Does delivery volume of family physicians predict maternal and newborn outcome?

Research

Recherche

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Abstract

Background: The number of births attended by individual family physicians who practice intrapartum care varies. We wanted to determine if the practice–volume relations that have been shown in other fields of medical practice also exist in maternity care practice by family doctors.

Methods: For the period April 1997 to August 1998, we analyzed all singleton births at a major maternity teaching hospital for which the family physician was the responsible physician. Physicians were grouped into 3 categories on the basis of the number of births they attended each year: fewer than 12, 12 to 24, and 25 or more. Physicians with a low volume of deliveries (72 physicians, 549 births), those with a medium volume of deliveries (34 physicians, 871 births) and those with a high volume of deliveries (46 physicians, 3024 births) were compared in terms of maternal and newborn outcomes. The main outcome measures were maternal morbidity, 5-minute Apgar score and admission of the baby to the neonatal intensive care unit or special care unit. Secondary outcomes were obstetric procedures and consultation patterns.

Results: There was no difference among the 3 volume cohorts in terms of rates of maternal complications of delivery, 5-minute Apgar scores of less than 7 or admissions to the neonatal intensive care unit or the special care unit, either before or after adjustment for parity, pregnancy-induced hypertension, diabetes, ethnicity, lone parent status, maternal age, gestational age, newborn birth weight and newborn head circumference at birth. High- and medium-volume family physicians consulted with obstetricians less often than low-volume family physicians (adjusted odds ratio [OR] 0.586 [95% confidence interval, CI, 0.479–0.718] and 0.739 [95% CI 0.583–0.935] respectively). High- and medium-volume family physicians transferred the delivery to an obstetrician less often than low-volume family physicians (adjusted OR 0.668 [95% CI 0.542–0.823] and 0.776 [95% CI 0.607–0.992] respectively). Inductions were performed by medium-volume family physicians more often than by low-volume family physicians (adjusted OR 1.437 [95% CI 1.036–1.992].

Interpretation: Family physicians' delivery volumes were not associated with adverse outcomes for mothers or newborns. Low-volume family physicians referred patients and transferred deliveries to obstetricians more frequently than high- or medium-volume family physicians. Further research is needed to validate these findings in smaller facilities, both urban and rural.

More than 20 years ago, Luft and associates[1] conducted one of the earliest volume–outcome studies. Since then, many studies addressing the relation between volume of procedures and patient outcomes have been published.[2,3] In some of these studies, either the hospital size or the physician procedural volume was used as a surrogate for physician expertise. Among studies analyzing hospital volumes and outcomes, better outcomes have been associated with higher patient volumes in some instances[4–7] but not others.[3,8,9] Some studies of individual provider volume have shown a positive relation between volume and outcomes,[10,11] whereas others have shown no relation or inconsistent results.[3,12] Finally, a few studies analyzing both hospital volume and provider volume have reported a positive volume–outcome relation.[13,14]

Criticism levelled at the methods used in volume–outcome studies have addressed the lack of adjustment for case mix, different cutoff points for volume categories and retrospective design.[3] Other factors that have an effect on patient outcomes but that have not been included in previous volume analyses include health maintenance organization status, physician certification and years since graduation, and patient socioeconomic status, age and ethnicity. Furthermore, most of the studies on volume have covered surgical or oncology specialities.

The few studies that have been done on volume and outcome in maternity care have shown variable effects. Rural health care is often associated with lower volumes of obstetric procedures. However, no differences in maternal or newborn outcomes have been shown in some comparisons of births in urban and rural locations.[15–18] Other studies have shown poorer maternal and newborn outcomes in low-volume hospitals, neonatal intensive care units (NICUs) and rural locations.[19–22] Conversely, higher volume (hospitals with more than 1000 deliveries per year) has been associated with more maternal lacerations or complications.[23]

When the health care provider has been the unit of analysis, a relation between volume and maternal or newborn outcome has been demonstrated in at least one study[24] but not in others.[25,26] Low volume has been defined as 20 to 24 deliveries per year.[24,26] Hass and colleagues[24] reported an adjusted odds ratio (OR) of 1.4 for low birth weight for infants delivered by low-volume non-board-certified physicians relative to high-volume non-board-certified physicians; the adjusted OR was 1.56 for low-volume board-certified physicians relative to high-volume board-certified physicians (98.7% of whom were obstetricians).

