Influence Of Site Of Obstetric Care And Delivery On Pregnancy Management And Outcome

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Abstract: A retrospective cohort study of 863 pregnancies cared for by family physicians at three sites—rural-rural (RR), rural-urban (RU), and urban-urban (UU)—was designed to test the hypothesis that ready on-site access to perinatal subspecialists would improve pregnancy outcome. No differences in delivery type, length of gestation, birth weight, or nursery care were found. An Apgar score of < 7 at 1 minute or < 8 at 5 minutes was 2.17 and 2.31 times more likely at RU and 2.48 and 2.60 times more likely at UU, respectively, than at RR. The overall Cesarean section rate was 9.6 percent, forceps rate was 7.2 percent, and nonroutine nursery care rate was 7.9 percent. Neonatal and perinatal mortality rates were 3.5 and 4.6 per 1,000 live births. There is no evidence that on-site perinatal subspecialists improve perinatal outcome when care is provided by board-certified family physicians. Small obstetric centers provide quality perinatal care with outcome dependent on physician's skill rather than on technology. (J Am Bd Fam Pract 1988; 1:152-63.)

This study was designed to answer the question: Does ready on-site access to perinatal subspecialists and technology improve pregnancy outcome for patients managed by board-certified family practice physicians? It does this by comparing groups of family physicians who care for patients at different prenatal and delivery locations. No comparison between family physicians and obstetricians is intended or implied. To rephrase the hypothesis stated above: Is immediate access to perinatal subspecialists on site superior to delayed access to perinatal subspecialists at a distant site?

Family physicians traditionally deliver babies and are trained during their residencies to provide prenatal, obstetric, and neonatal care.[1] Small obstetric services staffed primarily by family physicians deliver up to 40 percent of the babies in some regions.[2-4] Such obstetric services represent up to 80 percent of the maternity hospitals in some states.[3] Over the past 2 decades, these obstetric services have frequently been incorporated into regionalized systems of care[3,5,6] because of evidence that high-risk pregnancies have better outcomes when managed intensively in major referral centers.[3,7-9] Referral of high-risk pregnant patients has led to decreased neonatal mortality and has reduced the numbers of deliveries, especially high-risk, occurring in small hospitals.[3,10,11]

To identify high-risk pregnancies before delivery, when transfer is safer and more cost effective,[8,12] obstetric risk assessment scales have been devised and validated.[13-23] Yet, 8 percent to 40 percent of low-risk pregnancies require operative intervention,[24,25] and 30 percent of perinatal deaths occur in populations with low-risk scores.[25] These factors have caused some obstetricians,[25,26] lawyers,[27] and federal planners[28] to consider all pregnancies to be potentially high-risk and to recommend that level I obstetric centers be closed.[25,27,29]

Closure of small and rural low-technology obstetric centers would result in the denial of ready access to obstetric care and exposure of all obstetric patients, both low and high risk, to intensive high-technology obstetric care. Previous studies suggest that low-risk patients are subject to unnecessary intervention and have higher birthweight-specific perinatal mortality rates when delivery is by specialist obstetricians using maximum obstetric technology.[2,30] Obstetric care by family physicians in small centers has been noted to be safe,[2-4,31-34] cost effective,[35] and accessible.[3]

Family physicians need to develop creative solutions to meet the conflicting demands of providing accessible, low-cost, family-centered obstetric

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care while ensuring that the care provided to their patients is of high quality with minimal risk to mother or infant. This report describes how three different models of care used by family physicians in a Department of Family Medicine achieve these goals. The Institutional Review Board reviewed this study and determined it to be ethical.

Background

Within this Department of Family Medicine there are three different systems of providing obstetric care.

The urban/urban (UU) practice is located in the main clinic, in a city of 60,000 population, with obstetricians practicing in the same building. All deliveries take place in a hospital-based tertiary referral center, side by side with patients cared for by board-certified obstetricians. This setting provides ample opportunity for informal consultation and rapid on-site transfer of care when an adverse event threatens. All of the latest technology is available and is used.

The rural/urban (RU) practice is located within a rural community, population 3,100, approximately 30 minutes by automobile from obstetric consultation and from the delivery site. Approximately half of pregnancies are managed by family practice residents. A standardized prenatal risk assessment scale is used.[14,15,22] All deliveries take place in the same hospital that provides services for the UU site.

