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Rural-urban differences in childbirth care, 2002-2010, and implications for the future

Katy Kozhimannil

Abstract

Background—Approximately 15% of the 4 million annual U.S. births occur in rural hospitals.

Objective—To 1) measure differences in obstetric care in rural and urban hospitals and 2) examine whether trends over time differ by rural-urban hospital location

Research Design and Subjects—Retrospective analysis of hospital discharge records for all births in the 2002-2010 Nationwide Inpatient Sample, a 20% sample of U.S. hospitals (N=7,188,972 births; 6,316,743 in urban hospitals, 837,772 in rural hospitals).

Measures—Rates of low-risk cesarean (full-term, singleton, vertex pregnancies; no prior cesarean), vaginal birth after cesarean (VBAC), non-indicated cesarean, and non-indicated labor induction.

Results—In 2010, low-risk cesarean rates in rural and urban hospitals were 15.5% and 16.1%, respectively, and non-indicated cesarean rates were 16.9% and 17.8%. VBAC rates were 5.0% in rural and 10.0% in urban hospitals in 2010. Between 2002 and 2010, rates of low-risk cesarean and non-indicated cesarean increased, and VBAC rates decreased in both rural and urban hospitals. Non-indicated labor induction was less frequent in rural versus urban hospitals in 2002 (AOR=0.79 [0.78-0.81]), but increased more rapidly in rural hospitals from 2002-2010 (AOR=1.05 [1.05-1.06]). In 2010, 16.5% of rural births were induced without indication (12.0% of urban births).

Conclusions—From 2002-2010, cesarean rates rose and VBAC rates fell in both rural and urban hospitals. Non-indicated labor induction rates rose disproportionately faster in rural vs. urban settings. Tailored clinical and policy tools are needed to address differences between rural and urban hospitals.

Keywords

rural health; urban health; obstetrics; cesarean; labor induction

Introduction

Approximately 15% of the 4 million U.S. mothers who give birth each year deliver their babies in rural hospitals.^{1,2} Rural-urban differences in obstetric care are important for

(kbb@umn.edu).

Supplemental Digital Content

Supplemental Digital Content contains Supplemental Tables 1-4, and is uploaded as file “Supplemental Digital Content.docx.”

financial and policy reasons, as well clinical and public health reasons. Small absolute differences in childbirth care can affect the health of thousands of women and infants every year, with such differences growing ever-larger if they are driven by disparate trends.³

In 2009, childbirth-related hospitalizations accounted for 7.6% of all inpatient costs, totaling \$27.6 billion, and nearly half of births were paid for by state Medicaid programs.⁴ Rising costs are driven in part by greater use of obstetric procedures nationally,^{5,6} including increases in labor induction, first-time cesareans, and repeat cesareans.⁷⁻¹⁰ A rise in the prevalence of conditions that necessitate cesarean delivery, a changing medico-legal environment, and local clinical practice patterns may all contribute to the recent rise in cesarean rates and variation in the use of cesarean delivery across hospitals and geographic regions.¹¹⁻¹⁵ These same factors differ between rural and urban settings.^{16,17}

The use and appropriateness of obstetric care in rural and urban hospitals impacts the health of women and infants in these settings.¹⁷⁻²⁰ Cesarean delivery is an important and potentially life-saving intervention, but it is associated with certain risks, compared with vaginal delivery (e.g., infection, surgical injury, re-hospitalization, breastfeeding challenges, pain, placental disorders in future pregnancies, and infant respiratory illness), and labor induction and cesarean without medical indication, especially between 37-39 weeks gestation, adversely affect maternal and infant health (e.g., postpartum hemorrhage, infant morbidity and mortality, and prolonged length of stay).^{14, 21-26} Clinical guidelines and measurement protocols have been developed to guide maternity care quality improvement.^{11,21,27-30} These efforts are generally being implemented without particular regard for rural-urban differences. We document current obstetric practices, changes over time, and relevant differences between rural and urban settings.