Possible explanations for the differences among studies include differences in health care delivery systems, insurance coverage, experience and training of providers, maternal risk factors, triage or transfer of high-risk cases, choice of outcome measures, and changes over time in access to care, quality assurance and standard of living. Relations have been reported between maternal or newborn outcomes and smoking, maternal history of low birth weight (for previous pregnancies), pregnancy–induced hypertension, diabetes, prepregnancy weight, gestational weight gain, maternal height and age, multiple gestation, previous vaginal birth after cesarean section, history of previous delivery problems, parity, large-for-date fetus, ethnicity and fetal sex.[25,27–29] Few studies of the relation between volume of births and obstetric outcome have been able to control for these potentially confounding variables and adjust for maternal risk factors.

Our database of detailed accounts of births in one hospital setting allowed us to examine this issue more rigorously. We posed 2 research questions: Is there a relation between the volume of deliveries attended by individual family physicians and maternal and newborn outcomes? If there are differences in outcomes, are they related to different physician practice styles and consultation patterns?

Methods

We studied all births, excluding multiple gestations, at BC Women's Hospital and Health Centre from April 1997 to August 1998. The final sample consisted of 152 family physicians who attended a total of 4444 singleton births, which represented slightly fewer than half of the births at the institution during the study period. The remaining births, coded as "obstetrician responsible," were excluded from our analysis. We classified physicians into 3 categories of delivery volume on the basis of births attended per year: low (fewer than 12), medium (12 to 24) and high (25 or more). These categories are equivalent to those employed by the Society of Obstetricians and Gynaecologists of Canada (SOGC).[30] These volume categories corresponded to fewer than 18, 19 to 36, or 37 or more births for the 18-month study period.

Data on all births at our hospital are routinely collected from charts and entered into a database used for research and quality assurance purposes. The information recorded relates to the mother, the newborn, the delivery and the physician attending the birth. All data are measured, collected and reported by nursing or medical staff and are routinely abstracted from charts by trained medical records abstractors on the basis of guidelines developed by the Canadian Institute for Health Information (CIHI) and adapted by the facility.[31]

According to standard CIHI criteria, a birth is attributed to a family physician if he or she was considered the caregiver "most responsible" for the care of a particular patient, even if the care was shared with an obstetrician or the delivery was managed or performed by an obstetrician.[31] This method attributes responsibility to the family physician when he or she is the admitting physician. The designation of an obstetric consult is based on a written consultation, progress notes, or a delivery or operative report in the patient's chart. Our methods are intended to ensure that consultants are not held responsible for outcomes when they assist family physicians.

Race or ethnicity is coded according to 12 categories, which we collapsed into white and other (including Asian, Hispanic and Middle Eastern). The data on ethnicity are abstracted through 3 different sources: a structured nursing form, a structured antenatal form and physician progress notes. Entries are made by the designated professional.

The main outcome measures were maternal complications, 5-minute Apgar score less than 7, and admission to a NICU or special care unit. Maternal complications were grouped into a complex maternal morbidity index created specifically for this study, which reflected the presence of at least one of the following conditions: postpartum urinary tract infection, postpartum hemorrhage, intrapartum or postpartum pyrexia, complications of cesarean section (such as infection, hematoma or hemorrhage) or severe (greater than second-degree) perineal trauma. Because some of these outcomes are rare, we grouped all maternal complications into one measure. This index is based on presence or absence.

Secondary outcomes were obstetric procedures and consultation patterns: continuous electronic fetal monitoring, induction, oxytocin augmentation, epidural analgesia, episiotomy, instrumentation, cesarean section, obstetric consultation and delivery performed by the family physician or obstetrician.

The potential confounders available in the database and used in the multivariate analyses were parity, pregnancy-induced hypertension, gestational diabetes (type 1 or 2), ethnicity (white or other), lone parent status, maternal age, gestational age, birth weight and head circumference at birth.