The rural/rural (RR) practice is located in another small rural community, population 2,100, approximately 30 minutes from obstetric consultation. All deliveries, except those transferred to the hospital-based tertiary referral center for specialized care, take place in a 20-bed community hospital, 30 minutes from the nearest board-certified obstetrician. If problems arise, all decisions are made by the family physician with access to the obstetrician only by telephone. All patients requiring operative intervention are transferred to the hospital-based tertiary referral center.

Methods and Study Design

Records

A retrospective cohort study of 863 patients (approximately 300 pregnancies for each site) was carried out with an intent-to-treat design. The outcome of every pregnancy diagnosed by a family physician at each site was attributed to that family physician and site during the analysis, whether the family physician did the delivery. All pregnancies were reviewed through delivery, regardless of whether the delivery was by family medicine staff or the obstetrics staff, and each delivery was attributed to the site of initial care.

Medical records were identified by using computer access codes for patients whose diagnosis of pregnancy or initial prenatal care was at one of the three sites within the Department of Family Medicine. Records for patients delivered of infants prior to January 1, 1985, were reviewed in reverse chronologic order until approximately 300 records were reviewed from each site. The only records used for analysis were those for cases that met the following criteria: (1) singleton pregnancies, (2) gestation 20 weeks or more, (3) fetal weight in excess of 500 g, and (4) delivery within our system. The final assortment of records reviewed is given in Table 1. All records were reviewed through the neonate's first 28 days of life. Greater than 99 percent of all data sought were available.

Variables

The principal independent variable of this study was site of initial obstetric care. The dependent variables were measures of pregnancy outcome, including 1- and 5-minute Apgar scores, neonatal mortality, type of nursery care required, type of delivery, and birth weight. For purposes of analysis, we dichotomized these variables into a poor or abnormal outcome and a good outcome. The former was defined as follows: 1-minute Apgar score < 7, 5-minute Apgar score < 8, nonroutine nursery care, birth weight < 2,501 g or > 4,000 g, and other than a normal spontaneous vaginal delivery. To summarize these five variables, we defined an additional dichotomous variable, called "out-

Table 1. *Selection of Records for Analysis.*

	UU	RU	RR
Number reviewed	306	310	311
Number analyzed	290	277	296
Exclusions			
Patient moved	8	21	4
Miscarriage at < 20 weeks	5	6	8
Delivery at home	2	0	1
Therapeutic abortion	1	5	2
Twin gestation	0	1	0

come index," which was scored as abnormal for any pregnancy in which at least one of the abnormal outcomes listed above occurred. If none of these occurred, the outcome index was scored as normal.

To help understand any differences among sites in outcome, we considered two other types of variables: potential risk factors, and characteristics of obstetric care. Risk factors included age, parity, gravidity, year of delivery, marital status, social status, primary physician (whether resident or board certified), and risk statuses initially, immediately prepartum, and intrapartum. Social status was determined by the Hollingshead-Redlich scale—an index of occupation and education.[36] Initial and immediate prepartum risk statuses were determined by using a prepartum risk assessment scale developed by Morrison and Olsen; intrapartum risk was determined with a complementary intrapartum risk assessment scale.[13] Characteristics of obstetric care included number of prenatal visits, use of ultrasonographic and electronic fetal monitoring, and use and timing of consultation and referral to the Department of Obstetrics. For purposes of analysis, consultation and referral were treated as indicator variables for presence or absence. However, the timing of referral was also noted, whether at the initial visit, immediately prepartum, during stage 1 labor, or during stage 2 labor. This timing was used in some subanalyses.

Statistical Analysis

The focus of this study was comparison of outcomes among the three sites. The comparison was done in two ways.

First, there was a straightforward comparison of the proportions having abnormal outcomes on each of our outcome variables by means of the Pearson χ^2 statistic. These were unadjusted analyses.

Second, there were adjusted analyses, controlled for the risk factors. The risk factors were compared among the sites by means of the Kruskal-Wallis nonparametric analysis of variance. To identify which risk factors were important determiners of the various outcomes, we did a subset selection procedure for each outcome variable with logistic regression analysis. The set of candidate variables included all the risk factors listed above except gravidity, which was basically redundant with parity. Both forward stepwise and backward elimination were used. Those variables whose *P* value was less than 0.05 in both the forward and the backward methods were considered important risk factors for a given outcome. (In fact, the same set of risk factors for each outcome variable was picked by both the forward and backward procedures and was picked whether indicators for site were included.) The set of risk factors chosen for each outcome was then entered as a set of covariates along with dummy indicator variables for site in a logistic regression. These analyses compared the sites on the outcomes, adjusted for risk.

