).

The Helsinki region has three maternity hospitals in 20 kilometers radius, Kätilöopisto Maternity Hospital, Women's Hospital, and Jorvi Hospital. They are publicly financed teaching hospitals operated by the University of Helsinki, and are under the same administration. There are neither privately-owned delivery units nor midwife-led units in Finland. The Women's Hospital is the only tertiary delivery unit in Helsinki area. Jorvi Hospital, like Kätilöopisto Maternity Hospital, predominately take care of low-risk deliveries.

The opportunity to evaluate the effect of an increased number of low-risk deliveries on obstetric outcome emerged due to construction project of Women's Hospital, beginning in

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May 2013. Some deliveries which normally would have been directed to Women's Hospital were instead directed to Kätilöopisto or Jorvi Hospital. The annual volume of deliveries at Kätilöopisto Hospital increased from 5 600 to 7 500. At the same time the number of deliveries in Women´s Hospital decreased, and Kätilöopisto Hospital received supplementary staff and resources to perform the additional deliveries while staff to patient ratio remained the same.

The aim of this study is to evaluate the effect of increased number of low-risk deliveries on obstetric outcomes.

Material and Methods

The study population was singleton hospital deliveries in Helsinki region. During the study time, the number of annual deliveries increased by 1 900 in the study hospital (Kätilöopisto Maternity Hospital). To detect the changes significant only for the study hospital, we performed a simultaneous population-based analysis including all three maternity hospitals in Helsinki region.

Two periods were compared in the study: before the construction project (the beginning of 2011 to the end of 2012) and after the beginning of the construction project (the beginning of 2014 to the end of 2015). The earlier period was used as a reference. Women´s hospital, manages high-risk pregnancies and deliveries, such as insulin treated diabetes before pregnancy, multiple pregnancies, and very premature deliveries before the 32nd week of pregnancy. After the construction began, these criteria remained the same. Low-risk deliveries were centralized in the study hospital, but elective cesarean sections were relocated to Women's hospital. The study hospital has a special care nursery (SCN) but newborns requiring demanding neonatological care are transferred to the Helsinki Children's Hospital neonatal intensive care unit (NICU).

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Primary outcome measures were: induced deliveries, emergency cesarean section, operative vaginal deliveries (vacuum and forceps), third or fourth degree perineal tear, perinatal death (separately stillbirths and early neonatal deaths), low Apgar score at five minutes (0 to 6), very low Apgar score at five minutes 0 to 3, low umbilical artery pH (less than 7.00), transfer to SCN or NICU, hospitalization of a newborn for more than seven days, intubation of newborn, neonatal ventilator support, and antibiotic treatment.

We chose the following secondary outcome measures in order to detected possible confounding factors: birthweight, gestational age, any congenital anomaly detected in the perinatal period and elective cesarean section. We used SAS v9.3 (SAS Institute Inc., Cary, NC, USA) to analyze the data and calculated adjusted odds ratios (AOR) and 95% confidence intervals (95% CI), adjusted for maternal age, parity, and pre-pregnancy BMI in logistic regressions. Register-based studies require neither statement from a research ethics committee, nor informed consent of the registered persons in Finland. The data for the study were obtained from hospital register of the Helsinki and Uusimaa Hospital District. The Helsinki and Uusimaa Hospital District permitted us to use the data on all singleton hospital deliveries from the hospital register. Only anonymized data were used.

Results

Primary outcomes

The results are presented in Tables 1 and 2. The total number of singletons born in Helsinki area decreased from 29 019 to 28 074. The number of singleton low-risk babies born in the study hospital increased by 39.2% while in the population-based group the number decreased by 3.4%.

There was no significant difference in emergency cesarean section rates in the study hospital, 10.2% during the first period, and 10.3% during the second period (AOR 0.98, 95% CI; 0.90-

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1.07). In the population-based group, the rate decreased from 11.5% to 11.1% (AOR 0.95, 95% CI; 0.90-1.00). In the study hospital, the percentage of operative vaginal deliveries increased from 10.6% to 11.4%, while the percentage decreased from 10.3% to 9.8% in the population-based analysis. In both cases AORs were statistically insignificant.

The percentage of babies with low Apgar scores (<7) at five minutes increased from 1.2% to 2.1% (AOR 1.67, 95% CI; 1.36-2.05) in the study hospital. The proportion also increased in the population-based group from 2.0% to 2.6% (AOR 1.27, 95% CI; 1.38-1.42). However, when comparing very low (<4) Apgar scores, no significant difference was seen: 0.2% and 0.3% (AOR 1.21, 95% CI; 0.74-1.96) in the study hospital and 0.4% and 0.4% (AOR 1.10, 95% CI; 0.85-1.42) in the population-based analysis. Furthermore, the percentage of babies having low umbilical artery pH (<7.00) remained the same in both groups. The perinatal mortality rate remained low (4.0/1 000), and the observed decrease was statistically insignificant.

