International Journal of Women's Health

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ORIGINAL RESEARCH

Risk adjustment in maternity care: the use of indirect standardization

This article was published in the following Dove Press journal:
International Journal of Women's Health
19 August 2010
Number of times this article has been viewed

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Purpose: Annual US national rates of family physicians providing maternity care are decreasing and rates of cesarean delivery are increasing. Family physicians tend to have lower cesarean delivery rates than obstetrician specialists, but this association is usually explained by an assumed lower pre-delivery risk for cesarean delivery. This study was developed to compare the estimated risk of cesarean delivery in patients of the two specialties.

Methods: A retrospective cohort study within an urban teaching hospital compared 100 family-physician treated subjects to 300 subjects treated by obstetrician-specialists. Risk factors for cesarean delivery were identified, and an indirect standardization procedure was used to compare the pre-38 week of gestation risk of cesarean delivery in the two groups.

Results: The patients treated by family physicians had a projected pre-38 week of gestation risk of cesarean delivery (17.4%) that was similar to the actual rate of cesarean delivery in the obstetrician-specialist group (16.7%). The Standardized Cesarean Delivery Ratio was 1.04.

Conclusion: Lower cesarean delivery rates provided by family physicians may not be simply due to case-mix issues. Additional studies comparing the pre-delivery estimation of cesarean delivery risk would be helpful in measuring the relative levels of obstetric risk of patients treated by different maternity-care provider types.

Keywords: family medicine obstetrics, cesarean delivery

Introduction

The maternity care practices of family physicians are often assumed to contain lower levels of risk than the practices of obstetricians.[1,2] In keeping with this assumption, a variety of recommendations currently exist that outline the degree of involvement a family physician should take in maternity cases with increased risk.[1,2] At low levels of risk patients can be routinely managed by family physicians. At moderate levels of risk patients should be considered for referral for consultation with an obstetrician-specialist, but co-management remains an option. At high levels of risk most recommendations call for outright referral or transfer of the woman to an obstetrician-specialist.[1,2]

The maternity care provided by family physicians, and the outcomes that are obtained, have been studied extensively over the past 25 years.[3–20] Generally, family physicians provide excellent quality of care and have levels of outcomes that appear just as good as, and sometimes better than, their specialist colleagues. For example, family physicians, as compared to obstetrician-specialists, often have lower practice-based rates of episiotomy,[3,7,10] vacuum/forceps delivery[4,8] meconium passage,[12] and cesarean delivery.[3,7,8,10,11,20] The common reason given for these findings is that the obstetric practices of family physicians have lower levels of risk than the practices of obstetrician-specialists.[1,22,23]

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Dovepress
DOI: 10.2147/IJWH.S9494

However, it is possible that the obstetric risk present in the maternity practices of family physicians has been systematically underestimated.[13,14,20] The maternity practices of family physicians tend to have high levels of disadvantaged patients,[21,24] and it is known that low socio-economic status can be associated with less favorable birth outcomes. If the practices cared for by family physicians contain higher levels of low socio-economic status than the practices of obstetrician-specialists, then this might balance out higher levels of "major," but less common, risk factors in the specialist practices. Furthermore, family practice patients who value continuity of care, and who develop complications during the prenatal period, such that they fall into moderate to severe risk categories, are sometimes reluctant to have their care transferred to an unknown specialist physician. Consequently, some patients with increased risk profiles request that their prenatal care continue to be provided by their family physician.[9] Finally, some family physicians, either due to geographic location, additional training, or developed expertise, care for patients with increased risk profiles.[9,21] Hence, there is reason to question the belief that the pre-delivery risk for cesarean delivery in the maternity practices of family physicians is significantly less than overall level of risk in the practices of obstetrician-specialists. We chose to use Indirect Standardization to assist with an investigation of this question.