Ancillary analyses compared the obstetric care characteristics among sites. The yes-no indicator variables, consultation, referral to Department of Obstetrics, use of electronic fetal monitoring, and use of ultrasonography were analyzed by the Pearson χ^2 statistic. The Kruskal-Wallis test was used for the number of prenatal visits.

All pregnancies were analyzed as belonging to the site of the initial visit. In particular, patients referred to Obstetrics were not withdrawn from the analysis. One can think of our analyses as following the intent-to-treat rule, which would be the appropriate analysis for a study design in which pregnancies were randomly allocated to sites.

Power of the Study

The basic statistical method used in this study is logistic regression, which models the logarithms of odds of an abnormal outcome. Differences between pairs of sites are measured by the ratio of their odds. The power to detect an odds ratio that differs from 1.00 is related to the overall probability of the abnormal outcome, being greater for more common abnormal outcomes with probabilities nearer 50 percent.

This study has a 95 percent chance of detecting an odds ratio of abnormal outcomes between any two sites for outcome index ≥ 1.86 or a change from 35 percent to 50 percent abnormal outcomes at the two-sided 0.05 level. The power for each of the individual outcomes ranges from a 95 percent chance of detecting an odds ratio of abnormal birth weight ≥ 2.16 or a change from 15 percent to 26 percent abnormal birth weights at the two-sided 0.05 level to an 80 percent chance of detecting an odds ratio of a low 5-minute Apgar score of 3.82 or a change from 2 percent to 7 percent low Apgar scores at the two-sided 0.05 level. The power for nursery care, 1-minute Apgar score,

Table 2. *Risk Factors.*

Variable	UU Number or Mean	UU Percent	RU Number or Mean	RU Percent	RR Number or Mean	RR Percent	P
Married	274	94.8	242	87.4	263	88.9	0.01
Age, years	26.3		24.4		24.7		0.0001
Gravidity	2.19		2.28		2.42		0.005
Parity	0.95		1.02		1.12		0.04
Socioeconomic status	2.8		3.3		3.3		0.0001
Morrison risk							
Initial visit	1.15		0.97		0.97		0.02
Immediate prepartum	1.71		1.52		1.51		0.01
Intrapartum	1.28		1.33		1.11		0.07
Year of delivery							
1981	0		0		47	15.9	
1982	12	4.1	61	22.0	74	25.0	
1983	98	33.8	88	31.8	83	28.0	
1984	180	62.2	128	46.2	92	31.1	<0.001
Delivery by resident	0		130	46.9	0		

and type of delivery are intermediate between these extremes.

Results

Risk Factors

Patients from UU were more likely to be married, older, and of higher social class with lower gravidity and parity than patients from RU or RR (Table 2). Their initial and prepartum risk statuses were higher. UU deliveries were more recent than RU or RR.

Obstetric Care

Ultrasonography and electronic fetal monitoring were used more often in UU and RU than in RR (Table 3). There were no significant differences in numbers of prenatal visits. RU was more likely not to use episiotomy or to use midline episiotomy than UU or RR.

Consultations tended to be more frequent in UU than in RR, but there were no significant differences in timing of consultation, overall or intrapartum (Table 3). Although there was no significant difference in timing or total number of referrals overall, UU intrapartum transfers occurred significantly later than RR intrapartum transfers ($P = 0.04$): 20/57 transfers during stage 2 labor in UU and 9/58 in RR. The UU site tended to transfer more low-risk (10 percent UU, 6 percent RR) and fewer high-risk patients (35 percent UU, 41 percent RR) than the RR site ($P = 0.06$), and a higher proportion of these transferred patients had instrument delivery (0.81 for UU, 0.43 for RR; $P < 0.001$). Overall, 50 percent of the low birth weight (1,500 g to 2,500 g) and all of the very low birth weight (< 1,500 g) babies had been transferred in utero.

Outcome (Unadjusted Analyses)

Delivery Type

The proportion of normal spontaneous vaginal deliveries was significantly higher at RR than at UU or RU, and the proportions of forceps deliveries and Cesarean sections were lower.

