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Effect of hospital size and on-call arrangements on intrapartum and early neonatal mortality among low-risk newborns in Finland

Elina Karalis [a], Mika Gissler [b,c], Anna-Maija Tapper [a,d], Veli-Matti Ulander [a,*]

[a] University of Helsinki, Helsinki University Hospital, Department of Obstetrics and Gynecology, Helsinki, Finland
[b] THL, National Institute for Health and Welfare, Helsinki, Finland
[c] NHV, Nordic School of Public Health, Gothenburg, Sweden
[d] University of Helsinki, Hyvinkaa Hospital Area, Helsinki and Uusimaa Hospital District, Finland

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ABSTRACT

Objective: To evaluate the influence of delivery unit size and on-call staffing in the performance of low-risk deliveries in Finland.
Study design: A population-based study of hospital size and level based on Medical Birth Register data. Population was all hospital births in Finland in 2005–2009. Inclusion criteria were singleton births (birth weight 2500 g or more) without major congenital anomalies or birth defects. Additionally, only intrapartum stillbirths were included. Birthweights and maternal background characteristics were adjusted for by logistic regression. Main outcome measures were intrapartum or early neonatal mortality, neonatal asphyxia and newborns' need for intensive care or transfer to other hospital and longer duration of care. On-call arrangements were asked from each of the hospitals.
Results: Intrapartum mortality was higher in units where physicians were at home when on-call (OR 1.25; 95% CI 1.02–1.52). A tendency to a higher mortality was also recorded in non-university hospitals (OR 1.18; 95% CI 0.99–1.40). Early neonatal mortality was twofold in units with less than 1000 births annually (OR 2.11; 95% CI 0.97–4.56) and in units where physicians were at home when on-call (OR 1.85; 95% CI 0.91–3.76). These results did not reach statistical significance. No differences between the units were found regarding Apgar scores or umbilical cord pH.
Conclusion: The differences in mortality rates between different level hospitals suggest that adverse outcomes during delivery should be studied in detail in relation to hospital characteristics, such as size or level, and more international studies determining obstetric patient safety indicators are required.

Introduction

Finland has a population of approximately 5.5 million inhabitants, with an average of 60,000 births annually. The perinatal mortality in Finland is very low, 4.95 per 1000 newborns during the study period. All delivery units are a part of public health care. Hospitals are owned by coalitions of municipalities. A Parturient has the right to choose her delivery unit, although the nearest hospital is often selected. There is a well-functioning referral system within primary care. High-risk pregnancies are systematically directed to a higher-level hospital for obstetric care and delivery, and thus the newborn outcomes should not be worse in non-university hospitals. Midwives take care of the delivery in all hospitals, but physicians have the ultimate responsibility for the obstetric care. There are no midwife-led delivery units.

A large number of studies have shown that preterm newborns survive better if they are born or transferred to tertiary hospitals [1–3]. In Finland, the care of high-risk pregnancies, such as preterm birth (less than 35 gestational weeks), low birth weight deliveries or parturients with major medical diseases, are centralized to the tertiary units in university hospitals, where neonatological experience is available [4]. In contrast to preterm newborns, conclusions in studies on low-risk deliveries are incoherent [5]. Some studies have shown better outcomes for deliveries in tertiary hospitals [6,7] whereas others have not [8,9]. Also, current clinical practice varies among countries, thus making comparisons difficult. In our study we excluded stillbirths before delivery and with unknown timing, since our aim was to analyze the process of low-risk delivery more precisely. Therefore, we focused on intrapartum and early neonatal care and not on the maternal care before birth.

* Corresponding author at: Department of Obstetrics and Gynecology, Helsinki University Hospital, Haartmaninkatu 2, PL 140, 00029 Helsinki, Finland.
Tel.: +358 504 143 303.
E-mail address: Veli-Matti.Ulander@hus.fi (V.-M. Ulander).