Methods

Subjects for this study had been previously identified as subjects of a retrospective cohort study involving an alternative method of obstetric care called the Active Management of Risk in Pregnancy at Term (AMOR-IPAT).[25] One hundred sequentially delivered women exposed to AMOR-IPAT came from three family medicine offices and were identified for this study as being family practice patients. Three hundred randomly chosen women that were not exposed to AMOR-IPAT came from eight obstetrician-specialist offices and were identified as being obstetrician-specialist patients. The method of random selection of non-exposed women has been previously discussed.[25] The majority of obstetrician-specialist patients came from offices that provided general obstetrics, but several came from a maternal fetal medicine office and several came from a high-risk obstetric residency clinic All study subjects delivered between January 1, 1998 and July 31, 2001 and all study subjects received care in practices affiliated with the Hospital of the University of Pennsylvania, a quaternary-care teaching center. At the time of delivery, all subjects were at least 37 weeks 5 days gestation, and all were candidates for a trial of labor. This study focuses on the risk of cesarean delivery at 38-weeks of gestation. The Institutional Review Board of the University of Pennsylvania approved this study.

Indirect standardization has been previously described as a statistical method that can adjust for different frequencies of specific risk factors in two study groups, so that expected rates of a specific outcome can be compared.[26–28] Because our study of AMOR-IPAT at the University of Pennsylvania contained two study groups that had different frequencies of important risk factors for cesarean delivery,[22] indirect standardization was identified as a method that could determine and compare the expected rates of cesarean delivery in the two groups.

We performed a literature search to identify important risk factors for cesarean delivery.[29] Data collection for the published AMOR-IPAT study captured information concerning most salient variables, but did not capture information concerning hemoglobinopathies, level of depression (if any), or literacy status. The identification of risk factors to use in our indirect standardization involved two steps. First, the frequency of each risk factor for cesarean delivery within each study group was calculated and risk factors that were present at different levels, conservatively defined by $P \leq 0.40$ using the Fisher's exact test, were identified as possible risk factors for the indirect standardization procedure. Second, after identifying the patients treated by obstetrician-specialists (n = 300) as the reference group, possible risk factors identified in the first step were evaluated for their influence on cesarean delivery in the 300-patient reference group. Possible risk factors with an impact on cesarean delivery risk, conservatively defined by $P \leq 0.40$ using the Fisher's exact test, were identified as indirect standardization risk factors for this study. In situations where factors appeared to be co-linear with another factor (eg, nulliparity and multiparity), the risk factor with the lowest *P*-value was used in our model.

Once the set of risk factors was obtained, the mathematical computation of the indirect standardization ratio was relatively straightforward. First we determined for the obstetrics group (the reference group) the actual rates of cesarean delivery that occurred in the sub-groups defined by the presence and absence of each risk factors (eg, the rate of cesarean delivery that occurred among obstetrician-specialist patients who were short [ie, ≤62"] and the rate of cesarean delivery that occurred among obstetrician-specialist patients who were not short [ie, >62"]). Second, the cesarean delivery rate from each obstetrician-specialist patient sub-group was applied to the corresponding sub-group of family medicine patients (ie, the non-reference group). Therefore, the obstetrician-specialist

rate of cesarean delivery in its "short" group was applied to the number of short family medicine subjects, and the obstetrician-specialist rate of cesarean delivery in its "not-short" group was applied to the number of "not-short" family medicine subjects. The number of cesarean deliveries that would have been expected in the Family Practice group, had they had the same rates of cesarean delivery as occurred in the obstetrics group, for the "short" and the "not-short" sub-groups, was then determined. This process was repeated for each identified cesarean delivery risk factor. The average number of cesarean deliveries that would have expected to occur in the family practice group, using all identified risk factors was then calculated. Because there were 100 subjects in the family medicine group, this average number equaled the projected group cesarean delivery rate of the family medicine group. The predicted cesarean delivery rate in the family medicine group divided by the known cesarean delivery rate in the obstetrician-specialist group (16.7%) provided the "Standardized Cesarean Delivery Ratio" or SCDR ([expected cesarean delivery rate]/[reference group cesarean delivery rate]), which is the usual type of output used in an indirect standardization comparison.

Results

Table 1 describes the types of practices that made up the family medicine group and the obstetrician specialist group. Both groups were composed of multiple offices and both groups contained faculty-treated patients and resident-treated patients. The proportion of patients who received their basic prenatal care from residency practices, as compared to faculty practices, was lower in the family practice group (27% vs 56.3%, $P < 0.001$). In addition, as compared to the obstetric specialty groups, the family practice groups collectively had larger percentages of patients characterized by African-American race (88% vs 67%, $P < 0.001$), public assistance insurance status (74% vs 51.7%, $P < 0.001$) and multiparty (70% vs 54%, $P < 0.002$) patients. These differences underscore the need to use some kind of standardization to compare the risk for cesarean delivery at 38-weeks of gestation.The treated groups had very few Hispanic women (3% in the exposed group, and 2% in the non-exposed group [$P = 0.56$]).