Neonatal

There were only four perinatal deaths; three of these were neonatal deaths (overall perinatal mortality rate, 4.6/1,000 live births; neonatal mortality rate, 3.5/1,000 live births). The single stillbirth was due to a true knot in the umbilical cord. One neonatal death was due to extreme prematurity—birth at 27 weeks' gestation; fetus weight, 590 g. The two other neonatal deaths were secondary to hypoplastic left ventricle of the heart.

Gestational age at birth and birth weight were not significantly different among the three sites. One-minute and 5-minute Apgar scores were sig-

Table 3. *Obstetric Care.**

Feature	UU Number or Mean	UU Percent	RU Number or Mean	RU Percent	RR Number or Mean	RR Percent	*P*
Prenatal visits	12.4		12.0		12.3		0.17
Ultrasonography used	285	98.3	274	98.9	260	87.8	< 0.005
Electronic fetal monitoring used	288	99.3	275	98.3	121	41.0	< 0.005
Episiotomy							
None or midline	194	74.9	205	83.7	213	76.1	
Mediolateral or 3rd or 4th degree	65	25.1	40	16.3	67	23.6	0.04
Consultation							
One or more	92	31.7	77	27.8	70	23.6	0.09
Timing†							
Initial visit	12	4.1	5	1.8	11	3.7	
Prenatal care	41	14.1	37	13.4	32	10.8	
Stage 1 labor	24	8.3	25	9.0	22	7.4	
Stage 2 labor	23	7.9	19	6.9	9	3.0	> 0.20
Referral‡							
Timing							
Initial visit	3	1.0	1	0.4	6	2.0	
Prenatal care	15	5.2	19	6.9	19	6.4	
Stage 1 labor	19	6.6	23	8.3	24	8.1	
Stage 2 labor	20	6.9	14	5.1	9	3.0	> 0.20
Total	57	19.7	57	20.6	58	19.6	0.33

*Percentages may reflect changes in denominator due to exclusion of cases that are not appropriate to category.
†There may be more than one consultation per patient.
‡To Department of Obstetrics.

nificantly lower at UU and at RU than RR (Figure 1). Scores < 7 at 1 minute were less common at RR; scores < 8 at 5 minutes were not significantly different between sites (Table 4). There were no significant differences in the use of the higher levels of nursery care between the three sites.

Maternal

There were no maternal deaths.

Predictors of Abnormal Outcome

Differences in baseline characteristics among sites may influence outcome. Such influences need to be considered to avoid inappropriate conclusions from the data. The risk factors we considered were age at delivery, parity, socioeconomic status, marital status, year of delivery, each of three different risk statuses, and resident versus nonresident delivery. We did not include the number of prenatal visits. Many physicians will justifiably consider

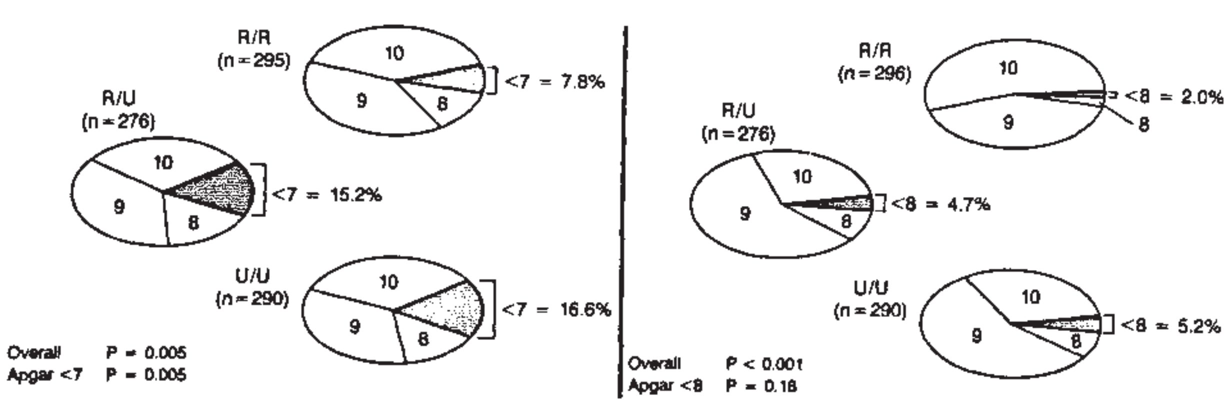

Figure 1. Distribution of Apgar scores by site. *Left,* 1-minute scores; *Right,* 5-minute scores.