We employed both univariate and multivariate analyses. In the univariate analysis, categorical variables were compared by means of the χ^2 test. Multiple logistic regression was used to estimate the adjusted effect of family physicians' delivery volume on maternal and newborn outcomes, as well as their use of selected procedures and consultation patterns. The continuous variables (maternal age, gestational age, birth weight and head circumference at birth) were categorized, and indicator variables were used. An indicator variable was also used to represent the 3 delivery volume cohorts. The variable for physicians' delivery volume was retained in all models, regardless of significance. All potential confounding factors were entered by means of forward selection stepwise logistic regression analysis and the likelihood ratio test, with a threshold for selection of $p < 0.05$. ORs and 95% confidence intervals (CIs) were calculated by logistic regression analysis. The probability of a type I error (α) was chosen to be 0.05 (2-tailed).

Our study received ethical approval from the University of British Columbia.

Results

A total of 4444 births were attended by 152 family physicians during the study period (Table 1). The 72 family physicians with a low volume of deliveries attended a total of 549 births, the 34 medium-volume family physicians attended 871 births, and the 46 high-volume family physicians attended 3024 births. There were few demographic or risk differences between the women attended by the 3 family physician cohorts. Statistically significant differences included percentage of white women (43.7%, 54.5% and 40.2% respectively, $p < 0.001$), percentage of women who were lone parents (8.6%, 10.6% and 6.3% respectively, $p < 0.001$) and percentage of newborns with head circumference greater than 35 cm (47.2%, 49.7% and 54.4% respectively, $p = 0.047$).

In the univariate analysis there were no statistically significant differences among the volume cohorts in the percentage of women with complex maternal morbidity, in percentage of infants with 5-minute Apgar score less than 7 or in rates of admission to the NICU or the special care unit (Table 2). Because of the possible differences in case mix and the distribution of risk factors across the 3 volume cohorts, the analyses were adjusted for variables potentially associated with the outcomes of interest. The multivariate

Table 1: Characteristics of mothers and newborns according to physicians' delivery volume over 18-month study period

	Physicians' delivery volume*; no. (and %) of mothers or newborns								
Characteristic	Total *n = 4444*		Low *n = 549*		Medium *n = 871*		High *n = 3024*		*p* value†
Mother									
Primiparous	2324	(52.3)	291	(53.0)	467	(53.6)	1566	(51.8)	0.60
Medical conditions									
Pregnancy-induced hypertension	133	(3.0)	22	(4.0)	27	(3.1)	84	(2.8)	0.29
Gestational diabetes (type 1)	46	(1.0)	3	(0.5)	6	(0.7)	37	(1.2)	0.19
Gestational diabetes (type 2)	185	(4.2)	24	(4.4)	28	(3.2)	133	(4.4)	0.30
White	1931	(43.4)	240	(43.7)	475	(54.5)	1216	(40.2)	< 0.001
Lone parent	330	(7.4)	47	(8.6)	92	(10.6)	191	(6.3)	< 0.001
Maternal age, yr									
< 20	105	(2.4)	14	(2.6)	26	(3.0)	65	(2.1)	
20–34	3347	(75.3)	404	(73.6)	630	(72.3)	2313	(76.5)	
≥ 35	992	(22.3)	131	(23.9)	215	(24.7)	646	(21.4)	0.10
Newborn									
Gestational age, wk									
< 37	242	(5.4)	31	(5.6)	49	(5.6)	162	(5.4)	
37–40	3453	(77.7)	419	(76.3)	658	(75.5)	2376	(78.6)	
≥ 41	749	(16.8)	99	(18.0)	164	(18.8)	486	(16.1)	0.32
Birth weight, g									
< 2500	193	(4.3)	30	(5.5)	38	(4.4)	125	(4.1)	
2500–3999	3769	(84.8)	456	(83.1)	734	(84.3)	2579	(85.3)	
≥ 4000	482	(10.8)	63	(11.5)	99	(11.4)	320	(10.6)	0.59
Head circumference at birth ≥ 35 cm	2338	(52.6)	259	(47.2)	433	(49.7)	1646	(54.4)	0.047

*Low volume, ≤ 18 deliveries during the study period; medium volume, 19–36 deliveries; high volume, ≥ 37 deliveries.
†χ^2 tests.

logistic regression analyses adjusted for statistically significant confounders confirmed that there were no statistically significant differences in maternal and newborn outcomes on the basis of physicians' delivery volume (Table 3).