Table 2 demonstrates the potential risk factors for cesarean delivery that were identified following a review of the medical literature and that could be addressed by our database, and also determines which of these factors were present at different levels in the two study groups. Several important risk factors for cesarean delivery did not meet the criteria for use in this indirect standardization because they were present at similar frequencies in the two study groups (eg, advanced maternal age, late prenatal care and previous cesarean delivery).

Table 3 lists risk factors that were present at different levels in the two study groups and reports their impact on actual cesarean delivery utilization in the obstetrics specialty group (the chosen reference group). Several known risk factors for cesarean delivery did not meet the criteria for use in this

Table 1 Composition of study groups

	Type of office	Study subjects office mix	Percent African-American	Percent public assistance	Percent nulliparous
Family medicine group	(N = 100)				
Office # 1	Residency clinic	26 (26%)	69.2% (18/26)	53.8% (14/26)	30.8% (8/26)
Office # 2	Affiliated practice	50 (50%)	92% (46/50)	80% (40/50)	34% (17/50)
Office # 3	Health center (1)	24 (24%)	100% (24/24)	83.3% (20/24)	20.8% (5/24)
Group totals	(ALL)	100	88% (88/100)	74% (74/100)	30% (30/100)
Obstetrics specialty group	(N = 300)				
Office # A	Residency clinic	142 (47.3%)	90.8% (129/142)	87.3% (124/142)	38.7% (55/142)
Office # B	University faculty practice	88 (29.3%)	25% (22/88)	1.1% (1/88)	60.2% (53/88)
Office # C	Affiliated practice	27 (9.0%)	77.8% (21/27)	25.9% (7/27)	48.2% (13/27)
Office # D	MFM office	12 (4%)	16.7% (2/12)	16.7% (2/12)	50% (6/12)
Office # E–G	Solo Practices (3)	4 (1.3%)	50% (2/4)	0% (0/4)	50% (2/4)
Office # H–K	Health centers (4)	27 (9.0%)	92% (25/27)	77.8% (21/27)	44.4% (12/27)
Group totals	(ALL)	300	67% (201/300)	51.7% (155/300)	47% (141/300)

Table 2 Identification of risk factors present at different levels in the study groups

Variable name	Comparison of rates by group		
	Family physicians n = 100	Obstetrician-specialists n = 300	*P* value
Demographics	–	–	–
Age, median	24 years	27 years	0.05
Early teen (<16 years)	3%	2%	0.56
Advanced age (>=35 years)	9%	11%	0.71
Caucasian	**6%**	**23.3%**	**>0.001*****
African-American	**88%**	**67%**	**>0.001*****
Asian	**2%**	**7%**	**0.08*****
Public assistance	**74%**	**51.7%**	**0.001*****
Past medical			
Major medical problem	53%	51.3%	0.77
Asthma	**19%**	**12.3%**	**0.10*****
Chronic hypertension	6%	4.3%	0.59
Cigarette abuse	**28%**	**15.3%**	**>0.001*****
Alcohol abuse	**15%**	**5.3%**	**0.004*****
Illicit drug abuse	4%	5%	0.68
Insulin dependent diabetes	0%	0.3%	–
Past ob/gyn			
Previous spontaneous abortion	22%	22%	1.00
Previous therapeutic abortion	**32%**	**26.3%**	**0.30*****
Previous abnormal PAP smear	**14%**	**20.7%**	**0.14*****
Prior assisted vaginal delivery	**6%**	**2.7%**	**0.12*****
Previous C-section	11%	10.7%	1.00
Prior large infant (>8 lb 7 oz)	**14%**	**8.7%**	**0.13*****
Prior small infant (<5 lb 8 oz)	**11%**	**5%**	**0.06*****
Laboratory			
Anemia (Hemoglobin <11.0)	**31%**	**16.3%**	**0.002**
1-hour glucola >135 mg/dl	11.0%	11.4%	1.00
Index pregnancy			
Nulliparous status	**29%**	**46.3%**	**0.002*****
Multiparous	**71%**	**53.7%**	**0.002*****
Multip w/o cesarean	**60%**	**43.0%**	**0.004*****
Multip with h/o cesarean	11%	10.7%	1.00
Gestational diabetes	**4%**	**1.7%**	**0.24*****
Late prenatal care (>5 months)	15%	13.3%	0.68
Size < dates (at least 3 cm)	6%	5.7%	0.90
Size > dates (at least 3 cm)	**45%**	**10.3%**	**<0.001*****
Maternal habitus			
Short (≤5' 2")	**26%**	**21%**	**0.33*****
Preconception BMI > 30 kg/m²	**33%**	**23%**	**0.08*****
Weight gain – pregnancy	**23 lb**	**30 lb**	**0.00**
Weight gain >30 lb	**25%**	**46.3%**	**>0.001*****