Table 4. *Outcome.**

Feature	UU		RU		RR		P
	Number	Percent	Number	Percent	Number	Percent	
Type of delivery							
NSVD†	234	80.7	221	79.8	263	88.9	
Low forcep	13	4.5	15	5.4	12	4.1	
Mid forcep	12	4.1	5	1.8	5	1.7	
Emergency Cesarean	23	7.9	27	9.7	13	4.4	
Routine Cesarean	8	2.8	7	2.6	3	1.0	
Breach extraction	0		2	0.7	0		0.006
Apgar score							
<7 at 1 minute	48	16.6	42	15.2	23	7.8	0.005
<8 at 5 minutes	15	5.2	13	4.7	6	2.0	0.18
Nursery care							
Routine	268	92.4	252	91.3	273	92.2	
Intermediate	14	4.8	15	5.4	12	4.1	
Intensive	8	2.8	8	2.9	11	3.7	0.87
Mortality							
Stillbirth	0		1	0.4	0		
Neonatal death	0		2	0.7	1	0.3	
Gestation age at birth							
<34 weeks	4	1.4	3	1.1	4	1.4	
34–36 6/7 weeks	7	2.4	6	2.2	7	2.4	
37–42 weeks	250	86.2	244	88.1	264	89.2	
>42 weeks	29	10.0	24	8.7	21	7.1	0.94
Birth weight							
<2,501 g	40	13.8	29	10.5	35	11.8	
2,501–4,000 g	224	77.2	228	82.6	233	78.7	
>4,000 g	26	9.0	19	6.9	28	9.4	0.98
Outcome index							
Abnormal‡	139	47.9	113	40.9	110	37.3	0.03

*Percentages may reflect changes in denominator appropriate to each category.

†Normal spontaneous vaginal delivery.

‡Presence of any of the following abnormal outcomes: Apgar score < 7 at 1 min or < 8 at 5 min, other than normal spontaneous vaginal delivery, birth weight < 2,501 or > 4,000 g, and nursery care other than routine.

this a risk factor; however, it did not differ among the sites and could not be considered a baseline characteristic. That subset of these risk factors important for each outcome was determined by subset selection, as described above. The subsets are shown in Table 5. These predictors were entered into a logistic regression model along with site to control for confounding.

The possibility of interactions between the predictors and site was examined, but none was found to be statistically significant. Therefore, no interaction terms were included in the regression models. For each of our dependent variables, we defined the parameters in the logistic regression equation to make the RR site the standard of comparison. Table 6, the results of the logistic regression models pertaining to differences among sites, shows the estimates of the two odds ratios, RU/RR and UU/RR, the associated *P* values to test whether each of these odds ratios differed from 1.00, and the 95 percent confidence limits. The third possible odds ratio, RU/UU, is not shown because it can be derived immediately from the two odds ratios presented and, in general, does not differ significantly from 1.00.

Individual Outcomes with Controlling for Confounding (Table 6)

Birth Weight and Nursery Care

Whether one controls for various risk factors and year of delivery or not, one comes to the same

Table 5. *Predictors of Abnormal Outcome.*

Predictor	Outcome: Apgar Score 1 Minute	Apgar Score 5 Minutes	Birth Weight	Nursery Care	Delivery	Outcome Index
Risk						
Initial	+*	–	–	+*	+	+*
Prepartum	+	–	+	+	+	+
Intrapartum	+	+	–	+	+	+
Parity	–	–	–	–	+	–
Age/socioeconomic status†	–	–	–	–	+	+
Delivery by resident	–	–	–	–	+	–
Delivery year	–	–	–	+	–	–

*Increased initial risk is protective in the presence of increased risk later in pregnancy.

†Age and socioeconomic status are highly correlated. Various combinations eliminate one or the other as a predictor for delivery. For outcome index, age alone is not a predictor but status is; if status and age are added together, only age is a predictor; if age, age squared, and status are added together, status is a borderline predictor.

conclusion. There is no evidence of differences among the sites. The odds ratios are close to 1.00. The *P* values for whether the odds ratios differ from 1.00 all exceed 0.2. The 95 percent confidence intervals for the odds ratios show that large differences among the sites (odds ratio > 2.2) are not compatible with the data.