Because of the possible association between procedures and maternal and newborn outcomes, we also analyzed the use of procedures and consultation patterns. In the univariate analyses, the only significant differences between the low-, medium- and high-volume cohorts were for induction of labour (14.4%, 19.3% and 15.1% respectively, $p = 0.008$), obstetric consultation (53.0%, 48.1% and 43.2% respectively, $p < 0.001$), and deliveries by an obstetrician (34.6%, 31.0% and 28.6% respectively, $p = 0.013$) (Table 4).

The multivariate logistic regression analyses, adjusted for maternal and newborn risk and demographic factors, showed that high- and medium-volume family physicians consulted with obstetricians less often than low-volume family physicians (adjusted OR 0.586 [95% CI 0.479–0.718] and 0.739 [95% CI 0.583–0.935] respectively) (Table 5). High- and medium-volume family physicians also transferred the delivery to an obstetrician less often than low-volume family physicians (adjusted OR 0.668 [95% CI 0.542–0.823] and 0.776 [95% CI 0.607–0.992] respectively). Births were induced more often for patients of medium-volume family physicians (19.3%) than for patients of low-volume family physicians (14.4%) (adjusted OR 1.437 [95% CI 1.036–1.992]). Patients of medium-volume family physicians were significantly less likely to undergo episiotomy (17.2%) than patients of low-volume family physicians (22.7%) (adjusted OR 0.662 [95% CI 0.482–0.911]).

Interpretation

The number of births that a family physician attends was not associated with rates of adverse outcomes in this large urban teaching hospital. This lack of a relation between delivery volume and maternal and newborn outcomes concurs with the findings of LeFevre[25] and Tilyard

Table 2: Maternal and newborn outcomes

	Physician's delivery volume; no. (and %) of mothers or newborns				
Outcome	Total *n = 4444*	Low *n = 549*	Medium *n = 871*	High *n = 3024*	*p* value*
Complex maternal morbidity†	746 (16.8)	92 (16.8)	164 (18.8)	490 (16.2)	0.189
5-min Apgar score < 7	158 (3.6)	22 (4.0)	25 (2.9)	111 (3.7)	0.441
Admission to NICU or SCU	507 (11.4)	64 (11.6)	101 (11.6)	342 (11.3)	0.954

Note: NICU = neonatal intensive care unit, SCU = special care unit.
*χ^2 tests.
†Presence of one or more of the following conditions: postpartum urinary tract infection, postpartum hemorrhage, intrapartum or postpartum pyrexia, complications of cesarean section or perineal wounds, third- or fourth-degree perineal tears.

Table 3: Multivariate odds ratios for association between physician's delivery volume over 18-month study period and maternal and newborn outcomes (*n* = 4267*)

Outcome and physician's delivery volume	Adjusted OR (and 95% CI)		*p* value	Variables adjusted for (significant at *p* < 0.05)
Complex maternal morbidity†				P, PIH, E, BW, HC
Low (reference)	1.0	–	–	
Medium	1.137	(0.845–1.529)	0.398	
High	0.960	(0.743–1.242)	0.758	
5-min Apgar score < 7				P, PIH, GA
Low (reference)	1.0	–	–	
Medium	0.652	(0.339–1.251)	0.198	
High	0.908	(0.540–1.524)	0.714	
Admission to NICU or SCU				P, PIH, GD (type 1), LP, GA, BW
Low (reference)	1.0	–	–	
Medium	0.862	(0.584–1.274)	0.457	
High	0.849	(0.610–1.181)	0.332	

Note: OR = odds ratio, CI = confidence interval, P = parity, PIH = pregnancy-induced hypertension, GD = gestational diabetes, E = ethnicity, LP = lone parent, GA = gestational age, BW = birth weight, HC = head circumference at birth.
*Data for 177 births were missing, so only 4267 births are covered by the adjusted models.
†Presence of one or more of the following conditions: postpartum urinary tract infection, postpartum hemorrhage, intrapartum or postpartum pyrexia, complications of cesarean section or perineal wounds, third- or fourth-degree perineal tears.

and collaborators[26] but not those of Hass and associates.[24] Hass and associates[24] used birth weight as the outcome variable, but we did not find any significant difference in birth weight among the volume cohorts in this study.

