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Evolving Trends in Maternal Fetal Medicine Referrals in a Rural State Using Telemedicine

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Abstract

Objective—To determine maternal fetal medicine (MFM) referral trends in a Medicaid population over time.

Study Design—Sixteen clinical guidelines and 23 clinical conditions were identified where co-management/consultation with MFM specialist is recommended. Linked Medicaid claims and birth certificate data for 2001–2006 were used to identify pregnancies with these conditions and whether they received co-management/consultation from a MFM specialist.

Results—Between 2001 and 2006, there were 108,703 pregnancies with delivery of 110,890 neonates. Forty five percent had one or more of the conditions identified for co-management/consultation. Overall pregnancies receiving MFM contact remained unchanged at 22.2% in 2001 and 22.1% in 2006. However, face to face contacts decreased from 14.6% (2001) to 8.7% (2006) while telemedicine consults increased from 7.6% (2001) to 13.3% (2006). Health departments were most likely and family practitioners least likely to refer to MFM ($p < 0.001$). Pregnancy complications leading to MFM referrals include cardiac complications, renal disease, systemic disorders, PPRM, suspected fetal abnormalities, and cervical insufficiency.

Conclusion—Referral of high risk pregnancies to MFMs varies with the level of expertise at the primary prenatal site. Increased contact between MFMs and local providers increased MFM referrals.

Keywords

Maternal fetal medicine; consultation/referral; telemedicine; pregnancy complications

Introduction

In 1972, the American Board of Obstetrics and Gynecology (ABOG) established the maternal-fetal medicine (MFM) specialty in obstetrics and gynecology with the overall goal of improving the health care of women who have complications with pregnancy by functioning as a consultant, co-manager, or direct care provider.¹ In an attempt to define the relationship between MFM specialists and general obstetricians, the Society for Maternal-Fetal Medicine (SMFM) published a document in 1996 to define the specialty of maternal-

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fetal medicine. The document states that the MFM specialists are complementary to obstetrical care providers in providing consultations and co-treatment or total patient care for a number of well-defined high-risk conditions and for a number of diagnostic or therapeutic procedures before and during pregnancy. However, the document did not provide any information regarding the actual relationship between the general obstetrician and the maternal-fetal medicine specialist with respect to patient referral in the presence of these high-risk conditions.²

In a survey of board-certified and board-eligible SMFM members, the national distribution of MFM specialists was found to be 1 for approximately 3000 births, with higher concentrations in the northeastern metropolitan obstetric areas and lower in the southeastern areas.³ The majority of MFM specialists practice in university hospital-based settings.¹ The density of MFM specialists has been significantly and inversely associated with maternal mortality ratios. It has been projected that an increase of 5 maternal-fetal medicine specialists per 10,000 live births results in a 27% reduction in the risk of maternal death,⁴ and earlier MFM consultation and care results in less prematurity, lower cesarean section rates, and fewer low 5-minute APGAR scores.⁵

A unique collaboration between the medical community of the State of Arkansas, the University of Arkansas for the Medical Sciences, the Arkansas Department of Health, and the Arkansas Department of Human Services, was undertaken by the formation of ANGELS (Antenatal and Neonatal Guidelines, Education and Learning Systems) to improve obstetrical care in rural Arkansas and to improve appropriate referrals to MFM specialists.⁶ The program was started to improve perinatal regionalization and support the medical community through telemedicine consultations, education by telemedicine, case management, best practice guidelines and a 24 hour call center.

In a survey of the relationship between obstetricians and MFM, the highest referral rate to a MFM specialist by a general obstetrician has been shown to be for diagnostic/therapeutic procedures, and the lowest referral rate was for patients who were admitted for reasons other than delivery.² Unpublished data at our institution shows that the ANGELS intervention in Arkansas was associated with a decline in MFM consults done for conditions not listed in ANGELS best practices as suggested conditions for MFM referral. We also showed greater likelihood of referrals for cases in areas where local physicians participated in tele-education and used a call line for direct consultations. Finally, we also observed marked variation in likelihood of referral for women based on the specialty and institutional setting of their prenatal care provider.

The goals of this study are twofold: to assess which specific conditions within the category of those suggested for referral are most likely to result in a referral, and to assess whether prenatal care providers of different specialties and institutional settings take different factors into account when referring patients to MFM specialists.

Methods

This study is not an outcomes study but an assessment of maternal fetal medicine referrals and consultations from face to face interaction to telemedicine over time in a rural population with the introduction of telemedicine. Although all of the data is from Arkansas, the Department of Healthcare Organization and Policy at the University of Alabama at Birmingham was contracted to analyze that data. This study was submitted and approved by Institutional Review Boards at UAMS and the University of Alabama at Birmingham.