Apgar Scores

As with birth weight and nursery care, the conclusions are the same whether or not one controls for risk factors. The conclusion for the 1-minute Apgar score is that UU and RU do worse than RR. The point estimates show that the odds of a poor 1-minute Apgar score in UU or RU are more than twice the odds in RR. The differences between these odds ratios and unity are statistically significant ($P << 0.01$). There is no statistically significant difference between RU and UU. The conclusion for the 5-minute Apgar score is similar but less clear-cut. The odds of a poor outcome in either RU or UU appear to be substantially greater than in RR. However, because a poor 5-minute Apgar score is a rare event (2.6 percent), the odds are difficult to estimate precisely. Therefore, the *P* values to test whether the odds ratios differ significantly from unity are borderline ($0.04 < P < 0.10$).

Table 6. *Outcomes Controlled for Confounding by Site and Physician Type.*

Outcome	UU/RR Odds Ratio*	UU/RR *P*	UU/RR 95% Confidence Interval	RU/RR Odds Ratio*	RU/RR *P*	RU/RR 95% Confidence Interval
Apgar score:						
1 minute	2.48	0.001	1.44–4.27	2.17	0.006	1.24–3.78
5 minutes	2.60	0.055	0.98–6.87	2.31	0.099	0.85–6.23
Delivery by resident†	1.44	0.203	0.82–2.53	1.56	0.208	0.78–3.12
				2.68	0.002	1.43–5.03
Birth weight	1.06	0.771	0.72–1.57	0.77	0.234	0.51–1.18
Nursery care	1.05	0.889	0.54–2.03	1.18	0.621	0.61–2.29
Outcome index	1.32	0.143	0.91–1.91	1.03	0.859	0.71–1.50

*Odds of an abnormal outcome: Apgar score < 7 min at 1 min or < 8 at 5 min, other than normal spontaneous vaginal delivery, birth weight < 2,501 or > 4,000 g, nursery care other than routine. The presence of any of the above indicates an abnormal outcome index.

†Odds ratios are given for both staff physicians and residents for RU/RR to demonstrate effect of physician type. Only RU has residents.

Table 7. *Proportion with Abnormal Outcome Index Stratified by Site and Socioeconomic Status/Risk Interaction.*

	Middle to Upper Class*				Lower Middle to Lower Class*			
	Low Risk†		High Risk†		Low Risk†		High Risk†	
Site	Proportion	n	Proportion	n	Proportion	n	Proportion	n
RR	0.24	125	0.69	55	0.31	68	0.46	44
RU	0.31	110	0.72	53	0.24	80	0.65	31
UU	0.39	149	0.67	78	0.38	37	0.58	26
P	0.03		0.83		0.28		0.25	
Overall	0.32	384	0.69	186	0.29	185	0.55	101

*Hollingshead–Redlich Index: 1–3 equals middle to upper class; 4–5 equals lower middle to lower class.

†High risk is defined as a score > 2 on any risk evaluation (initial, immediate prepartum, or intrapartum).

We conclude that there is weak evidence in the data that RR does better on the basis of the 5-minute Apgar score.

Delivery

The conclusion drawn depends on whether risk factors are controlled. A crude comparison suggests that, compared with RR, RU and UU have approximately twice the odds of a delivery other than normal spontaneous vaginal delivery. However, controlling for prepartum and intrapartum Morrison risk, parity, and socioeconomic status reduces the UU/RR odds ratio from 1.91 to 1.44 and removes its statistical significance ($P > 0.2$). In addition, when one controls for physician type much of the difference between RU and RR is due to the RU residents. The two lines in Table 6 showing how physician type affects the RU/RR odds ratio make this clear. The odds of an abnormal delivery for a pregnancy seen by an RU resident are 2.68 times ($P < 0.01$) the odds at RR, after controlling for risk, parity, and socioeconomic status. However, the odds of an abnormal delivery for a pregnancy seen by an RU staff physician are only 1.56 times the odds at RR ($P > 0.2$).

We conclude that there is no evidence of large differences in type of delivery among the sites that cannot be explained by risk factors and physician type. The confidence intervals suggest the possibility of small residual differences.

Outcome Index

The conclusion one draws about the outcome index depends on how one controls for risk factors. The overall proportions shown in Table 4 suggest a simple ordering of the three sites, with RR having the lowest probability of a poor outcome and UU having the highest. However, when one controls for the three Morrison risk scores and socioeconomic status, the picture changes. Table 6 shows that RU and RR are essentially equivalent with an odds ratio of 1.03. The odds ratio UU/RR has also been substantially reduced, from 1.55 ($P < 0.01$) to 1.32 ($P = 0.14$).