Methods

Data

Obstetric deliveries in both rural and urban hospitals were identified from the Nationwide Inpatient Sample³¹ (NIS) datasets 2002-2010 (N=7,188,972 total births; 6,316,743 urban and 837,772 rural). The NIS uses a stratified, single-stage cluster sampling design, with region, urban or rural location, teaching status, ownership, and bed size to identify strata. After stratification, a 20% random sample of hospitals from the target population (US community hospitals) is taken. The NIS, with 100% of discharges from sampled hospitals, has been a uniform database to support comparative health services research since 1998.³¹

Measurement

Primary outcomes for this analysis use *International Classification of Diseases* – 9th revision (ICD-9) codes and reflect measures appropriate for assessing quality in rural hospitals;³² outcomes include low-risk cesarean, vaginal birth after cesarean (VBAC), cesarean without medical indication, and labor induction without medical indication. Low risk is defined as a woman with a pregnancy that is full term (≥ 37 weeks gestation), singleton, vertex position, and no prior cesarean delivery. Medical indications are defined based on the Specifications Manual for Joint Commission National Quality Measures

(v2011A, Appendix A). Medical indications possibly justifying labor induction included premature or prolonged rupture of membranes, , HIV infection, placenta previa, vasa previa, antepartum hemorrhage, hypertensive disorders, post-dates, liver, renal or cardiovascular disease, abnormal blood glucose, coagulation defects, multiple gestation, unstable lie, fetal malformation, poor fetal growth, fetal chromosomal abnormality, fetal-maternal hemorrhage, Rh/ABO isoimmunization, fetal distress, intrauterine death, stillbirth, polyhydramnios, oligohydramnios, abnormal fetal heart rates, amniotic infection, and pregnancy with poor obstetric history. Contraindications for vaginal delivery included complications related to preterm labor or multiple gestation, long or obstructed labor with multiple gestation, malpresentation (e.g. breech), complications from prior cesareans, and other serious fetal or placental problems.

Hospital urban-rural status was based on U.S. Census Core-Based Statistical Area (CBSA) codes. Patient-level covariates were maternal age, race/ethnicity, primary payer, and maternal medical conditions, including the following complications of pregnancy, labor, and delivery: diabetes, hypertension, pre-eclampsia, eclampsia, post-term pregnancy, multiple gestation, placental complications, malpresentation, fetal disproportion, fetal distress, prior cesarean delivery, and preterm delivery.

Analysis

We used generalized estimating equations (GEE) with a log link and adjusted standard errors to account for hospital-level clustering. Models controlled for age, race, and payer, and included interaction terms between year and rural location to evaluate whether annual trends in outcomes differed by hospital location. We also calculated unadjusted odds with models controlling for age alone, age and race, and clinical covariates. These results confirm main analyses and are presented as Supplemental Digital Content. To illustrate rural and urban time trends, we also calculated predicted probabilities using mean covariate values (Table 1) to represent a typical childbirth-related hospitalization and coefficients generated by the GEE models described above (Table 3). All analyses were performed using SAS, version 9.3.

This research was approved by the University of Minnesota Institutional Review Board (ID 1209S20781).

Results

Differences between births rural and urban hospitals and trends over time

Women giving birth in rural hospitals were younger than those giving birth in urban hospitals (52.9% versus 37.5% below age 25), less diverse (46.9% white versus 38.5% white), and more likely to have Medicaid coverage (50.9% versus 39.3%; Table 1). Additionally, there were lower rates of pregnancy complication in rural versus urban hospitals. From 2002 to 2010, obstetric trends were similar across settings (Table 2). In rural hospitals, unadjusted cesarean rates for low-risk women grew from 12.9% to 15.5%, versus 12.7% to 16.1% in urban hospitals. VBAC rates declined from 13.1% to 5% in rural hospitals and from 18.8% to 10.0% in urban hospitals. Non-indicated labor induction

increased from 9.3% to 16.5% in rural hospitals and from 10.3% to 12.0% in urban hospitals. This represents a 17.3% relative increase among urban hospitals versus a 77.7% increase in rural hospitals. Non-indicated cesarean rates grew from 14.3% to 16.9% in rural hospitals and 14.3% to 17.8% in urban hospitals.