Data Sources and Variable Selection

The primary data source is a set of Medicaid claims for pregnancy linked to birth certificates for women covered by Medicaid in Arkansas who delivered infants between April 2001 and December 2006. Only consultations and patient services covered by Medicaid were evaluated in this study. The ANGELS program was implemented in 2003 and evaluating the program from 2001 to 2006 allows an assessment of 21 months before and 48 months after the program was started. The pregnancies and live births were clustered by claims into 108,703 pregnancy episodes by date in association with the infant's birth date recorded on the birth certificate. These included Medicaid covered births to Arkansas residents that occurred in surrounding states. Pregnancies in this population were considered to include a maternal-fetal medicine (MFM) specialist visit if a paid claim for an ambulatory, ultrasound or telemedicine service from a MFM provider was present in the episode of care. The Security Advisory Committee and the Deputy Director of Medical Services at the Arkansas Health Department approved the request by Dr. Magann to submit the paper and data tables for publication.

Clinical guidelines developed in the course of the ANGELS program identified 16 clinical conditions where co-management or transfer to a maternal fetal medicine specialist is recommended: severe asthma, selected cardiac condition, diabetes, hemoglobinopathy, chronic hypertension with renal or heart disease, severe or obstructive pulmonary disease, renal disease, severe systemic diseases, connective tissue disease, history of intracranial injury, extensive condylomata, hydramnios at less than 34 weeks gestation, multiple gestations greater than two, monoamniotic or conjoined twins, oligohydramnios at less than 34 weeks gestation and placenta accreta. For an additional 23 clinical conditions maternal fetal medicine consults are recommended: epilepsy, family history of genetic problems, hypertension, moderate pulmonary disease, moderate renal disease, over age 35 at delivery, cervical insufficiency, threatened early labor, prior fetal abnormality, prior fetal death, prior preterm or low birth weight delivery, uterine malformation, Rh blood isoimmunization, proteinuria, elevated blood pressure during pregnancy, hyperemesis past first trimester, discordant twins, suspected fetal abnormality, hypercoagulable state, HIV infection, severe pre-eclampsia, premature rupture of membranes before 34 weeks gestation and anemia unresponsive to treatment. Through a combination of diagnoses from medical claims data and maternal conditions on birth certificate data were used to code for 20 of these 39 conditions. The remaining 19 conditions could not be coded from available administrative data. Details of the coding procedure are reported elsewhere.⁷ The referral norms and practice guidelines are available at <http://www.uams.edu/ANGELS/>. We focused this analysis on women with one or more of these conditions as coded, excluding women whose only risk factor was a maternal age of over 34 years. This yielded a data set of 48,455 pregnancy episodes (44.6% of the total).

Additional demographic data on the pregnant women derived from the matched vital records data were also included. County of residence for pregnant women in the data set was ascertained based on the zip code of residence recorded on Medicaid claims. Where there were multiple zip codes recorded, the zip code recorded on the claim closest by date to the delivery was used. Demographic data for the county of residence in the calendar year of the delivery was drawn from the Area Resource File. All board certified MFM specialists were in one county and all other counties reporting high risk obstetric care did not have direct MFM services. Over the time course of this investigation there was one other MFM specialist who was practicing in the State of Arkansas and working in a community hospital but was not board certified.

We used prenatal care claims for pregnancies in the data set to identify medical specialties for the primary prenatal care provider, defined as the maternity service provider who billed

for the majority of a woman's prenatal care visits. We categorized these specialties as (1) general or family physicians, (2) health departments providing early prenatal care then continued by a physician at the third trimester, (3) health departments with no physician providing prenatal care, and (4) obstetricians. For this study of referrals to maternal fetal medicine specialists, we further limited our data set to pregnancies where a consistent prenatal care provider in one of these specialty categories could be identified. This yielded a data set of 29,965 pregnancies.

To adjust for the convenience of women accessing specialty care services, we included on each record the distance in miles from a woman's zip code of residence to UAMS in Little Rock and to the closest telemedicine site. These distances were estimated as straight line distances between the centroid longitude and latitude of the zip code of residence and the zip code location for the sites.

The likelihood of exposure to the Angels program was assessed by evaluating the distance to the closest telemedicine site and 5 other measurement variables. These measures were the number of completed obstetrics and neonatal practice guidelines, the number of guidelines actively in preparation in the six months including the delivery, participation in ANGELS obstetrics teleconferences at the hospitals in the residential county in the year of delivery, and number of physician calls and patient calls to the ANGELS call center from the county in the six month period that included the delivery. To control for other factors related to the time trend, we included a dummy variable for cumulative months elapsed between April 1, 2001 and the infant delivery date. This study was approved by Institutional Review Boards at UAMS and the University of Alabama at Birmingham.