Low-volume family physicians consulted with obstetricians and transferred deliveries to obstetricians more often than their higher-volume colleagues, a finding similar to that reported by Tilyard and collaborators.[26] The tendency for patients of medium-volume family physicians to undergo slightly more inductions and slightly fewer episiotomies was unexpected and difficult to interpret. It is most likely a statistical difference of little clinical importance. None of the literature reviewed reported differences in practice patterns between low- and medium-volume physicians.

Rates of continuous electronic fetal monitoring, induction, use of epidural analgesia, performance of cesarean section and obstetric consultation were higher in this population than in similar populations, but rates of oxytocin augmentation and episiotomy use were lower.[32,33,35] It is unlikely that patient risk factors were responsible for the higher procedure rates, since the risk factors in our population were similar to those reported in other studies. It is possible that the higher rate of procedure use was a result of more frequent obstetric consultation (45.4% of the mothers in this study were referred for such consultation).[36]

Most family physicians practising obstetrics in British Columbia have a low volume of deliveries (mean 31.6 per year), although the self-reported national average is 40.[37] The average for our study population was 29 births in 18 months or 19.3 births/year. Of the 152 physicians in our sample, 72 (47.4%) had a low volume of deliveries. The SOGC has until recently recommended that "physicians with low volumes of obstetrical patients should restrict their practice to 'normal' obstetrics and should update their skills every 2 to 3 years."[30] Two provincial medical regulatory bodies have already recommended application of this guideline. If this policy were to be enforced, it might result in many low-volume family physicians abandoning maternity care, which would in turn limit access to maternity care. We have shown that low-volume family physicians can achieve maternal and newborn outcomes comparable to those of high-volume physicians, if, they are able to consult with obstetricians when needed. Thus the SOGC and provincial guidelines may have to be revised.

There are a number of possible reasons why the outcomes in this study did not vary with physician volume, for example, the existence of maternity care policies and procedures, the higher obstetric consultation rate by low-volume physicians and a lower-risk study population. Ethnicity might also have been a factor. It has been reported that perinatal outcomes among Chinese women and infants are better than those of white women and newborns.[27,28] Of the women in this study, 60% were non-white, whereas 31% of women in the Vancouver area belong to visible minorities.[38] Because of the inconsistent coding of ethnicity, we are unable to correctly estimate the percentage of the study group that was Chinese. It is therefore possible that the patients were generally "healthier" than might be expected. Apart from ethnicity, the risk factors in this study population were similar to or higher than those reported elsewhere.[32–34]

We cannot say if access to the resources of a tertiary care facility, including obstetricians and pediatricians, was a factor enabling low-volume family physicians to achieve similar outcomes to their higher-volume counterparts. The results of this study may not be generalizable to smaller centres, where obstetric and pediatric consults are not as readily available. We did not include the number of years in practice as a variable, but this characteristic might affect maternal and newborn outcomes. Further work in other institutions, with similar data collection methods and adjustment for case mix, risk, hospital size, and urban or rural location as well as number of years of experience of the physician, is needed to validate these findings. This is the next phase of our investigations.

Table 4: Frequency of procedures and processes

	Physician's delivery volume; no. (and %) of deliveries				
Procedure or process	Total *n* = 4444	Low *n* = 549	Medium *n* = 871	High *n* = 3024	*p* value
Electronic fetal monitoring	3184 (71.6)	400 (72.8)	642 (73.7)	2142 (70.8)	0.20
Induction	705 (15.9)	79 (14.4)	168 (19.3)	458 (15.1)	0.008
Oxytocin augmentation	703 (15.8)	94 (17.1)	126 (14.5)	483 (16.0)	0.38
Epidural	1280 (28.8)	174 (31.7)	267 (30.6)	839 (27.7)	0.07
Episiotomy*	711 (19.2)	103 (22.7)	125 (17.2)	483 (19.1)	0.06
Instrument delivery†	590 (13.3)	79 (14.4)	109 (12.5)	402 (13.3)	0.60
Cesarean section	735 (16.5)	96 (17.5)	145 (16.6)	494 (16.3)	0.80
Obstetric consultation	2016 (45.4)	291 (53.0)	419 (48.1)	1306 (43.2)	< 0.001
Baby delivered by obstetrician	1326 (29.8)	190 (34.6)	270 (31.0)	866 (28.6)	0.013

*Vaginal deliveries only (*n* = 3709). For these deliveries, 453 were by low-volume physicians, 726 were by medium-volume physicians and 2530 were by high-volume physicians.
†Forceps and vacuum.