Transfers to SCN or NICU increased from 7.3% to 8.1% (AOR 1.11, 95% CI; 1.02-1.22) in the study hospital and from 10.3% to 10.8% (AOR 1.06, 95% CI; 1.00-1.14) in the population-based group. No statistical difference was detected in intubation or ventilator support of newborn in any of the groups.

The percentage of newborns receiving antibiotic treatment remained stable, 2.9% in the study group while it decreased in the population-based group from 5.8% to 5.4% (AOR 0.93, 95% CI; 0.86-1.00). Hospitalization of a newborn for more than seven days increased in the study hospital from 0.5% to 0.6% (AOR 1.03, 95% CI; 0.73-1.43), but decreased in population-based group from 1.2% to 1.0% (AOR 0.84, 95% CI; 0.71-0.98).

In the study hospital, the induction rate increased from 22.4% to 24.8% (AOR 1.06, 95% CI; 1.00-1.12) while in the population-based group the rate decreased from 22.2% to 21.5%

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(AOR 0.96, 95% CI; 0.92-1.00). Third and fourth degree perineal tears increased from 1.4% to 2.0% (AOR 1.47, 95% CI; 1.19-1.82) in the study hospital and from 1.7% to 1.9% (AOR 1.15, 95% CI; 1.00- 1.32) in the population-based group.

Secondary outcomes

In the study hospital, the percentage of babies born prematurely (before week 37) had no significant change, with 3.4% in the first period and 3.2% in the second period. Similarly, no significant change was observed in the population-based analysis: 5.4% and 5.1%. Furthermore, the change in the percentage of newborns weighting less than 2 500g was insignificant in both groups. No significant change in the percentages of babies being small for gestational age was observed in any population.

The percentage of babies weighting more than 4 500g decreased from 2.4%) to 1.9% (AOR 0.84, 95% CI; 0.71-0.99) in the study hospital. The percentage decreased also in the population-based group from 2.4% to 2.1% (AOR 0.90, 95% CI; 0.80-1.00). The percentage of babies born large for gestational age (LGA) decreased in both analyses. The change in congenital anomalies reported during the early neonatal period was insignificant in the study hospital, decreasing from 7.8% to 7.2%. In the population-based group, the percentage increased from 9.5% to 10.0% (AOR 1.07, 95% CI; 1.01-1.13).

Comment

We studied the effect of increased number of low-risk deliveries on maternal and neonatal outcome in one maternity unit in Helsinki region. The number of deliveries increased in the study hospital by 39% up to 7 800 deliveries per year. Even though the induction rate, the percentage of babies receiving low (<7) Apgar score at five minutes, and transfers to NICU

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or to tertiary hospital increased, we detected no other evidence of increased risk for adverse outcome. The increased percentage of transfers could not be explained by increased need for antibiotics or respiratory treatment. Neonatal transfers increased in all delivery units in the region and most likely reflected the change in the trend of admitting neonates to pediatric unit responsible for therapeutic hypothermia for neonates.

Studying one separate large hospital while collecting data from all hospitals in the same area allowed us to perform a population-based analysis to evaluate the simultaneous variations in the outcome measures in the same region. We excluded year 2013 because the organizational changes occurred in the middle of the year and therefore the organization and the personnel had time to be accustomed to the new circumstances.

Analyzing the effect of increased number of low-risk deliveries in one unit prevented many confounding factors which can emerge when comparing different units. The study focused on the delivery volume increase and its effects without needing to consider academic level, staff resources, medical equipment or different obstetric practices. We analyzed the secondary outcomes in order to detect other confounding factors. However, we did not collect information on the use of epidural analgesia which could possible bias the results. The use of epidural analgesia has increased from 47.3% in 2011 to 49.5% in 2015 in all Finland. The usage is much higher in the hospitals in Helsinki region (Kätilöopisto Hospital 63.7%, Women's Hospital 68%, and Jorvi Hospital 55.5% in 2015). (12)

A potential limitation of the study is that the changes and the increased volume with possible understaffing could have resulted in increased medical errors. We believe that this was not an issue in this study, since the organization scheduled trained staff and resources to assist in the

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increased workflow. Another limitation is that Finland has very low perinatal mortality. In 2015, perinatal mortality was 4.1/1 000 and early neonatal mortality was 1.0/1 000. (12) Thus, our data were not enough large to show any possible changes in mortality rates.