Table 7 controls for risk and socioeconomic status in a different way, by substratum analysis. We defined four substrata by dichotomizing risk and social status. It is interesting that there is a suggestion of significant differences among the sites only in the stratum consisting of low-risk pregnancies in middle- to upper-class patients. There is a continuum, from RR to RU to UU, of increasing frequency of abnormal outcome. A more detailed analysis of this particular substratum, which used logistic regression to control for the residual differences in risk and socioeconomic status among the sites, showed strong evidence of a difference in frequency of abnormal outcomes between UU and RR (odds ratio = 1.97, $P = 0.016$) but no other difference (odds ratio RU/RR = 1.35, $P = 0.32$; UU/RU = 1.45, $P = 0.18$).

There is a suggestion of a difference among the sites in outcome index for low-risk pregnancies in middle- to upper-class women. However, this finding may have been secondary to multiple comparisons rather than a real difference. When the effect of multiple comparisons is considered, the probability of one of the four substrata in Table 7 having a difference large enough to produce a P value of 0.03 is 0.115. Therefore, we conclude that there is weak evidence of a difference among the sites in outcome index for low-risk pregnancies in middle- to upper-class women but no evidence of a difference between the groups overall.

Cost

The total cost of obstetric care through postpartum day 3 for the mother and neonate, averaged across the entire population receiving obstetric care at each site, is estimated to be $2,250 for RR, $2,540 for RU, and $2,545 for UU. This reflects the more frequent use of ultrasound and electronic fetal monitoring as well as more expensive room rates and delivery room fees at the RU and UU sites.

Discussion

The data accumulated in this study provide no support for the hypothesis that ready on-site access to perinatal subspecialists and technology improves pregnancy outcome. Within this Department of Family Medicine, board-certified family physicians provide quality obstetric care that is essentially equivalent regardless of site of prenatal or intrapartum care and regardless of access to on-site perinatal subspecialists. All of the outcomes measured either show no significant difference between sites or tend to favor the low-technology RR site.

The principal issue regarding obstetrics in rural sites is access to suitable and timely high-quality, high-technology care. The concern is that physicians at rural sites without on-site perinatal subspecialists will not ask for consultations or refer their patients as frequently as quality care would dictate. It is of further concern that once the decision to consult or refer is made, geographic isolation from perinatal subspecialists and technology results in a delay due to distance and that the quality of care suffers. This study shows no significant difference in the overall frequency or timeliness of consultation or referral between the RR and UU physicians.

It is of interest that the RR physicians refer their patients significantly earlier during labor than the physicians at the RU or UU site. Perhaps this timing compensates for the necessary geographic delay and explains the lack of significant differences in outcome between sites.

This study compares pregnancy outcome between three sites of prenatal care and two delivery sites for family physicians in the same Department of Family Medicine. One, the RR site, provides accessible care to a relatively low-risk population and maintains quality by early identification of problems and early transfer of patients while the fetus is in utero. A second, the RU site, provides locally accessible prenatal care to a similarly low-risk population and maintains quality by immediate access to high technology at the delivery site. Third, the UU site, provides local access to a population at slightly higher risk and also maintains quality by immediate access to high technology at the delivery site.

The quality of obstetric care provided is excellent. The overall perinatal and neonatal mortality rates were 4.6 and 3.5 per 1,000 live births, respectively. All of the infant deaths were unavoidable, and there were no maternal deaths. For comparison, neonatal mortality rates were 6.2/1,000 in 1980 in the state of Minnesota[37] and 7.3/1,000 in 1983 nationwide.[38] The total Cesarean section rate of 9.6 percent and forceps rate of 7.2 percent compare favorably with the rates in a family medicine department in Washington,[39] a rural family practice in Nebraska,[40] and a solo family practice in California.[41]

Approximately 8 percent of the neonates required nonroutine nursery care, with about 3 percent requiring neonatal intensive care. This is similar to the rate reported from Ohio.[42] The consultation rate (27.7 percent) and referral rate (19.9 percent) are similar to or less than those elsewhere.[39,43] All of the neonates with very low birth weight (< 1,500 g) and half of the neonates with low birth weight (1,500 to 2,500 g) had been transferred in utero. This is consistent with trends in Iowa[3] and Colorado.[9] Yet, overall, 80 percent of the patients were managed through delivery by their own physicians.