Differential time trends between rural and urban hospitals

Controlling for socio-demographic factors, low-risk women had 6% higher odds of cesarean delivery in a rural (versus urban) hospital in 2002 (AOR=1.06 [1.04-1.07]; Table 3), but the odds of cesarean delivery among low-risk women grew slightly more quickly in urban hospitals, with an annual increase of 4% across the study period (annual AOR=1.04 [1.03-1.04]). Rural hospitals were also more likely to perform a cesarean without medical indication in 2002 (AOR=1.03 [1.02-1.05]), and the pattern of increase over time in rural and urban hospitals was similar to that for low-risk cesareans. Additionally, odds of VBAC were 38% lower in rural versus urban hospitals in 2002 (AOR= 0.62 [0.60-0.65]). VBAC odds declined 10% each year in urban hospitals from 2002-2010 (annual AOR=0.90 [0.90-0.91]) and less rapidly among rural hospitals (annual AOR=0.96 [0.95-0.97]). Finally, non-indicated labor induction was less frequent in rural versus urban hospitals in 2002 (AOR=0.79 [0.78-0.81]). In urban hospitals, the odds of non-indicated labor induction increased 4% per year from 2002-2010 (annual AOR=1.04 [1.04-1.04]), but odds of non-indicated labor induction increased more rapidly in rural hospitals from 2002-2010 (annual AOR=1.05 [1.05-1.06]). All noted trends and comparisons were significant at $P<0.001$.

Figure 1 shows predicted probabilities for labor induction for a woman with population average characteristics (from Table 1, age 28, white, privately-insured, and without medical indications necessitating labor induction) giving birth in either a rural or an urban hospital in the years 2002-2010. Though the predicted probability of non-indicated labor induction for a typical low-risk woman was lower in 2002 in a rural hospital (11.0%) compared with an urban hospital (13.4%), chances of non-indicated induction increased more rapidly in rural hospitals. By 2010, a low-risk woman had a higher probability of non-indicated labor induction if she gave birth in a rural hospital compared with an urban hospital, with predicted probabilities of 20.7% and 17.8%, respectively.

Discussion

Rising cesarean rates are a challenge faced in both rural and urban locations. Non-indicated labor induction is increasingly common for births in rural hospitals. This analysis indicates that women giving birth in rural and urban hospitals may experience different childbirth-related benefits and risks. Whether these trends continue will depend in part on the implementation of current policy recommendations and health reform efforts.

Financial and policy implications

Medicaid pays hospitals about 50% less than private insurers for childbirth-related services.⁴ A higher proportion of rural (versus urban) residents are enrolled in Medicaid, and rural hospitals receive 14% of their revenue from Medicaid.³³ Rural hospital administrators often

cite a high percentage of Medicaid patients as a financial concern in their obstetric services line.³

Due to Medicaid's important role in financing childbirth care, particularly in rural hospitals, Medicaid payment policy has great potential to inform and catalyze quality improvement in obstetric care,³⁴ for example, by adjusting payment to discourage non-indicated deliveries before 39 weeks gestation.³⁵ However, rural-urban differences should be considered in implementation of payment policies. hospitals that struggle to comply with requirements or recommendations to reduce the use of this procedure may experience Revenue reductions may hamper efforts (e.g. educational trainings, protocol development, or staffing increases) that may be required for effective implementation of quality improvement efforts. The medico-legal environment may also influence rural obstetric practice via liability insurance rate surcharges for low-volume and family physician obstetric providers.³⁶

New and emerging models of healthcare delivery including the establishment of Accountable Care Organizations (ACOs) may provide opportunities for shared resources and shared savings to facilitate the implementation of evidence-based care,^{37,38} but rural-urban differences in ACO implementation may impact obstetric care. One consequence of perinatal regionalization has been reduced availability of obstetric services in some rural areas,^{23,39} and ACO implementation may further decrease the availability of rural obstetric care through hospital consolidations. It may, however, also catalyze new maternity care practice models, including collaborative practice between obstetricians, nurse-midwives, and family physicians as well as ACO collaborations across rural and urban sites.^{40,41}

Health and clinical practice implications

Small differences in annual trends between rural and urban hospitals constitute large cumulative effects over time. Our findings have important implications for the adoption of quality improvement programs and clinical management protocols in both rural and urban hospitals. A recent NIH consensus panel issued recommendations for reducing the rate of first-time cesareans.²¹ These recommendations, while not yet universally agreed upon, may be helpful to clinicians and administrators and are clinically valid in both rural and urban hospitals; however, implementation and logistical barriers may delay or prevent adoption of the recommendations in rural settings, which face staffing shortages and resource limitations.^{3,16,17,42}

The goal of any hospital – rural or urban – should be to provide evidence-based care consistently to all maternity care patients. While the means may differ across settings, policy efforts should enable rural and urban hospitals to achieve the same level quality of care. Future research should assess the appropriateness and effectiveness of these and other obstetric care guidelines in both rural and urban settings. Efforts underway to narrow the rural-urban gap in quality of maternity care specifically, and health care generally, should be rigorously evaluated.