The rates for induction of delivery are rising worldwide. The American College of Obstetricians and Gynecologists has suggested that birth may be induced for logistic reasons, such as, risk of rapid labor, distance from hospital, or psychosocial reasons. (13) In the state of Ohio, US, 19-25% of term deliveries are induced at university hospitals and 27-39% at community hospitals. (14) Whereas the latest maternity statistics from the United Kingdom report 27% of deliveries being induced. (15)

The percentage of women with severe perineal tears increased in every delivery unit. The rate (1.9%) is higher than in all Finnish population (1.1%) but same as the European average (1.9%). (16) Furthermore, operative vaginal delivery rate in the study hospital (11.4%) is higher than in the total Finnish population (8.6%) and higher than the average European rate (7.6%). However, the emergency cesarean section rate was 10.3% in the study hospital while the rate is 10.2% in all Finland and in all the Europe the average emergency cesarean section rate is 13.3%. (17)

Processes and structural characteristics affect volume outcome association. Volume attracts financial resources and skills but it also is prone to congestion (18,19) Since significant changes in outcomes were rare, our study indicates that volume is not the only indicator for quality of care. Moreover, the number of deliveries a physician attends annually is not considered a predictive factor for maternal and fetal outcome if the delivery happens in a unit where an obstetrician and a pediatrician are readily available.(20) In larger hospitals, the knowledge gained through the interactions with other clinical specialists can potentially help

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clinicians to improve quality of outcomes for their patients. (21) A study of very-low-birth weight neonates from Germany suggest that hospital volume explains only 15% of the differences in outcomes. (22)

In conclusion, increasing patient load in high volume delivery unit could compromise the capacity to deliver quality of care, resulting in poor outcomes. Since the study hospital received supplementary staff and resources which kept the patient/ staff ratio stable, the rate of severe adverse outcomes did not increase. Our study demonstrates that in the study hospital, centralization and increased annual number of low-risk deliveries increased induction rate. It is noteworthy, that even if the rate of inductions increased, there were no increase of operative assisted delivery or emergency cesarean sections. Our study suggest that volume is one indicator for quality of care, but not the only one to be used. To ensure patient safety and staff satisfaction, further evaluation of obstetric units is required to understand how services can be best structured to optimize obstetric outcomes.

Declaration of interests

All the authors state explicitly that there are no conflicts of interest in connection with this article.

Funding

This work has no external funding.

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Table 1. Singleton hospital deliveries in study hospital (Kätilöopisto Maternity Hospital) and in all Helsinki University Maternity Hospitals (population-based analysis) in 2011-2012 and 2014-2015.

	Kätilöopisto Maternity Hospital						All Helsinki University Hospitals					
	2011-2012		2014-2015		Change		2011-2012		2014-2015		Change	
	n (%[a])		n (%[a])		n	(%)	n (%[a])		n (%[a])		n	(%)
Total number of babies born	11,267		15,704		4,437	(39.4)	29,019		28,074		-945	(-3.3)
Number of babies borns at the hospital	11,237		15,637		4,400	(39.2)	28,950		27,979		-971	(-3.4)
Small for gestational age	380	(3.4)	583	(3.7)	203	(53.4)	1,111	(3.8)	1,127	(4.0)	16	(1.4)
Large for gestational age	219	(1.9)	197	(1.3)	-22	(-10.0)	692	(2.4)	564	(2.0)	-128	(-18.5)
Weight < 2 500g	259	(2.3)	338	(2.2)	79	(30.5)	1,161	(4.0)	1,050	(3.8)	-111	(-9.6)
Weight $\geq$ 4 500g	269	(2.4)	303	(1.9)	34	(12.6)	687	(2.4)	591	(2.1)	-96	(-14.0)
Gestational age < 37+0 weeks	383	(3.4)	493	(3.2)	110	(28.7)	1,573	(5.4)	1,424	(5.1)	-149	(-9.5)
Congenital anomalies	879	(7.8)	1,133	(7.2)	254	(28.9)	2,762	(9.5)	2,803	(10.0)	41	(1.5)
Planned cesarean section	563	(5.0)	45	(0.3)	-518	(-92.0)	1,808	(6.2)	1,732	(6.2)	-76	(-4.2)
Induction of labour (planned cesarean sections exluded)	2,516	(22.4)	3,874	(24.8)	1,358	(54.0)	6,414	(22.2)	6,004	(21.5)	-410	(-6.4)
Operative vaginal delivery	1,186	(10.6)	1,785	(11.4)	599	(50.5)	2,970	(10.3)	2,746	(9.8)	-224	(-7.5)
3rd or 4th degree perineal tear	130	(1.4)	284	(2.0)	154	(118.5)	399	(1.7)	447	(1.9)	48	(12.0)
Emergency cesarean section	1,143	(10.2)	1,613	(10.3)	470	(41.1)	3,343	(11.5)	3,108	(11.1)	-235	(-7.0)
Apgar score at five minutes 0-6	138	(1.2)	322	(2.1)	184	(133.3)	592	(2.0)	729	(2.6)	137	(23.1)
Apgar score at five minutes 0-3	27	(0.2)	48	(0.3)	21	(77.8)	113	(0.4)	124	(0.4)	11	(9.7)
Umbilical artery pH < 7.00	45	(0.4)	63	(0.4)	18	(40.0)	118	(0.4)	131	(0.5)	13	(11.0)
Transfer to SCN or NICU	818	(7.3)	1,278	(8.1)	460	(56.2)	2,986	(10.3)	3,023	(10.8)	37	(1.2)
Neonatal ventilator support	132	(1.2)	211	(1.3)	79	(59.8)	455	(1.6)	464	(1.7)	9	(2.0)
Intubation of a newborn	149	(1.3)	233	(1.5)	84	(56.4)	483	(1.7)	420	(1.5)	-63	(13.0)