Statistical Approaches

We examined trends over time in maternal fetal medicine visits and in characteristics over the population, testing for statistical significance in trends using the Cochran Armitage trend test for frequencies and F tests for means. We also compared maternal fetal medicine referral rates and population characteristics across the four types of providers, using chi square statistics to test for significant differences in categorical variables and F test statistics to test for significant differences in continuous variables. We then used logistic regression analysis to examine the relationship between the individual and county level factors and the receipt of any maternal fetal medicine contact, modeling each prenatal care provider separately to assess whether different factors influenced the decision for the different providers. Analyses were conducted using SAS 9.2 with the Proc Logistic procedure.

Results

Table 1 examines time trends in the population characteristics of the study population from 2001 through 2006. The overall age of the women increased, the percentage of black women decreased while the percentage of Hispanic and other races increased over this period. The percentage of not married women with no father identified decreased while the percentage of not married with the father identified increased and the percentage of married women remained unchanged. The percentage of women not graduating from high school or low school for age remained unchanged while high school graduates decreased and women with some college or college graduates increased. The medical complications of renal disease, systemic disease, and epilepsy increased. Pulmonary disease, diabetes, cardiac complications, hypertension, HIV infected women, women with coagulation disorders and pregnant women with severe asthma remained unchanged. A pregnancy history of a prior fetal or infant death decreased while a history of a prior fetal abnormality or preterm delivery remained unchanged. The pregnancy complications of hyperemesis > 14 weeks, preeclampsia/eclampsia, suspected fetal anomaly, and oligo/polyhydramnios and increased.

The pregnancy complications of maternal anemia, PPROM, and placenta previa decreased while women with an incompetent cervix remained unchanged. The percentage of primiparas, plurality > 2, total number of risks, history of head injury remained unchanged. The mean gestational age at the time of delivery increased.

Table 2 examines county and ANGELS program characteristics of the study population, along with prenatal provider specialty and characteristics of the MFM contact. The portion of women living in counties where hospitals reported high risk OB services increased, along with the portion living in rural counties. Exposure to ANGELS interventions increased over this period, while distance to the closest telemedicine site decreased. The portion of women with prenatal care provided by family practitioners and by health departments alone decreased, while the portion seen by health departments combined with physicians increased. The portion of women with prenatal care provided by obstetricians remained unchanged over the time period. The use of MFM consults varied over time but not in a consistent trend. The telemedicine consults began to substitute for face-to-face consults with a MFM over the six year time period.

Table 3 compares characteristics of the population and use of MFM specialty visits by prenatal care provider. Note that the provider use changed over time and differed geographically, so that some of the differences across providers may really be the result of time trends or other factors. The data show that health departments most often referred patients to MFM specialists, while family and general practitioners referred least often. Health departments were more likely than the other providers to refer patients for face to face specialty visits. Health departments also diagnosed more high-risk characteristics in patients, but as is clear from the individual listings, this is primarily because diabetes was much more frequently diagnosed in these patients. There were race, ethnicity, age and education differences in the distribution of the population across prenatal care providers. Non-white, unmarried, younger, less educated women with delayed initiation of prenatal care were more likely to see general or family practitioners or health department clinics.

Table 4 shows the results of a multivariate analysis examining factors that predicted receiving any MFM consult for this population with diagnosed high risk conditions. Models are estimated separately for each type of prenatal care provider. Since one of the goals of this study was to identify differences across provider types in factors associated with referral to MFMs, estimates in bold indicate associations that are significantly different across specialty types, that is where the 95% confidence intervals for the odds ratios do not overlap.

Table 4 analyzes the likelihood of patient referral by patient provider groups. The most frequently referred conditions are all associated with conditions affecting the fetus: plurality greater than twins, suspected abnormality, and oligohydramnios and polyhydramnios. The most common maternal conditions referred was a woman who was HIV positive. Most common obstetric conditions referred include women with cervical insufficiency and eclampsia. The only significant association for referral by condition was for pregnancy induced hypertension; both family physicians and health department prenatal providers were more likely to refer patients with this diagnosis for MFM assessment, compared to the likelihood of referral for patients with OB prenatal care. Health department patients with increasing numbers of conditions were less likely to be referred to an MFM.

Across one or more prenatal provider specialties, women over age 35, Black women, primiparous women, unmarried women with no father identified on the birth certificate, women with less than a high school education and those who eventually delivered preterm were more likely to have contact with MFM than other women. Women with multiple pregnancies receiving care from Family Physicians were more likely to have MFM contact

than women receiving care from health departments. Women starting prenatal care in the first trimester were more likely to have MFM contact, except that trimester of start did not matter for women whose care providers were a combination of health departments and physicians.