Notes: ***Present at different levels.

indirect standardization because they did not have an impact on cesarean delivery in the reference group (eg, gestational diabetes, asthma, high preconception body mass index). The risk factors that were both present at different levels in the two study groups and that had an important impact on cesarean delivery utilization in the obstetrics specialty group were: public assistance, alcohol use, previous assisted vaginal delivery (vacuum or forceps), previous large infant (>8 lb 8 oz), first trimester anemia (<11.0 mg/dl), nulliparous status, short stature (≤62") and high weight gain (>30 lbs). The size > dates variable, and the residency practice vs faculty practice variable, were not considered for inclusion in the model due to concerns about measurement bias, information bias and selection bias. However, the inclusion of either variable into the model would have increased the estimated risk of cesarean delivery in the family practice group.

Table 4 lists the variables that met criteria to be included in the indirect standardization model, and it shows the calculations used to perform the Indirect Standardization. The left portion of Table 4 includes the numbers of cesarean

Table 3 Identification of risk factors associated with cesarean delivery

Variable name	Risk ratio, with 95% CI, for C/S in obstetrics-specialist group (n = 300)		
	RR for C/S** (univariate)**	**95% CI**	***P* value**
Demographics			
Caucasian	1.05	(0.52–2.11)	0.90
African-American	0.96	(0.56–1.63)	0.87
Asian	0.82	(0.25–2.73)	0.76
Public assistance	**0.68**	**(0.41–1.13)**	**0.13****
Past medical			
Asthma	1.12	(0.54–2.31)	0.82
Cigarette abuse	0.75	(0.34–1.66)	0.67
Alcohol abuse	**1.54**	**(0.63–3.75)**	**0.36****
Past ob/gyn			
Previous therapeutic abortion	0.88	(0.49–1.60)	0.73
Previous abnormal PAPS	0.84	(0.43–1.64)	0.70
Previous vaginal assist	**3.17**	**(1.51–6.67)**	**0.03****
Previous large baby (>8 lb 7oz)	**1.71**	**(0.86–3.42)**	**0.17****
Previous small baby (<6 lb 8oz)	0.79	(0.21–2.95)	1.00
Laboratory			
Anemia – (Hemoglobin < 11.0 mg/dl)	**1.51**	**(0.80–2.86)**	**0.24****
Index pregnancy			
Nulliparous status	**1.56**	**(0.93–2.60)**	**0.09****
Multiparous			n/a**
Gestational diabetes	0	~*	1.00
Size > dates (by at least 3 cm)	**1.9**	**(1.03–3.53)**	**0.07****
Maternal habitus			
Short (≤5' 2")	**1.8**	**(1.07–3.05)**	**0.04****
Preconception BMI ≥ 30 kg/m²	1.23	(0.71–2.15)	0.47
High weight gain (>30 lbs)	**1.22**	**(0.91–1.63)**	**0.21****

Notes: ****Risk ratio for cesarean delivery in the Obstetrics-specialty group only. ***Risk factors with an impact on cesarean delivery rates (in the Obstetrics-specialty group only). **n/a – risk factor co-linear with the preceeding factor. *No cesarean deliveries in the four obstetrician-specialist women with gestational diabetes.