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In 2010 the Ministry of Social Affairs and Health suggested that each delivery unit in Finland should have at least 1000 deliveries annually with a 24/7 readiness for emergency cesarean section. The objective of our study was to evaluate how two organizational features – size of the delivery unit and on-call physician staffing, affected the performance of maternity units in Finland before the Ministry's recommendation.

Materials and methods

We collected information from the National Medical Birth Register for the period 2005–2009. Only minor changes in clinical practice or in the number of hospitals occurred during those years. All delivery units in Finland submit their birth and stillbirth data to the Register, when the gestational age is at least 22 weeks or the birth weight is at least 500 g. For non-hospital deliveries, the data is submitted by the person assisting during or after the birth. The Register is maintained by the National Institute for Health and Welfare (THL). It is supplemented with data compiled by the Population Register Centre on live births and with data compiled by Statistics Finland on stillbirths and early neonatal deaths. The Register includes, among other things, information on child's health, interventions and diagnoses (International Statistical Classification of Diseases and Related Health Problems, ICD 10) up to the age of seven days and maternal diagnoses during pregnancy and labor (ICD 10).

We focused on low-risk deliveries using university hospitals as a reference group. The following exclusion criteria was applied: antepartum stillbirth, planned or unplanned home delivery, delivery on the way to hospital, birth weight under 2500 g, multiple pregnancy, and major congenital anomalies or birth defects of the newborn as reported to the National Register on Congenital Anomalies. Data from the Medical Birth Register and the National Register on Congenital Anomalies were linked by using the mothers' and infants' identification numbers. In Finland, Register-based studies require no statement from a research ethics committee. Permission to use the Register data was obtained from THL, the organization that holds the Medical Birth Register. The data set used in the analysis was made anonymous.

Antenatal screening for chromosomal anomalies was not uniform or comprehensive during this period in Finland. Government regulation concerning antenatal screening, which includes combined chromosomal screening (serum and nuchal translucency) in the first trimester and morphological examination in the second trimester, has been offered to all pregnant women since 2010, but implementation of this regulation started in 2007. Therefore, most major congenital anomalies are known in advance and the births concerned are directed to a higher level hospital.

During the study period, delivery units arranged on-call autonomously in Finland. In smaller units – most with fewer than 1000 births, but also in some units with 1000–1999 births annually – physicians were allowed to be at home while on-call, arriving within 30–60 min when necessary. Physicians were either specialists or residents in Obstetrics and Gynecology. Pediatrician was available within 30–60 min and a neonatologist was available only in the tertiary unit at the university hospitals. In small units anesthesiologists were also allowed to be at home while on-call, whereas the rest of the operating theater staff was staying at the hospital.

We investigated the influence of the unit size and on-call arrangements on intrapartum, early neonatal mortality, neonatal asphyxia, newborn's need for more intensive care or hospitalization, by conducting multivariable logistic regression, while adjusting for demographic characteristics (maternal age and parity). Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to indicate the likelihood of adverse obstetric and neonatal outcomes. The statistical software package SAS 9.3 (SAS Institute Inc., USA) was used for data analysis.

Between 2005 and 2009, 296,397 births occurred. Our study group consisted of 267,390 births (90.2%). During the study, 324 cases (0.1%) were excluded as a result of missing values, thus 267,066 deliveries remained for statistical analysis. University hospitals were categorized separately and used as a reference group. According to the annual number of deliveries, the remaining hospitals were stratified into three size categories; large units (2000 births or more annually), medium-sized units (1000–1999 births) and small units (fewer than 1000 births). Furthermore, two groups were created according to the arrangements of the physician on-call: hospitals with the physician at the hospital and hospitals where the physician was allowed to be at home. University hospitals were also here categorized separately.

Neonatal asphyxia was defined by any of the following criteria: umbilical cord artery pH less than seven postpartum, one-minute Apgar score between 0 and 3, or five-minute Apgar score between 0 and 6. These criteria were chosen according to international consensus to define an acute intrapartum hypoxic event [10]. We also collected data on newborns' need for intensive care, transportation of the newborn to another (higher level) hospital, and duration of hospitalization of the newborn.