In general, women residing in counties where local hospitals report providing high risk obstetrics care were less likely to have contact with MFM; this was significantly more the case for women with Family physicians as providers compared to other women. In addition, there was more geographic variation in likelihood of MFM contact across women receiving care in health departments only than across other provider types, suggesting that health department providers have different arrangements for referral to OB specialists in different counties. In particular, women receiving health department prenatal care in Pulaski County where UAMS is located were much less likely to have a claim for a MFM contact, while women in the same county with other providers were much more likely to have such a contact. This is probably because MFM specialists regularly serve as attending physicians in health department prenatal clinics in the county. Women receiving prenatal care from the combination of health department and physician providers declined significantly in their likelihood of having an MFM contact over the six years of the study, while the likelihood of contact over time remained relatively constant for the other three groups.

Across all prenatal specialty categories, women living in counties where more providers participated in teleconference rounds were more likely to have MFM contact. Physician use of the call center was also associated with patient MFM contact, although statistical significance for this association was reached only for OB providers. As more practice guidelines were finalized, MFM contact for health department patients declined; this association was not observed for women with other types of providers.

Discussion

In 2002, the University of Arkansas for the Medical Sciences in cooperation with the Arkansas Department of Health and the Arkansas Department of Human services initiated a statewide program to improve pregnancy outcomes in a state that had only 3–5 board certified and one non board certified Maternal Fetal Medicine specialists during the time of this assessment (2001–2006). This new service was called ANGELS (Antenatal and Neonatal Guidelines Education and Learning Systems). The new program provided maternal fetal medicine services using telemedicine to provide consultation services to a fairly rural state which ranks 34th with a population density of 56 inhabitants per square mile.⁸ Arkansas is also one of the poorest states with a median household income of \$37,987 ranking it at 49th (2010) in the United States.⁹ This investigation evaluated the trends in referrals to MFM just prior to and in the first few years after initiation of the ANGELS project to improve perinatal regionalization, and increase appropriate referrals and consultations in a state with limited health care dollars and personnel.

Overall, we observed that the maternal fetal medicine contacts for conditions targeted for referral to MFM did not change over the time period of this study; however, the method in which the patients were seen changed dramatically. Contact by telemedicine consistently increased each year, while face to face contact consistently decreased. Additionally, calls by patients and medical doctors to the UAMS call center and the use of obstetric and neonatal guideline increased each year, while the distance to the closest telemedicine site decreased as new sites were opened each year.

Although rates of referral for consultation varied across prenatal provider types, multivariate modeling identified only a few significantly different factors related to the likelihood of

referral across the types. Family physicians and to some extent health departments were more likely to refer for conditions that OBs provided care for themselves, including pregnancy induced hypertension and twin pregnancies. Health departments differed in care referral rates geographically and over time, probably based on differential and evolving arrangements they had with local obstetricians and specialists. Overall, conditions of the fetus were most likely to result in contacts between pregnant women and MFM. It seems likely that the crude differences in portions of women with targeted conditions receiving MFM contact across specialties, ranging from 14% for patients of Family physicians to 32% for health department patients, is primarily to different characteristics of patients across these types. In particular, in Arkansas more of the health department prenatal patients were non-white, older than 35, and had more total number of risk conditions. Fewer of the family or general physician prenatal care patients had diabetes, high risk previous pregnancy experiences, insufficient cervix or suspected fetal anomalies.

A limitation of this investigation was that there was no independent validation of the medical claims data and linked birth certificates for this study. The Medicaid claims data is continuously evaluated for its correctness by Medicaid itself and a number of State agencies assess the legitimacy of birth certificates. Another limitation is that although we have observed lower preterm birth rates in Medicaid over time, we do not have sufficient information to claim that this is because of the ANGELS program of the change from face to face to telemedicine MFM consultations. The lower mortality that we have observed goes along with lower prematurity rates but we do not currently have a good method to measure the impact of the changes and relate them to telemedicine

Despite an increasing availability of both telemedicine consults and yearly updated clinical guidelines, unfortunately, providers (both obstetricians and family/general practitioners) and health departments not involved in weekly telemedicine conferences showed minimal change to either their practice or referrals patterns. Telemedicine began in 2003 with 2 sites and 215 patient encounters and by December of 2006 there were 6 sites and 891 patient encounters. The use of on-going telemedicine education and published protocols are effective in the referral of at-risk women for appropriate maternal fetal medicine consultations. The on-going challenge will be to connect those health care providers in Arkansas who are currently not utilizing maternal fetal medicine consultations/ referrals, best practice guidelines and/or ANGELS.