In conclusion, the number of births that a family physician attends does not appear to be a factor in birth outcomes, at least in a large urban teaching hospital with appropriate resources and expertise. In this setting, low-volume physicians tended to consult with obstetricians more frequently. The conventional wisdom relating to volume and outcome is based primarily on surgical practices and should not be applied to other types of medical practice.

Postscript

In light of this and other evidence, the SOGC, the College of Family Physicians of Canada and the Society of Rural Physicians of Canada have come together to affirm that competence in obstetric care does not depend on the number of births attended annually. This position replaces SOGC policy statement 24 on the recommended number of deliveries to maintain competence.[30]

Table 5: Multivariate OR for association between physician's delivery volume (over 18-month study period) and selected procedures (*n = 4267*)*

Procedure and physician's delivery volume	Adjusted OR	(and 95% CI)	*p* value	Variables adjusted for (significant at $p < 0.05$)
Electronic fetal monitoring				P, PIH, GD (type 1), LP, GA
Low (reference)	1.0	–	–	
Medium	0.996	(0.762–1.302)	0.98	
High	0.914	(0.727–1.148)	0.44	
Induction				P, PIH, GD (type 1), E, GA, HC
Low (reference)	1.0	–	–	
Medium	1.437	(1.036–1.992)	0.030	
High	1.120	(0.840–1.494)	0.44	
Oxytocin augmentation				P, PIH, LP, MA, BW, HC
Low (reference)	1.0	–	–	
Medium	0.759	(0.557–1.034)	0.08	
High	0.887	(0.685–1.149)	0.36	
Epidural analgesia				P, PIH, GD (type 1), E, GA, BW, HC
Low (reference)	1.0	–	–	
Medium	0.829	(0.643–1.068)	0.15	
High	0.757	(0.610–0.941)	0.012	
Episiotomy†				P, PIH, E, MA, GA, HC
Low (reference)	1.0	–	–	
Medium	0.662	(0.482–0.911)	0.011	
High	0.777	(0.598–1.011)	0.06	
Instrument delivery‡				P, MA, GA
Low (reference)	1.0	–	–	
Medium	0.799	(0.575–1.110)	0.18	
High	0.883	(0.670–1.163)	0.38	
Cesarean section				P, PIH, GD (type 1 and 2), E, MA, GA, BW, HC
Low (reference)	1.0	–	–	
Medium	0.880	(0.654–1.186)	0.40	
High	0.846	(0.658–1.089)	0.19	
Obstetric consultation				P, PIH, GD (type 1 and 2), MA, GA, BW, HC
Low (reference)	1.0	–	–	
Medium	0.739	(0.583–0.935)	0.012	
High	0.586	(0.479–0.718)	< 0.001	
Baby delivered by obstetrician				P, PIH, GD (type 1 and 2), E, MA, GA, BW, HC
Low (reference)	1.0	–	–	
Medium	0.776	(0.607–0.992)	0.043	
High	0.668	(0.542–0.823)	< 0.001	

Note: P = parity, PIH = pregnancy-induced hypertension, GD = gestational diabetes, E = ethnicity, LP = lone parent, MA = maternal age, GA = gestational age, BW = birth weight, HC = head circumference at birth.
*Data for 177 births were missing, so only 4267 births are covered by the adjusted models.
†Vaginal deliveries only (*n* = 3709).
‡Forceps and vacuum.

Competing interests: None declared.

Contributors: Michael C. Klein is the senior author and was the principal investigator for the study. He initiated the work and maintained overall responsibility for the integrity of the research and the writing. Andrea Spence was the research assistant on the project. She did some of the data manipulation and constructed some of the presentations for the initial version of the paper. She remained involved in the writing of the paper and verification of the data. Janusz Kaczorowski was the principal statistical and epidemiological resource for the study. He conducted most of the analyses and wrote the Methods section. Ann Kelly conducted some of the analyses and participated in the rewriting and editing of the manuscript. Stefan Grzybowski was part of the research group and was involved in editing the manuscript.

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