deliveries that actually occurred in the reference (obstetrics-specialty) group, and the right portion includes the numbers of cesarean deliveries that would have been expected to occur in the family physicians group if the same rate of cesarean delivery occurred in the risk factor (+) and the risk factor (–) portion of each risk strata. For example, the rate of cesarean delivery in the obstetrics specialty group for patients with short stature (≤62") was applied to the family practice patients who had short stature, and the rate of cesarean delivery in the obstetrics group for patients who did not have short stature was applied to the family medicine patients who did not have short stature. The major difference between the two sides of the table is the proportion of patients with, and without, short stature. This difference leads to different rates of cesarean delivery within each risk strata (actual for the obstetrics group and expected for the family medicine group). The final line of Table 4 presents the averaged actual and expected cesarean delivery rates for the two study groups. As shown, the obstetrician-specialist group had a cesarean delivery rate of 16.7% while the family medicine group had an expected cesarean delivery rate of 17.4%. These results provide a "Standardized Cesarean Delivery Ratio," or SCDR, of 1.04.

Discussion

Previously there has been a belief that the maternity practices of family physicians contain significantly lower levels of risk for cesarean delivery than the practices of obstetrician-specialists. Although this may be true if all areas of maternity care are considered, including multiple gestations, major fetal anomalies or patients who are not candidates for a trial of labor, this urban study of women with a reasonable chance of vaginal delivery provides evidence that the overall risk levels in the two specialties, from a cesarean delivery perspective, were quite similar.

There may be several reasons for our finding. First, most of the referral strategies permit family physicians to manage patients with a variety of moderate risk factors for cesarean delivery. If moderate risk factors for cesarean delivery occur more frequently in the practices of family physicians as compared to those of obstetrician-specialists,

Table 4 Calculation of standardized cesarean section rates

Variable name	Standardization calculation			
	Obstetrics group (reference)		Family practice	
	(n = 300)	Actual	(n = 100)	Predicted
Demographics				
Public assistance	(+) 155*0.135	21	(+) 74*0.135	10
	(–) 145*0.20	29	(–) 26*0.20	5.2
Past medical				
Alcohol abuse	(+) 16*0.25	4	(+) 15*0.25	3.75
	(–) 284*0.16	46	(–) 85*0.16	13.6
Past ob/gyn				
Previous vaginal assist	(+) 8*0.5	4	(+) 7*0.5	3.5
	(–) 292*0.16	46	(–) 93*0.16	19.9
Previous large infant	(+) 26*0.27	7	(+) 14*0.27	3.8
(>8 lb 7 oz)	(–) 274*0.16	43	(–) 86*0.16	13.8
Laboratory				
Anemia –	(+) 38*0.24	9	(+) 24*0.24	5.8
(Hemoglobin < 11.0)	(–) 262*0.16	41	(–) 76*0.16	12.2
Index pregnancy				
Nulliparous status	(+) 141*0.21	29	(+) 31*0.21	6.5
	(–) 159*0.13	21	(–) 69*0.13	9.0
Maternal habitus				
Short stature	(+) 63*0.25	16	(+) 26*0.25	6.5
(≤5' 2")	(–) 237*0.14	34	(–) 74*0.14	10.4
High weight gain	(+) 75*0.23	17	(+) 11*0.23	2.5
(>30 lb)	(–) 225*0.15	33	(–) 89*0.15	13.4
Total cesareans	(based on eight sets of 300 patients)	400	(based on eight sets of 100 patients)	139.85
Group cesarean rate		16.7%		17.4%

Note: Based upon the non-AMOR-IPAT exposed population only – n = 300.

then the use of these factors in an indirect standardization procedure might balance out the impact of more serious, yet less prevalent, risk factors that occur more frequently in the obstetrics-specialty treated groups. Second, our method of selecting risk factors for the indirect standardization procedure may have identified underlying risk factors that are not usually understood to be associated with cesarean delivery *but* that are more commonly found in the practices of family physicians. For example, anemia and substance abuse have been described as important risk factors for cesarean delivery,[30,31] yet these risk factors are not usually included in the strategies that direct family physicians to co-manage or refer their pregnant patients to obstetrician-specialists.[1,2] Furthermore, because anemia and substance abuse may be more prevalent in socio-economically disadvantaged groups, and because family physicians often have higher percentage of socio-economically disadvantaged patients in their practices than obstetrics-specialists,[21] it is reasonable to consider that the practices of family physicians may contain higher levels of certain mild-moderate risk for cesarean delivery in a systematic way. Finally, patients who have, or develop, increased levels of prenatal risk are often reluctant to have care transferred to obstetric specialists. Patients in this study may have remained in the practice of, and had their labor managed by, family physicians.