Acknowledgments

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Table 1

Time trends in population characteristics

	2001 (N=3005)	2002 (N=4826)	2003 (N=4390)	2004 (N=4942)	2005 (N=4833)	2006 (N=6225)
<u>Maternal age (yr)</u>						
% < 19	15.0	13.8	13.7	15.4	12.5	12.6 **
% 19–24	57.3	56.0	56.0	54.4	53.7	50.8 ***
% 25–34	24.2	25.9	26.4	26.0	29.8	32.7 ***
% 35	3.5	4.3	3.8	4.1	4.0	3.9 *
<u>Race</u>						
% White	60.3	63.6	64.032.7	65.6	62.3	59.1
% Black	36.6	35.2	2.4	28.9	28.6	26.8 ***
% Hispanic	2.2	2.4	0.9	4.6	8.3	13.0 ***
% Other	0.91	0.7		0.9	0.7	1.2 ***
<u>Parity</u>						
% Primiparous	40.3	39.2	40.4	41	36.3	39.9
<u>Multiple births</u>						
% Multiple births	3.5	3.0	2.9	3.2	3.0	2.5*
<u>Marital status</u>						
% Not married father identified	26.7	29.5	29.9	32.1	33.0	34.1 ***
% Not married no father identified	31.9	30.5	29.9	26.0	24.8	27.2 ***
% Married	41.4	40.0	40.2	41.9	42.2	38.7
<u>Education</u>						
% < high school or low for age	27.7	26.4	25.5	26.2	26.7	27.7
% High School graduate	54.5	54.6	54.1	53.5	52.1	50.4 ***
% Some college or college graduate	17.8	19.0	20.3	20.3	21.2	21.9 ***
Total number of risks recorded (mean)	1.42	1.45	1.18	1.47	1.46	1.44**
<u>Past Medical History %</u>						

	2001 (N=3005)	2002 (N=4826)	2003 (N=4390)	2004 (N=4942)	2005 (N=4833)	2006 (N=6225)
Severe Asthma	0.93	1.22	5.1	1.42	1.32	1.32
Cardiac disease	4.4	4.2	11.8	4.4	4.6	4.9
Diabetes	11.2	11.9	3.2	10.5	10.7	11.6
Pulmonary disease	2.9	2.9	4.1	3.1	3.1	3.2
Renal disease	2.4	3.6	4.6	3.3	4	3.9 **
Systemic diseases	4.1	4.3	0.11	5.4	5.5	5.8 ***
History of head injury	0.07	0.12	1.73	0.08	0.06	0.19
Epilepsy	1.86	1.78	6.5	1.56	2.26	2.57 **
Hypertension	6.9	6.9	0.14	6.6	6.7	6.6
HIV positive	0.13	0.21	0.21	0.51	0.10	0.10
Coagulation disorders	0.17	0.23	5.1	0.24	0.10	0.32
<u>Past Obstetric History %</u>						
Prior fetal abnormality	0.07	0.04	0.16	0.22	0.19	0.16
Prior fetal / infant death	7.8	6.5	5.7	5.7	5.1	5.5 ***
Prior preterm delivery	4.2	3.5	3.5	3.9	3.3	2.7
<u>Pregnancy complications % with</u>						
Incompetent cervix						
Hyperemesis > 14 weeks	1.2	1.7	1.4	1.4	1.1	1.4
Maternal anemia	11.2	11.9	14.9	14.8	14.3	12.9 **
Preeclampsia / eclampsia	36.3	35.3	34.7	34.2	33.0	29.7 ***
PPROM	4.9	5.1	4.9	4.7	5.6	5.7 *
Suspected fetal anomaly	7.6	7.9	6.8	7.5	7.0	6.3 **
Oligo/Polyhydramnios	9.8	12.3	16.3	15.9	18.2	18.7 ***
Placenta previa	0.17	0.25	0.46	0.49	0.64	0.37 *
	1.86	1.51	0.96	0.38	0.62	0.34 ***
Gestational age at delivery (mean weeks)	38.4	38.5	38.5	38.6	38.6	38.6 ***

* p < .05.

p < .01,
p < .001 C-A time trend test for frequencies, f test for means

Table 2
Home location of patients, Angels call center and telecommunication, and MFM contact