Results

Our study group consisted of 267,066 low risk deliveries. One third of them, 84,681 (32%) births occurred in large non-university units, 51,185 (19%) deliveries in medium-sized units, and 39,385 (15%) deliveries in small units. One third of the deliveries (92,139 deliveries, 34%) were reported in university hospitals. In total, 63,198 (24%) births occurred in units where the physician was at home when on-call. In our data on low-risk deliveries, the intrapartum mortality was 2.7 per 1000 newborns ($n = 709$) and early neonatal mortality rate was 0.2 per 1000 newborns ($n = 54$).

Maternal background information is shown in Table 1. Most women were 25–34 years old and nearly half of them (43%) were nulliparous. Newborn outcomes are shown in Table 2. Combined 5 min Apgar scores and cord blood pH values were better in large non-university units (OR 0.83; 95% CI 0.78–0.89). However, when comparing very small units to university hospitals, there was no difference recorded (OR 0.99; 95% CI 0.91–1.08). The intrapartum mortality rate was elevated in units where physicians were at home when on-call (OR 1.25; 95% CI 1.02–1.52) and in mid-sized hospitals (OR 1.31; 95% CI 1.07–1.61). The early neonatal mortality rate was twofold in small units and in units where physicians were allowed to be at home when on-call (OR 2.11; 95% CI 0.97–4.56 and OR 1.85; 95% CI 0.91–3.76, respectively) even though these results did not reach statistical significance (Table 4). However, when studying Apgar scores and umbilical cord pH values, the adverse outcomes could not be expected.

Newborn hospitalization in any type of hospital or mode of on-call duty for more than 7 days did not give raise to suspect differences in mortality. Most newborns stayed at the hospital for 2–3 days. It is noteworthy that in very small units a higher percentage of newborns were hospitalized for more than 3 days compared to university hospitals. (Table 3) In university hospitals, infants received more intensive care and were transferred to neonatal intensive care units more often than in smaller hospitals, as expected (Table 2).

Comment

Our study was challenging, the first attempt to assess intrapartum care of low-risk deliveries and infants without congenital anomalies in Finland. We excluded antepartum

Table 1
Background information of singleton hospital births excluding newborns with birth weight less than 2500 g and with major congenital anomalies (%).

	University hospital	Annual number of births			On-call		Total
		≥2000	1000–1999	≤999	At hospital	At home	
N	92,139	84,681	51,185	39,385	112,053	63,198	267,390
Maternal age							
14–19	2098 (2.3)	2022 (2.4)	1393 (2.7)	1219 (3.1)	2825 (2.5)	1809 (2.9)	6732 (2.5)
20–24	13,961 (15.2)	12,971 (15.3)	8868 (17.3)	7446(18.9)	17,487 (15.6)	11,798 (18.7)	43,246 (16.2)
25–29	29,056 (31.5)	27,026 (31.9)	17,197 (33.6)	12,825 (32.6)	36,027 (32.2)	21,021 (33.3)	86,104 (32.2)
30–34	29,153 (31.6)	27,384 (32.3)	15,039 (29.4)	11,213 (28.5)	35,624 (31.8)	18,012 (28.5)	82,789 (31)
35–39	14,104 (15.3)	12,548 (14.8)	6972 (13.6)	5370 (13.6)	16,436 (14.7)	8454 (13.4)	38,994 (14.6)
40–44	3599 (3.9)	2635 (3.1)	1636 (3.2)	1259 (3.2)	3522 (3.1)	2008 (3.2)	9129 (3.4)
45–52	168 (0.2)	95 (0.1)	80 (0.2)	53 (0.1)	132 (0.1)	96 (0.2)	396 (0.1)
Parity							
0	39,703 (43.1)	36,388 (43.0)	20,540 (40.1)	14,982 (38.0)	47,456 (42.4)	24,454 (38.7)	111,613 (41.7)
1	30,766 (33.4)	29,054 (34.3)	17,269 (33.7)	13,021 (33.1)	38,442 (34.3)	20,902 (33.1)	90,110 (33.7)
2	12,769 (13.9)	11,929 (14.1)	8115 (15.9)	6416 (16.3)	16,234 (14.5)	10,226 (16.2)	39,229 (14.7)
3	4401 (4.8)	3952 (4.7)	2841 (5.6)	2473 (6.3)	5408 (4.8)	3858 (6.1)	13,667 (5.1)
4–18	4408 (4.8)	3145 (3.7)	2418 (4.7)	2476 (6.3)	4300 (3.8)	3739 (5.9)	12,447 (4.7)
Unknown	92 (0.1)	213 (0.3)	2 (0.0)	17 (0.0)	213 (0.2)	19 (0.0)	324 (0.1)