This study has several limitations. First, the study excluded several special risk categories such as infants with major anomalies, women with more than two prior cesarean deliveries and multiple gestations (twins, triplets). These types of cases are clearly high risk and would be more likely to be found in obstetric-specialist groups. However, previous investigations comparing the outcomes of family physicians and obstetrician-specialists have not included patients with these special risk factors. Second, the study was not matched for parity, and there were fewer nulliparous women in the family medicine group. However, nulliparity was used as a factor in the indirect standardization procedure. Third, the use of indirect standardization is not able to deal with the issues of partial co-linearity or interaction between variables. However, multiparty was excluded from our model due to co-linearity with nulliparity, and the set of variables used in the final standardization model do not seem to cover identical or highly

similar domains. Finally, the family physicians in this study used a preventive approach to the management of obstetric risk, and were therefore more comfortable managing patients with moderate to high levels of obstetric risk. For this reason, as well as the urban setting of the study, our results may not be generalizable to all family medicine situations. However, previous studies documenting increased levels of Medicaid insurance in the practices of family physicians came from rural non-academic settings, and our findings are consistent with those papers.

Despite these limitations, our findings suggest a similar risk for cesarean delivery at 38-weeks of gestation in the maternity practices of our family physicians and obstetrician-specialists for patients who are eligible for vaginal delivery. If this finding can be corroborated in other locations, it would suggest that more attention should be placed on improved outcomes that have been reported in groups cared for by family physicians. If overall levels of risk for cesarean delivery at 38-weeks of gestation are equivalent between family physicians and obstetrician-specialists, yet practice rates of cesarean delivery and other adverse outcomes are lower in family practice groups as compared to obstetrician-specialist groups, then perhaps the practice styles, decision making and/or preventive prenatal care that occurs within the discipline of family practice might be of more interest and importance to the maternity-care community at large. While obstetrician-specialists are clearly skilled in the management of abnormal labor and emergency obstetric situations, including situations requiring cesarean delivery, perhaps family physicians are better able to promote higher rates of safe vaginal delivery.

In this paper we presented data suggesting that the risk of cesarean delivery at 38-weeks gestation was similar in the family practices and obstetric-specialist practices of an urban teaching hospital when patients had a singleton pregnancy and were a good candidate for a trial of labor. Although this finding is counter to common assumptions that the maternity practices of family physicians contain less risk than the practices of obstetrician-specialists, we believe that the amount of risk in the practices of family physicians has been systematically underestimated. In this paper we discuss why this may have been so, and offer indirect standardization as a way to compare levels of risk between two different groups. Other methods, such as the use of propensity scoring, could also be used for this purpose. Although it would be interesting to consider a study randomizing subjects to family physician care vs obstetrician care, such a study is unlikely to be conducted at anytime in the near future. As a result, the comparison of outcomes in the two specialties should only be done following a fair risk adjustment procedure that includes a full range of prenatal variables including variables related to socioeconomic status.

Definition

AMOR-IPAT – the Active Management of Risk in Pregnancy at Term. AMOR-IPAT is a preventive approach to obstetric care that uses prostaglandin E2-assisted preventive induction of labor, to ensure that every woman is offered a chance to enter labor during the part of gestation that offers the greatest likelihood for a healthy delivery for mother and infant. AMOR-IPAT uses a published risk-scoring system to estimate for each gravida a patient-specific upper limit of the optimal time of delivery (UL-OTD). If any gravida does not enter labor by 3–4 days prior to her UL-OTD, then she is scheduled for preventive labor induction such that she enters labor on or before her UL-OTD. If a gravida is scheduled for a preventive induction of labor, but has a modified cervical Bishop's score of five or less, then she is provided with cervical ripening with PGE2 prior to the start of oxytocin.

Disclosure

The author of this manuscript has no conflicts of interest to report.

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