	2001 (N=3005)	2002 (N=4826)	2003 (N=4390)	2004 (N=4942)	2005 (N=4833)	2006 (N=6225)
<u>Home location of patients</u>						
Hospital offering high risk OB services in home county (%)	55.8	56.4	60.8	59.4	62.2	66.2 ***
% Rural county	28.2	28.5	29.7	32.0	32.9	35.5 ***
% Urban county	47.6	46.6	45.5	43.6	43.5	43.7 ***
% Small town county	24.2	24.9	24.8	24.4	23.6	20.8 ***
% Pulaski county	14.8	13.6	13.5	12.6	13.3	13.6
Distance to UAMS (mean miles)	81.2	82.1	81.1	82.9	82.5	82.9 *
<u>Angels Call Center</u>						
MD call to call center	0	0	0	72.6	63.7	80.5 ***
Patient call to call center	0	0	0	85.5	95.2	93.8
MD teleconference participation	0	0	9.3	6.1	12.8	23.9 ***
Guidelines completed	0	0	9.8	45.1	68.6	96
Distance to closest telemedicine site (mean miles)	92.6	92.6	75.2	42.3	33.3	28.6 ***
<u>Obstetric Provider</u>						
% FP or GP	21.0	19.5	17.1	13.2	9.7	12.4 ***
% OB	55.0	54.5	56.0	45.5	47.3	58.6
% Health Dept with MD	12.4	15.7	17.9	32.2	31.5	21.6 ***
% Health Dept Only	11.5	10.3	8.9	9.1	11.5	7.3 ***
<u>MFM contacts</u>						
Any MFM contact	22.2%	24.8%	24.1%	20.5%	18.8%	22.1% ***
MFM with telemedicine	7.6%	9.3%	10.3%	12.5%	11.7	13.3% ***
MFM face to face	14.6%	15.5%	13.8%	8.4%	7.1%	8.7% ***

* p < .05.

 $p < .01$,
 $p < .001$ C-A time trend test for frequencies, f test for means

Table 3

Comparison of Characteristics by Prenatal Care Provider

	FP or GP 4220 (14.9%)	Health Dept with MD 6380 (22.6%)	Health Dept Only 2697 (9.6%)	OB 14,924 (52.9%)
<u>Maternal age (yr)</u>				
% < 19	15.2	14.6	12.5	13.1 **
% 19–24	56.3	55.3	53.9	53.3 ***
% 25–34	25.1	26.7	28.9	29.2 ***
% ≥ 35	4.1	3.4	4.7	4.3 ***
(12 with missing age)				
<u>Race</u>				
% White	64.0	65.0	41.7	64.0 ***
% Black	28.2	29.1	46.2	29.7 ***
% Hispanic	6.8	5.3	11.0	5.3 ***
% Other	0.9	0.6	1.0	1.0 **
(515 with race missing)				
Primiparous	37.2	42.6	37.5	39.2 ***
Plurality > 2	0.05	0.09	0	0.11
Multiple births	2.5	3.0	2.6	3.1
<u>Marital status</u>				
% Not married no father identified	27.4	27.7	32.2	27.6 ***
% Not Married father identified	30.2	31.7	32.6	31.3
% Married	42.4	40.6	34.2	41.1 ***
<u>Education</u>				
% < high school or low for age	32.0	27.7	31.8	25.9 ***
% High School graduate	49.9	49.5	46.2	48.9 *
% Some college or college graduate	16.0	20.6	20.1	23.1 ***
<u>Prenatal care start in first trimester</u>	72.6	75.0	74.3	76.1 ***
<u>Total number of risks recorded (mean)</u>	1.45	1.41	1.65	1.44 ***
<u>Past Medical History by %</u>				
Severe Asthma	1.2	1.3	0.9	1.4
Cardiac disease	3.6	4.2	3.5	5.3 ***
Diabetes	5.2	8.4	29.1	11.1 ***
Pulmonary disease	2.8	2.7	3.0	3.3

	FP or GP 4220 (14.9%)	Health Dept with MD 6380 (22.6%)	Health Dept Only 2697 (9.6%)	OB 14,924 (52.9%)
Renal disease	4.1	3.1	2.7	2.9 ***
Systemic diseases	5.5	5.2	3.5	5.1
History of head injury	0.09	0.05	0.15	0.14
Epilepsy	1.8	2.0	1.4	2.2
Hypertension	5.5	6.5	5.3	7.3 ***
HIV positive	0.21	0.19	0.15	0.21
Coagulation disorders	0.21	0.24	0.07	0.24
<u>Past Obstetric History</u>				
% Prior fetal abnormality	0	0.20	0	0.19 **
% Prior fetal / infant death	4.4	5.7	6.1	6.4 ***
% Prior preterm delivery	3.8	3.1	2.7	3.6 *
<u>Pregnancy comp % with</u>				
Insufficient cervix	0.69	1.33	0.74	1.72 ***
<u>Pregnancy induced hypertension (PIH)</u>				
Hyperemesis > 14 wks	20.6	25.0	18.1	22.5 ***
Maternal anemia	13.647.5	15.030.6	7.9	13.7 ***27.0 ***
Preeclampsia/eclampsia	3.8	5.1	54.1	5.7 ***
PPROM	11.3	5.9	4.6	6.7 ***
Suspected fetal anomaly	9.5	15.9	5.4	17.5 ***
Oligo/Polyhydramnios	0.310.85	0.47	15.3	0.39
Placenta previa		0.71	0.52	0.88
			1.04	
Gestational age at delivery (mean weeks)	38.6	38.6	38.6	38.5 ***
<u>Home location of patients</u>				
% Hospital offering high risk OB services in home county	56.4	48.8	65.1	66.2 ***
% Rural county	33.5	37.3	27.7	29.3 ***
% Urban county	45.0	34.5	53.8	47.6 ***
% Small town county	21.5	28.2	18.5	23.1 ***
% Pulaski county	4.1	5.3	28.1	17.0 ***
Mean distance to UAMS	100.9	87.5	77.5	76.4 ***
<u>Angels Call Center</u>				
MD call to call center from county	33.1	48.1	39.3	41.2 ***
Patient call to call center from county	40.6	62.7	51.8	50.6 ***
MD teleconference participation in county	12.5	10.6	7.3	9.5 ***