stillbirths since our aim was to focus on intrapartum and early neonatal care, not on the maternal care prior to birth. Thus our results should reflect the actual intrapartum care better than previous studies of perinatal mortality.

Due to the low rate of perinatal mortality in Finland, a large cohort with data covering several years is needed to observe any differences between delivery units. This study demonstrates that the intrapartum mortality was higher in units where the physician on-call was at home.

One possible explanation to the fact that pH values did not correspond with perinatal mortality is that the smaller the hospital the less pH values were recorded, even though pH value measurement was in use in all but one small hospital during the study period. Evaluating the lactate value could not be used, since it was not in use during this period in Finland.

Even though there are only a few intrapartum and neonatal deaths annually, for the couples death is devastating. By centralizing all births to bigger units with a physician on-call at the hospital, a few perinatal deaths could be saved per year. Also, deliveries in small units are expensive and increase healthcare expenditure [11]. However, centralization might lead to increasing numbers of unplanned out-of-hospital deliveries, as the distance to the birth unit becomes longer. This negates the positive effect of centralization, since perinatal mortality rate in unplanned out-of-hospital deliveries is shown to be at least twofold compared to hospital deliveries [12]. Also, a recent Finnish study showed that by decreasing the number of delivery units from 49 to 34, the rate of unplanned out-of-hospital deliveries doubled in two decades [8]. In addition, perinatal and neonatal deaths are associated with the most expensive instances of compensation regarding patient injuries [13]. A more detailed cost evaluation is needed to estimate the total costs of centralization, including costs of hospital births, accidental out-of-hospital births and adverse maternal and infant outcomes.

A strength of this study is the reliability of the National Medical Birth Register, as shown in previous data quality studies [14,15]. The completeness of the register data allowed us to use accurate exclusion criteria; infants with congenital anomalies, low birth weight, multiple births and births occurring outside the hospital.

A possible limitation of this study is that intrapartum and early neonatal mortalities are rough ways to assess adverse outcomes. We used several other measures for perinatal outcomes, but their value as outcome measures is limited because of subjective elements of Apgar scores and missing information of umbilical cord pH values. Another limitation is that even after using our exclusion criteria, the deliveries did not have equally low risk in different levels of hospitals, since mothers with other risk factors than those available for our exclusion criteria were sent to higher-level hospitals.

Intrapartum or early neonatal mortality is a rare complication. Unfortunately, the significance of several other indicators during delivery still remains unclear. In our study, Apgar scores and umbilical pH values did not reveal differences in care during delivery. This is in line with previous studies in determining obstetric patient safety indicators, suggesting more national and international projects for creating international consensus on quality indicators [16,17]. Newborn outcomes should not be worse

Table 2
Newborn outcome by the size of birth hospital, Finland 2005–2009.