The three sites had different patient populations, with more high-risk pregnancies at the UU site. The differences between sites in obstetric and neonatal outcomes are minimal. These differences are limited to the use of ultrasound and electronic fetal monitoring and to differences in Apgar scores, deliveries done by residents, overall frequency of abnormal outcomes for low-risk middle- to upper-class women, and average cost of obstetric care.

Family physicians often increase their use of technology when in a high-technology environment.[44] Our study supports this observation. The advantage for the RR site on Apgar scores is not easily dismissed. Apgar scores are subject to error, with scores on the same newborn frequently varying by two to three points.[45] Observer bias also may be present; physicians at the RR site routinely assign Apgar scores to the infants they deliver; at the other sites, the scores often are assigned by independent observers. Despite this, rural and low-technology sites have been shown[30,32] to have improved Apgar scores compared with urban and high-technology sites, and large studies have shown 1- and 5-minute Apgar scores to be accurate predictors of infant mortality.[46,47] The meaning of an advantage in Apgar scores is unclear, but it may suggest a true difference.

High technology has previously been associated with untoward effects when applied to low-risk pregnancies.[2,30] Our study suggests there may be such an effect for low-risk pregnancies in middle- to upper-class women in this study. This group includes more than 40 percent of the patient population and exhibits a significant increase in frequency of abnormal outcomes at the UU site relative to the RR site. This finding merits further study.

Resident-managed pregnancies were significantly more likely to have instrument delivery. This difference persisted even after controlling for confounding variables. The overall rate of instrument delivery for residents was 26.9 percent. This is similar to that for family practice residents in Washington.[43] The reasons for a high rate of instrument delivery by residents also merit further investigation.

One study of maternity care costs[35] found cost to be significantly lower for room rates and delivery room fees in small hospitals. Our study found a reduction in average cost of maternity care of about 12 percent. The differences were due to lower use of technology such as electronic fetal monitoring and ultrasound combined with less expensive delivery room fees and room rates.

Once differences in population are controlled for, the three sites are similar. Differences seen favor the RR population. Some of these differences may be due to bias, adverse effects of technology, physician experience, or unmeasured variables. Overall cost is less in the RR setting.

Study Design

This study has the strength of a complete data base with more than 99 percent of data sought being available. Because it was designed as an intent-to-treat study, with each patient initially receiving care at one site being credited to that site, no matter where she ultimately delivered, referral bias is avoided. The data were recorded prospectively, thus avoiding recall bias. However, the study is subject to selection bias, observer bias, misclassification bias, and random error. Specifically, the selection of the study population was not random, and there were significantly different populations at the different sites. These potential confounders were controlled for by using logistic regression analysis. Observer and misclassification biases may have been present for Apgar scores at the time of their assignment. These two biases also may have been present when the record was reviewed—i.e., consultations may not have been recorded in the record, or the record may have been misinterpreted by the reviewer. Random error is always present. Use of multiple comparisons, as in this study, makes this particularly worrisome. This was minimized by using logistic regression for multivariate analysis. Furthermore, many of the findings were significant at the $P < 0.01$ level, making this less of a concern.

Generalization

The findings of this study may be generalized only to board-certified family physicians and family practice residents working in both rural and urban settings and using moderate- to high-level technology with access to perinatal subspecialty consultation. This study does not compare family physicians with obstetricians or other perinatal subspecialists. The patient population was essentially all white, making generalization to other races impossible. All three sites make extensive use of obstetric technology, including electronic fetal monitoring and ultrasound. The RR site is within a relatively short distance of perinatal subspecialists. Therefore, nothing can be inferred about small obstetric centers that do not have access to such technology or that are at great distances from perinatal subspecialists.

Conclusions

There is no evidence that on-site perinatal specialists and technology improve perinatal outcome when care is provided by board-certified family physicians. The quality of perinatal care provided by board-certified family physicians is excellent. Perinatal outcome depends on physician's skill rather than on technology.

There is no evidence that small rural obstetric centers provide inferior care. They do not delay referral unnecessarily. Rather, they provide high-quality, inexpensive perinatal care that is readily accessible to the local population. Closing such facilities would be a disservice to the people of this country.

Is there an optimal level of technology for low-risk pregnancies? Some authors suggest that using the maximum technology available may have undesirable side effects without really improving perinatal outcome.[44,48-50] We conclude that this may be a true phenomenon and further study is needed.

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