	FP or GP 4220 (14.9%)	Health Dept with MD 6380 (22.6%)	Health Dept Only 2697 (9.6%)	OB 14,924 (52.9%)
Distance to closest telemedicine site (mean in miles)	57.9	55.8	60.3	56.6 ***
<u>MFM contacts</u>				
Any MFM contact	14.1%	26.1%	32%	20.7% ***
MFM with telemedicine	8.6%	13.9%	11.5%	10.9% ***
MFM face to face	5.6%	12.2%	20.5%	9.8% ***

*
p<0.05,

**
p< 0.01,

p< 0.001 Chi Square test for frequencies, f test for means

Table 4

Logistic Regression Testing Likelihood of Any Referral to Maternal Fetal Medicine Specialists

Characteristic	FP or GP O.R. (95% C.I.)	Health Dept with MD O.R. (95% C.I.)	Health Dept only O.R. (95% C.I.)	OB O.R. (95% C.I.)
Total number of conditions noted	0.80 (0.62, 1.04)	1.01 (0.84, 1.22)	0.52 (0.39, 0.69)	0.91 (0.80, 1.04)
Specific Condition (reference is anemia, shown by order of magnitude for OB)				
Plurality > 2	<0.001 (<0.00, >999.99)	4.309 0.762, 24.381	(no cases)	27.73 (7.30, 105.24)
Suspected fetal abnormality	30.83 (21.60, 44.00)	32.26 (25.24, 41.22)	37.56 (24.81, 56.85)	24.93 (21.06, 29.51)
Oligohydramnios	6.292 (0.39, 101.05)	4.61 (1.13, 18.85)	8.92 (1.37, 58.15)	16.54 (6.76, 40.48)
Polyhydramnios	2.12 (0.55, 8.21)	7.67 (3.34, 17.63)	8.30 (3.02, 22.86)	7.34 (4.21, 12.80)
HIV infection	3.10 (0.52, 18.41)	1.86 (0.21, 16.61)	32.53 (2.03, 520.44)	5.06 (2.10, 12.22)
Cervical insufficiency	5.26 (1.89, 14.61)	2.41 (1.34, 4.34)	3.09 (0.99, 9.62)	2.40 (1.66, 3.46)
Maternal cardiac conditions	3.51 (2.08, 5.93)	2.19 (1.54, 3.12)	6.86 (3.83, 12.30)	2.35 (1.85, 2.99)
Eclampsia/pre-eclampsia	1.79 (1.00, 3.20)	1.11 (0.75, 1.63)	1.65 (0.90, 3.01)	2.04 (1.58, 2.62)
Epilepsy	3.63 (1.84, 7.16)	1.64 (0.95, 2.84)	2.39 (0.90, 6.33)	2.15 (1.52, 3.03)
Systemic diseases	1.86 (1.13, 3.05)	1.70 (1.20, 2.41)	2.26 (1.20, 4.27)	2.00 (1.54, 2.59)
Placenta previa	0.19 (0.02, 1.51)	2.04 (0.96, 4.36)	2.22 (0.83, 5.96)	1.96 (1.17, 3.28)
Chronic hypertension	1.30 (0.76, 2.23)	1.194 (0.826, 1.73)	1.99 (1.13, 3.52)	1.85 (1.44, 2.36)
Diabetes	2.84 (1.76, 4.59)	1.79 (1.34, 2.40)	1.54 (0.99, 2.41)	1.78 (1.46, 2.17)
Renal disease	1.92 (1.03, 3.56)	2.31 (1.51, 3.52)	3.53 (1.86, 6.70)	1.63 (1.21, 2.20)
PPROM	1.86 (1.19, 2.91)	1.43 (1.00, 2.02)	2.36 (1.41, 3.93)	1.45 (1.14, 1.85)
Prior fetal or infant death	1.65 (0.95, 2.87)	0.90 (0.63, 1.30)	2.32 (1.44, 3.74)	1.40 (1.10, 1.78)
Coagulation disorders	0.45 (0.02, 7.99)	4.08 (1.04, 15.99)	18.03 (1.01, 321.33)	2.62 (0.99, 6.91)
Asthma	1.22 (0.41, 3.61)	1.10 (0.56, 2.17)	4.25 (1.53, 11.79)	1.53 (0.96, 2.44)
PIH	1.84 (1.29, 2.62)	1.02 (0.81, 1.30)	2.39 (1.65, 3.47)	1.03 (0.85, 1.25)
Hyperemesis > 14 weeks	1.56 (1.05, 2.31)	0.79 (0.60, 1.04)	2.09 (1.33, 3.28)	1.16 (0.95, 1.42)
History of preterm birth	0.27 (0.09, 0.95)	1.13 (0.72, 1.75)	2.23 (1.11, 4.47)	0.94 (0.67, 1.32)
Thrombosis	119.22 (10.97, >999.99)	2.37 (0.38, 14.77)	2.36 (0.16, 34.93)	3.20 (0.78, 13.07)
Patient Demographic Characteristics				
Age 35	1.83 (1.07, 3.12)	1.42 (0.99, 2.05)	1.31 (0.78, 2.22)	1.73 (1.38, 2.17)
Black vs. white	1.19 (0.89, 1.59)	1.26 (1.04, 1.52)	1.02 (0.77, 1.36)	1.15 (1.01, 1.31)
Primiparous	1.10 (0.84, 1.44)	1.29 (1.08, 1.54)	0.88 (0.68, 1.14)	1.13 (0.90, 1.28)
First trimester start of prenatal care	1.39 (1.06, 1.82)	0.88 (0.74, 1.05)	1.59 (1.23, 2.07)	1.48 (1.30, 1.69)
Multiple births	5.47 (3.10, 9.64)	1.65 (1.08, 2.53)	1.70 (0.92, 3.14)	2.83 (2.20, 3.65)
Less than high school vs high school	0.94 (0.72, 1.24)	1.22 (1.02, 1.46)	0.90 (0.70, 1.17)	1.09 (0.95, 1.24)
Gestational age at delivery	0.91 (0.87, 0.95)	1.02 (0.99, 1.06)	0.93 (0.89, 0.97)	0.94 (0.92, 0.96)
County Characteristics				
Hospital in county offering high risk OB	0.37 (0.28, 0.49)	0.81 (0.68, 0.97)	0.58 (0.43, 0.78)	0.76 (0.67, 0.87)
Rural residential county vs small towns	1.21 (0.87, 1.69)	0.85 (0.69, 1.03)	0.63 (0.44, 0.90)	0.98 (0.84, 1.14)
Urban residential county vs small towns	0.80 (0.58, 1.10)	1.02 (0.83, 1.24)	1.91 (1.38, 2.65)	1.09 (0.93, 1.26)