Limitations

NIS data do not contain information to distinguish nulliparous women or identify non-indicated procedures performed between 37-39 weeks gestation. Clinical notes and

information on the number of obstetric providers within hospital catchment areas are also unavailable. We construct outcome measures based on ICD-9 codes. Therefore, some diagnoses or procedures (e.g. labor induction) may be under-reported; we do not, however, expect this to differentially affect births in rural and urban hospitals. Our final regression models controlled for individual demographic characteristics, but we also used alternative model specifications, based on **hospital characteristics** and clinical conditions; results were robust to these specifications (See Supplemental Digital Content).

Conclusions

This analysis offers important insight into obstetric care trends in rural and urban hospitals. Rising cesarean rates for low-risk pregnancies and non-indicated cesareans are challenges for both rural and urban hospitals. National trends toward greater use of non-indicated labor induction were especially pronounced in rural hospitals. Maternal and child health promotion policies, including payment reforms for non-indicated interventions and labor management practices, may face different implementation challenges in rural and urban hospitals. These findings provide clinicians, hospital administrators, and policymakers an opportunity to address disparate trends between rural and urban settings and to improve maternity care quality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Note: Predicted probabilities were calculated using coefficients generating using the model presented in Table 3.

Figure 1.

Predicted Probability of Labor Induction For A Low-Risk Woman With Average Characteristics And No Medical Indication For The Procedure (Age 28, White, Private Insurance, No Complications) by Hospital Geographic Location, Over Time (2002-2010).

Note: Predicted probabilities were calculated using coefficients generating using the model presented in Table 3.

Table 1

Maternal Descriptive Statistics for Childbirth Hospitalizations in Rural and Urban Hospitals, 2002 - 2010

	Number of Childbirth-Related Hospitalizations 2002-2010 (%) ^a			
	ALL (n=7,188,972) ^b	RURAL (n=837,772)	URBAN (n=6,316,743)	P Value
DEMOGRAPHICS				
Age Category				
<20	1,018,434 (14.2)	169,366 (20.2)	842,300 (13.3)	P<.001
21-25	1,813,878 (25.2)	273,732 (32.7)	1,529,501 (24.2)	P<.001
26-30	1,977,568 (27.5)	216,462 (25.8)	1,751,672 (27.7)	P<.001
31-35	1,556,359 (21.7)	123,456 (14.7)	1,427,640 (22.6)	P<.001
35+	816,654 (11.4)	54,587 (6.5)	759,720 (12)	P<.001
Race/Ethnicity				
White	2,841,802 (39.5)	392,855 (46.9)	2,433,821 (38.5)	P<.001
Black	727,915 (10.1)	49,684 (5.9)	672,006 (10.6)	P<.001
Hispanic	1,248,800 (17.4)	50,176 (6.0)	1,194,171 (18.9)	P<.001
Other	580,839 (8.1)	44,931 (5.4)	532,932 (8.4)	P<.001
Missing	1,789,616 (24.9)	300,126 (35.8)	1,483,813 (23.5)	P<.001
Primary Payer				
Medicaid	2,928,166 (40.7)	425,967 (50.8)	2,483,937 (39.3)	P<.001
Private Insurance	3,774,089 (52.5)	340,842 (40.7)	3,420,363 (54.1)	P<.001
Self	238,194 (3.3)	26,736 (3.2)	210,050 (3.3)	P<.001
Other	237,559 (3.3)	41,846 (5)	193,959 (3.1)	P<.001
CLINICAL CONDITIONS				
Diabetes	422,205 (5.9)	38,768 (4.6)	381,351 (6)	P<.001
Hypertension	615,460 (8.6)	71,575 (8.5)	540,253 (8.6)	P<.001
Pre-eclampsia/Eclampsia	250,683 (3.5)	27,281 (3.3)	221,895 (3.5)	P<.001
Post dates (>40 wks)	784,838 (10.9)	73,985 (8.8)	707,413 (11.2)	P<.001
Multiple Gestation	95,884 (1.3)	6,927 (0.8)	88,513 (1.4)	P<.001
Placenta Problems	134,025 (1.9)	13,451 (1.6)	119,937 (1.9)	P<.001
Malpresentation	544,806 (7.6)	54,816 (6.5)	487,532 (7.7)	P<.001
Disproportion	373,610 (5.2)	51,970 (6.2)	320,007 (5.1)	P<.001
Prior Cesarean	1,066,758 (14.8)	120,346 (14.4)	940,838 (14.9)	P<.001
Preterm delivery (<37 wks)	542,020 (7.5)	46,603 (5.6)	492,331 (7.8)	P<.001