	University hospital	Annual number of births			Total
		≥2000	1000–1999	≤999	
N	92,139	84,681	51,185	39,385	267,390
1 min Apgar score 0–3					
n	799	667	397	291	1863
%	0.9	0.8	0.8	0.7	0.7
5 min Apgar score 0–6					
n	1342	1034	793	600	3169
%	1.5	1.2	1.5	1.5	1.2
pH value of umbilical artery blood <7					
n	361	235	179	99	775
%	0.4	0.3	0.3	0.3	0.3
Low Apgar scores or low pH value					
n	1891	1452	1041	753	4384
%	2.1	1.7	2.0	1.9	1.6
Newborn care at intensive care unit, observation unit or transferred to other hospital					
n	8750	6125	4550	2139	19,425
%	9.5	7.2	8.9	5.4	7.3

Adjusted OR (age, parity) with 95% CI

University hospital	Annual number of births		
	≥2000	1000–1999	≤999
1.00	0.91 (0.82–1.00)	0.92 (0.82–1.04)	0.90 (0.79–1.03)
1.00	0.84 (0.77–0.91)	1.10 (1.00–1.20)	1.11 (1.00–1.22)
1.00	0.71 (0.60–0.84)	0.94 (0.79–1.13)	0.70 (0.56–0.88)
1.00	0.83 (0.78–0.89)	1.02 (0.95–1.10)	0.99 (0.91–1.08)
1.00	0.74 (0.72–0.77)	0.95 (0.91–0.98)	0.57 (0.54–1.59)

Table 3
Newborn hospital care in days (%).

Days	University hospital	On-call		Annual number of births			Total
		At hospital	At home	≥2000	1000–1999	≤999	
0	203 (0.2)	388 (0.3)	228 (0.4)	264 (0.3)	184 (0.4)	168 (0.4)	819 (0.3)
1	2426 (2.6)	3807 (3.4)	1842 (2.9)	3001 (3.5)	1395 (2.7)	1253 (3.2)	8075(3.0)
2	20,578 (22.3)	31,882 (28.5)	14,787 (23.4)	23,718 (28.0)	14,694 (28.7)	8257 (21.0)	67,247 (25.1)
3	28,565 (31.0)	32,008 (28.6)	20,999 (33.2)	21,937 (25.9)	18,380 (35.9)	12,690 (32.2)	81,572 (30.5)
4	15,319 (16.6)	14,966 (13.4)	12,950 (20.5)	10,662 (12.6)	8688 (17.0)	8566 (21.7)	43,235 (16.2)
5	6639 (7.2)	5072 (4.5)	6455 (10.2)	3283(3.9)	3721(7.3)	4523 (11.5)	18,166 (6.8)
6	3779 (4.1)	2204 (2.0)	2743 (4.3)	1482 (1.8)	1607 (3.1)	1858 (4.7)	8726 (3.3)
7	2754 (3.0)	1174 (1.0)	2066 (3.3)	663 (0.8)	1406 (2.7)	1171 (3.0)	5994 (2.2)
Unknown	11,876 (12.9)	20,558 (18.3)	1128 (1.8)	19,671 (23.2)	1110 (2.2)	899 (2.3)	33,556 (12.5)

Table 4
Intrapartum and early neonatal deaths.

	University hospital	On-call		Annual number of births			Total
		At hospital	At home	≥2000	1000–1999	≤999	
Intrapartum deaths							
n	219	309	181	227	155	108	709
per 1000	2.4	2.8	2.9	2.7	3.0	2.7	2.7
Early neonatal deaths							
n	14	23	17	15	13	12	54
per 1000	0.2	0.2	0.3	0.2	0.3	0.3	0.2
Adjusted OR (age, parity) with 95% CI							
Intrapartum deaths	1.00	1.18 (0.99–1.40)	1.25 (1.02–1.52)	1.15 (0.95–1.38)	1.31 (1.07–1.61)	1.19 (0.95–1.51)	
Early nenonatal deaths	1.00	1.36 (0.70–2.64)	1.85 (0.91–3.76)	1.17 (0.56–2.42)	1.72 (0.81–3.66)	2.11 (0.97–4.56)	

in smaller non-university hospitals, since high-risk pregnancies are systematically directed to a higher-level hospital for obstetric care and delivery. Our study suggests that adverse outcomes during delivery should be studied in detail and in relation to hospital characteristics, such as size and level of care.

Conflict of interest

The authors report no conflict of interest.

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