Characteristic	FP or GP O.R. (95% C.I.)	Health Dept with MD O.R. (95% C.I.)	Health Dept only O.R. (95% C.I.)	OB O.R. (95% C.I.)
Pulaski county	6.03 (3.08, 11.81)	1.54 (1.05, 2.26)	0.35 (0.21, 0.61)	1.36 (1.10, 1.68)
Months elapsed since 4/2001	1.00 (0.98, 1.02)	0.97 (0.96, 0.98)	1.02 (1.00, 1.04)	1.00 (0.99, 1.01)
Exposure to ANGELS Intervention				
Any MD call to Angels Call Center from residence county	1.26 (0.80, 1.99)	1.10 (0.87, 1.40)	1.14 (0.78, 1.68)	1.46 (1.22, 1.76)
Any PT call to ANGELS Call Center from Residence County	1.05 (0.61, 1.80)	1.12 (0.83, 1.50)	0.98 (0.56, 1.73)	0.85 (0.67, 1.08)
Any MD teleconference participation in residence county	1.53 (1.08, 2.15)	1.86 (1.42, 2.43)	1.74 (1.09, 2.79)	1.38 (1.14, 1.67)
Number of practice guidelines completed	1.00 (0.99, 1.01)	1.00 (0.99, 1.00)	0.97 (0.96, 0.98)	1.00 (1.00, 1.01)
Distance to closest telemedicine facility	1.00 (1.00, 1.01)	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)	1.01 (1.00, 1.01)
Distance to UAMS	0.99 (0.99, 1.00)	1.00 (0.99, 1.00)	0.99 (0.99, 0.99)	0.99 (0.99, 0.99)

The analysis has been adjusted for all the other variables (variables that are not significant are not shown)