Note: P-values come from chi-square tests of significance for differences in the distribution of demographic and clinical characteristics between rural and urban settings.

^aPercentages may not total 100 due to rounding.

^b34,457 observations (0.5%) did not have hospital location indicator.

Table 2
Changes Over Time in Obstetric Procedures, 2002-2010, in Rural and Urban Hospitals

	Numerator/Denominator (%)			
	All, 2002-2010 (n=7,188,972)	2002 (n=735,322)	2010 (n=776,191)	% change, 2002-2010
Rural Hospitals (n=837,772)				
Cesarean delivery among low risk women ^a	94,369/631,901 (14.9)	10,245/79,131 (12.9)	10,547/68,254 (15.5)	19.4%
Vaginal birth after cesarean (VBAC)	8,101/120,346 (6.7)	1,689/12,940 (13.1)	726/14,577 (5.0)	-61.8%
Labor induction without indication ^b	63,249/511,658 (12.4)	5,877/63,370 (9.3)	8,880/53,875 (16.5)	77.7%
Cesarean delivery without indication ^c	106,024/649,919 (16.3)	11,583/80,977 (14.3)	11,845/70,274 (16.9)	17.8%
Urban Hospitals (n=6,316,743)				
Cesarean delivery among low risk women ^a	708,248/4,588,462 (15.4)	60,322/473,569 (12.7)	77,031/477,666 (16.1)	26.6%
Vaginal birth after cesarean (VBAC)	105,850/940,838 (11.3)	15,181/80,889 (18.8)	11,107/111,373 (10.0)	-46.9%
Labor induction without indication ^b	405,000/3,502,914 (11.6)	37,362/363,786 (10.3)	42,771/355,168 (12.0)	17.3%
Cesarean delivery without indication ^c	813,017/4,734,953 (17.2)	69,723/486,995 (14.3)	87,674/492,575 (17.8)	24.3%

Note: Numerators are hospitalizations with the corresponding outcome.

Denominators are total hospitalizations among women eligible to experience the outcome (i.e. low risk women, women with prior cesarean deliveries; women without medical indications for induction or cesarean).

Percent change between 2002 and 2009 highlights the time trend for each outcome in rural and urban hospitals.

^a Low risk women refer to women with term, singleton, vertex pregnancies and no prior history of cesarean delivery.

^b Pregnancies without medical indication to hasten delivery.

^c Pregnancies without contraindication to vaginal delivery (i.e., with no medical indication for cesarean delivery).

Table 3

Adjusted Odds Ratios (AOR) of Differences by Rural Status, Annual Time Trends, and Differential Time Trends by Rural for Obstetric Procedures, N=7,188,972

	N ^b	AOR [95% CI] ^a		
		Rural (vs. urban)	Time trend	Differential annual time trend for rural (vs. urban)
Cesarean delivery among low risk women	5,244,898	1.06 [1.04-1.07]	1.04 [1.04-1.04]	0.99 [0.99-0.99]
Vaginal birth after cesarean (VBAC)	1,066,758	0.62 [0.60-0.65]	0.90 [0.90-0.91]	0.96 [0.95-0.97]
Labor induction without medical indication	4,014,572	0.79 [0.78-0.81]	1.04 [1.04-1.04]	1.05 [1.05-1.06]
Cesarean delivery without medical indication	5,384,872	1.03 [1.02-1.05]	1.03 [1.03-1.04]	0.99 [0.99-0.99]

Note: All models use standard errors adjusted for hospital clustering and control for age, race/ethnicity, and primary payer. Results are all statistically significant at P<.05.

^a 95% CI- 95% Confidence Interval.

^b N-total hospitalizations among women eligible to experience the outcome (i.e. low risk women, women with prior cesarean deliveries; women without medical indications for induction or cesarean).