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Neonatal antibiotic treatment	322	(2.9)	449	(2.9)	127	(39.4)	1,678	(5.8)	1,517	(5.4)	-161	(9.6)
Hospitalization of a newborn >7 days	58	(0.5)	90	(0.6)	32	(55.2)	341	(1.2)	284	(1.0)	-57	(-16.7)
Stillbirth	32	(0.3)	28	(0.2)	-4	(-12.5)	87	(0.3)	73	(0.3)	-14	(-16.1)
Early neonatal death	2	(0.0)	3	(0.0)	1	(50.0)	35	(0.1)	35	(0.1)	0	(0.0)
Perinatal death	34	(0.3)	31	(0.2)	-3	(-8.8)	122	(0.4)	108	(0.4)	-14	(-11.5)

[a]Percentage of the babies born at the hospital.

Table 2. Odd ratios and 95% confidence intervals of singleton hospital deliveries in study hospital (Kätilöopisto Maternity Hospital) and in all Helsinki University Maternity Hospitals (population-based analysis) in 2011-2012 and in 2014-2015[a].

	Kätilöopisto Maternity Hospital			All Helsinki University Hospitals		
	2011-2012	2014-2015		2011-2012	2014-2015	
	OR		95% CI	OR		95% CI
Small for gestational age	1.00	1.09	0.95-1.24	1.00	1.05	0.96-1.15
Large for gestational age	1.00	0.67	0.55-0.81	1.00	0.84	0.75-0.95
Weight < 2 500g	1.00	0.92	0.78-1.08	1.00	0.94	0.86-1.02
Weight ≥ 4 500g	1.00	0.84	0.71-0.99	1.00	0.90	0.80-1.00
Gestational age < 37+0 weeks	1.00	0.92	0.80-1.06	1.00	0.94	0.87-1.01
Congenital anomalies	1.00	0.94	0.86-1.03	1.00	1.07	1.01-1.13
Planned cesarean section	1.00	0.05	0.04-0.07	1.00	0.98	0.92-1.05
Induction of labor (planned cesarean sections excluded)	1.00	1.06	1.00-1.12	1.00	0.96	0.92-1.00
Operative vaginal delivery	1.00	1.07	0.99-1-16	1.00	0.95	0.90-1.01

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3rd or 4th degree perineal tear	1.00	1.47	1.19-1.82	1.00	1.15	1.00-1.32
Emergency cesarean section	1.00	0.98	0.90-1.07	1.00	0.95	0.90-1.00
Apgar score at five minutes 0-6	1.00	1.67	1.36-2.05	1.00	1.27	1.38-1.42
Apgar score at five minutes 0-3	1.00	1.21	0.74-1.96	1.00	1.10	0.85-1.42
Umbilical artery pH < 7.00	1.00	0.96	0.65-1.43	1.00	1.12	0.87-1.45
Transfer to SCN or NICU	1.00	1.11	1.02-1.22	1.00	1.06	1.00-1.14
Neonatal ventilator support	1.00	1.12	0.90-1.40	1.00	1.06	0.93-1.21
Intubation of a newborn	1.00	1.08	0.87-1.34	1.00	0.88	0.77-1.01
Neonatal antibiotic treatment	1.00	0.97	0.83-1.12	1.00	0.93	0.86-1.00
Hospitalization of a newborn >7 days	1.00	1.03	0.73-1.43	1.00	0.84	0.71-0.98
Stillbirth	1.00	0.66	0.40-1.11	1.00	0.87	0.63-1.20
Early neonatal death	1.00	1.03	0.17-6.21	1.00	0.96	0.59-1.56
Perinatal death	1.00	0.69	0.42-1.13	1.00	0.90	0.69-1.17

[a]Adjusted for maternal age, parity, and BMI.